STRENGTH OF SHIPS - ON THE NEUTRAL AXIS LOCATION

Artur Licínio de Albuquerque Ferreira da Silva

DUDLEY KNOX LIBRARY NAVAL POSTGRADUATE SCHOOL MONTERLY, CALLEC INA 92.040 STRENGTH OF SHIPS - ON THE NEUTRAL AXIS LOCATION

by

ARTUR LICÍNIO DE ALBUQUEHQUE FERREIRA DA SILVA Lieutenant, Portuguese Navy

B.S., Portuguese Naval Academy (1969)

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ABSTRACT

This work is an attempt at determining the optimum neutral axis location in the midship section of a vessel, using as a model for the calculations a box girder, subject to several different conditions of sagging and hogging bending moments; several values of design stress are also considered and in the end what happens when lateral hydrostatic load is considered along with different values assigned to the design stress in tension and in compression is also analysed.

Thesis Supervisor: J. Harvey Evans Title: Professor of Naval Architecture



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I want to express my gratitude to Professor Evans for his expert advice and guidance that encouraged me throughout this work.

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LIST OF SYMBOLS

a	-	distance between transverse stiffening members						
AL	-	length of box girder or vessel						
в	-	beam						
BOT	-	thickness of the plating on the bottom						
BM	-	bending moment						
D	-	depth						
DIBOT	-	distance of the bottom from the neutral axis						
DITOP	-	distance of the top from the neutral axis						
DSC	-	design stress in compression						
DST	-	design stress in tension; also design stress without						
		discrimination when DSC=DST						
Н	-	head of sea water (lateral load)						
HB	-	head of sea water on the bottom						
HM	-	hogging bending moment						
HT	-	head of sea water on the top						
I	-	moment of inertia of the cross section with respect						
		to the neutral axis (GMI in the program)						
LBS	-	longitudinal bending stress						
S	-	spacing of longitudinal stiffening members						
SBCRIT	-	critical stress on bottom						
SBH	-	stress on bottom due to hogging						
SBS	-	stress on bottom due to sagging						
SM	-	sagging bending moment						
STCRIT	-	critical stress on top						
STH	-	stress on top due to hogging						
STR	_	stress						



STR1	- primary stress = LBS
STR2	- secondary stress
STR3	- tertiary stress
STR 3B	- tertiary stress on bottom
STR3T	- tertiary stress on top
STRCR	- critical stress
STS	- stress on top due to sagging
t	- thickness of theplate
Т	- draft
TOP	- thickness of the plating on the top
TS	- thickness of the side plating
TSTH	- total stress on top in hogging
TSTS	- total stress on top in sagging
TSBH	- total stress on bottom in hogging
TSBS	- total stress on bottom in sagging

INTRODUCTION

It is frequently found in the literature related with the strenght of ships such statements as:

"In general the neutral axis is expected to be at 40% of the depth (D) above the base line ... a preliminary estimate of the thickness required for the bottom plating (BOT) can be obtained from

$$1.875(\frac{0.4D}{0.6D})2240 \quad \sqrt[3]{AL} = \frac{40300}{1.75} \\ 1 + \frac{1}{950}(\frac{S}{BOT})$$

where the Montgomerie's expression is being considered to determine the critical stress (SBCRIT psi) and the short edges are assumed far apart and simply supported.



a- distance between transverse stiffening members (inches)1.875 accounts for a factor of safety

Tobin's expression was considered in the above formula to give the maximum permissible bending stress (LBS, psi)

LBS= 2240
$$\sqrt[3]{AL}$$



We see thus that this procedure allows for an estimate of the bottom thickness to be obtained after knowing the length and assuming a longitudinal frame spacing. What may be questioned here is the reason why one assumes the neutral axis 0.4D above the base line and also the reasons behind the choice of a frame spacing.

In the following a procedure to estimate the scantlings of longitudinal members is described; this procedure can also be found frequently in the literature dealing with the subject.

... "For a particular set of principal dimensions , general arrangement and frame spacing, plate panel thicknesses for one after another of the amidships longitudinally continuous elements are selected for an assumed position of the neutral axis at 40% of the depth above the keel. The composite midship section assemblage is then tested for the adequacy of its section modulus when ranged alongside some standard value, such as given by the Load Line Regulations or some function of it. Thus the modulus is judged sufficient to limit ship bending stresses to the value previously set and incorporated into the design equations.

For all but the deepest ships the modulus will undoubtedly need to be increased and a small arbitrary increment is added to the upper deck or bottom whichever happens still to be farther from the true neutral axis location found after the first design cycle. The shift of neutral axis resulting from the scantling increment requires a compensating increment in the opposite flan-

ge with the obvious outcome that the neutral axis is shifted in reverse with attendant effect on the scantling chosen first; a cyclic process is then begun. More trials will be necessary before the match of available to required section modulus is achieved."

From this transcript, we may again note the initial statement "...for a particular set of principal dimensions, general arrangement and frame spacing..." and question whether or not the frame spacing should be chosen as an input or rather be left as a variable and be obtained as a result of a structural design procedure. It is here aknowledged though that in these procedures an acceptable solution can be worked out and each new cycle is an improvement over the precedent ones. What may be questionable though is whether the first cycle, due to the assumptions made at its beginning, has or not a strong influence in the outcome leading to a solution among the various possible ones which in the end does not lead to"the optimum design" whatever its definition may be.

It seems that this trial procedure can be looked at as a "weakness" of the structural design procedure for the determination of scantlings and it is perhaps reasonable to make some effort in order to work out a process that could give the scantlings in a direct manner and be at the same time in agreement with what can be considered "the optimum design", (usually based on economic considerations).

Nowadays much concern is given to economics in ship design and naturally the strength calculations of a ship are also made with economical optimization in mind. With this respect, we can realize that in ships structures there is a desirability to minimize structural weight and some define structural efficiency as being the least weight structure capable of resisting the loads for which they are designed.

It should be clear that the cost of construction and of maintenance and repair are inter related factors together with least weight, to be considered when bringing economics into ship structural design. Also other matters such as accessibility, weldability and availability of material must be considered as well.

In the following sections an attempt is made to obtain without any interactions the scantlings for the plating of a box girder. It is hoped that through this simple model some helpful conclusions can be made in view of their application to a vessel's structure. Each of the different situations analized will be exhaustively explained in the following sections.

PRELIMINARY CALCULATIONS

The model used in this section and also throughout this work with only very small additional considerations is a box girder which cross section is pictured in figure 1.



As will be seen in the calculations of the following sections, the dimensional parameters used are of the order of

magnitude of those considered in ship design.

This model was chosen due to its simplicity for the performance of the following calculations as can be understood immediately from its geometrically symmetrical cross section.

The objective of this section is to determine the necessary formulation to be used in future sections.

The formulation dealt with in this section is related only to the particular model chosen and the geometry of its cross section.



preservation per re-		Constant or Designed		-,
$\begin{bmatrix} b \\ H \\ I=b^{*}H \\ 2 \\ (in^{*}ft)^{2} \end{bmatrix}$	1	2*TS*(D/12) ³	I	∑ 1=
HEIGHT OF MEMBER H(ft)	I	D/12	I	
WIDTH of member b(in)	д	2*TS	م	
A*d*d (in*ft)	B*TOP*(D/12)	TS*D*\$\$/12)/12	I	Σ (A*d*d)= + ΣI= IBOT= IBOT=
A*d 2 (in*ft)	B*T0P*D/12	TS*D*D/12	I	$\Sigma(\mathbf{A} * \mathbf{d}) = -\Sigma_{\mathbf{A} * (1)}$
DISTANCE TO BOTTOM (ft)	D/12	D/(2*12)	I	
AREA A (in)	, B*TOP	2*TS*D	B*BOT	Σ A=
SCANTLINGS inches (in)	B*TOP	2*TS*D	B*B0T	
MEMBER	TOP	SIDE	BOTTOM	



DIBOT =
$$\frac{\Sigma(A^{*d})}{\Sigma A}$$
 *12
DIBOT ! = $\frac{\Sigma(A^{*d})}{\Sigma A}$

∠ A=B*TOP+2*TS*D+B*BOT=2*D*TS+B*(TOP+BOT)

DIBOT =Neutral axis location above bottom (in) DIBOT'= " " " " (ft) ^IBOT =Moment of inertia with respect to the bottom I = " " " " " " neutral axis

∑(A*d)=(D/12)*(B*TOP+D*TS)

 $I = \Sigma (A * d * d) + \Sigma I - (\Sigma (A * d))^2 / (\Sigma A)$

DIBOT=D*(B*TOP+D*TS)/(2*D*TS+B*(TOP+BOT)) This formula will give DIBOT in inches if D and B are expressed in inches; it will give DIBOT in feet in the event that D and B are expressed in feet.

DITOP=D-DIBOT DITOP=D*(B*BOT+D*TS) (2*D*TS+B(TOP+BOT))

DITOP in units of inches or feet as explained for DIBOT

The following formula will give I in units of $(in*ft)^2$ for B and D given in inches.

$$I = \frac{(D/12)^{2} * (3*B*B*TOP*BOT+(D*TS)^{2}+2*B*D*TS*(TOP+BOT))}{3*(2*D*TS+B*(TOP+BOT))}$$

Next formula gives I in units of $(in*ft)^2$ for B and D given in feet.

These expressions will be used in most of the following sections with B and D expressed in feet.

NOTE: TS which is defined as the thickness of the side plating is considered throughout this work to be uniform and will always be equal to the larger of the thicknesses obtained for the top and for the bottom plating.

FORMULAS USED IN THE ANALYSIS

BEAM EQUATION

Assuming pure bending, the stresses in the cross section of the box girder are given by



where y is the distance from the neutral axis to the point where the stress is being determined.

The neutral surface indicated in fig. 2 is composed of all the points which are not subjected to any stress in pure bending.

BRYAN EQUATION - Plate under inplane load



When a/S>2 then K=4

STRCR given in psi for t andS expressed in inches and E in psi.

N=3.1416



PLATE UNDER LATERAL LOAD

The stresses are more severe at points A and B but we are particularly interested in the stresses at point B because there they will combine with the stresses resulting from bending also called primary stresses.

Note that for a panel under lateral load, the direction of the stresses is, at the edges, perpendicular to them, so at B they are directed "longitudinally".

For a/S>2 we have K=0.685

Replacing all the numbers in the above formula, we obtain STR3=0.152222*H* $\left(\frac{S}{t}\right)^2$


The following stress definitions and figures 3 and 4 will help understanding the reasons behind the calculations made in many of the following sections.

STRESS DEFINITIONS

STR1 - SHIP BENDING STRESS or PRIMARY STRESS

Since this stress is directly proportional to distance from the ship's neutral axis, it is substantially constant at any point on the cross section of the bottom or top plating when the vessel is in an upright attitude. For distinction, this stress may be termed a primary stress or an area stress in this location and under such a condition. While the longitudinal direction is implied in the foregoing comments, they are equally applicable transversely.

STR2 - GIRDER BENDING STRESS or SECONDARY STRESS

Girder bending stress arises from the reaction of a plating stiffener combination to a loading normal to the plating such as may be due to water pressure. Following the usual concept, the plating acts as one flange of the composite girder and so is stressed. Due to shear lag, this secondary stress in the plating is a maximum in way of the stiffener and diminishes with distance from it.

For the previous case of bottom plating and vessel upright, the transverse variation of fore and aft stress will be sensibly constant for some distance from the stiffener but will vary significantly through the plating thickness as the plate thickness is a substantial part of the distance to the neutral axis



of the plate stiffener combination. For convenience such a stress may be termed a line stress although for a wide spacing of stiffeners with consequently greater deviation from uniform distribution some inaccuracy of concept is introduced by using this term.

For girders continuous over several supports, such as transverse bulkheads, maximum bending moments occur at the supports and will readily be in the order of twice the field moment.

STR3 - PLATE BENDING STRESS - TERTIARY STRESS

Proceeding in turn to ever more elemental portions of the ship's structure concludes with the simple plate panel supported on its four edges. In such a plate under lateral or normal loads, bending stresses are created which are variable from point to point on the panel and through its thickness with maxima occurring at one or the other surface. Since any such stress is effective at a point only, it may be called a point stress or tertiary stress.

Each elemental panel of ship's plating is generally one of a repeating pattern. Quite appart from any rotational restraint provided by the panel supports consisting of floors, frames, longitudinals, etc., there is the restraint afforded by the continuity of the plating and its loading. For pratical purposes then, a condition of edge clamping exists with maximum stresses being found at the midlength of the longer panel edges and secondary maxima at the midlength of the shorter edges. In both cases these stresses are normal to their respective edges.



BENDING STRESSES IN SHIPS





From the previous definitions and figure 3 we may summarize in figure 4 the effect of STR1, STR2 and STR3.



Fig. 4

At point A STR2 is larger than at point B STR2 is acting in the longitudinal direction STR3 is larger than at point B STR3 is acting in the transverse direction STR1 and STR2 are here combined acting both in the longitudinal direction

At point B STR2 may be acting in the tansverse direction STR3 is acting in the longitudinal direction STR1 and STR3 are here combined acting both in the longitudinal direction.



Usually STR2 is attributed a constant value and can be taken into account by automatically decreasing the design stress by the value assigned to STR2.

THE BENDING MOMENT EQUATION

The bending moment equation used is derived from

 $BM = \Delta *AL/35 \quad ton*ft$ knowing that $\Delta = \nabla/35 \quad ton$ and that $\nabla = B*T*AL*C_{b}$ and using $C_{b} = 0.75$ we obtain $BM = \frac{0.75}{35*35} *B*T*AL*AL \quad ton*ft$ where AL = is the length in ft B = is the beam in ft T = is the draft in ft $C_{b} = is the block coefficient$

or multiplying by 2240 we obtain

BM = 1.37143*B*T*AL*AL lb*ft

Note:

abla is the displacement volume and Δ is the corresponding displacement weight.



MOMENT ACTING IN ONE DIRECTION

NO RESTRICTION IMPOSED ON THE COMPRESSION STRESS

Considering the box girder subjected to a bending moment acting in hogging BM, we will observe as a consequence that the top will be subjected to tension and the bottom to compression. These stresses are given by the already introduced formula

or in this case, being interested on the top and bottom, $STH = \frac{BM*DIBTOP}{I}$ $SBH = \frac{BM*DIBOT}{I}$

In this introductory study it was decided not to limit the value of the stress in compression. Only the value of the stress in tension, here STH will be requested to be equal to the value chosen for the design stress in tension (or smaller).

SBH will be a consequence of the value of DST and also of the S value chosen.

So, we will basically have 3 equations DST = STH TOP Bending equation S + SBH + BOT Bending equation + Bryan formula







The three equations that can be obtained will allow one to determine the three unknowns which are BOT, SBH, TOP.

By replacing in the equations already mentioned the expressions derived previously for DIBOT, DITOP and I and solving for BOT, TOP and SBH we obtain after a lengthy but simple process the equations in their final format as we will see.

Note here that in order to solve the three equations, the thickness of the side plates TS was made equal to the larger TOP or BOT; since TOP and BOT were not known and had to be determined after deciding on TS, the equations had to be solved twice. First the equations are solved assuming that TOP>BOT this simply implying that the neutral axis is going to be chosen already closer to the top and TS = TOP. Second, the equations are solved assuming BOT>TOP thus making TS = BOT.

As will be seen, only one solution is possible, the other being rejected by giving a result that does not agreee with the

we will obtain, by assuming first TOP> BOT

$$A = \frac{9*B*B*D}{140*BM}$$

$$C = \frac{3*B*D*D}{70*BM}$$

$$F = \frac{3*D*D*D}{140*BM}$$

Making

$$\frac{\text{DST}}{\text{SBH}} = \frac{\text{B*BOT+D*TS}}{\text{B*TOP+D*TS}}$$

BOT =
$$\sqrt{G} \sqrt{SBH}$$

G = 0.30396* $\frac{(S)^{2}*(1-(POI)^{2})}{F}$

$$BM (ton*It)$$

$$I (in*ft)^{2}$$

$$DST \geqslant STH = \frac{560*BM*(B*BOT+D*TS)}{D*(3*B*B*TOP*BOT+2*B*D*TS*(TOP+BOT)=(D*TS)^{2})}$$

$$SBH = \frac{560*BM*(B*TOP+D*TS)}{Same denominator}$$

assumption just mentioned.

DM (Landor)

TOP, BOT, S (inches)

DST, STH, SBH, E (psi)

B, D, DITOP, DIBOT, AL (ft)



$$DIBOT = \frac{D^*(B+D)*TOP}{(2*D+B)*TOP+B*BOT}$$

$$DITOP = \frac{D^*(B*BOT+D*TOP)}{Same \ denominator}$$

$$I = 4*D*D*\frac{(2*B*D+D*D)*TOP*TOP+(2*B*D+3*B*B)*TOP*BOT}{Same \ denominator}$$

$$TOP = \frac{B^*(BOT)^3}{(B+D)*G*DST-D*(BOT)^2}$$

$$BOT = \frac{TOP^*(12*D-(C+F)*DST*TOP)}{DST*(A+C)*TOP-12*B}$$

Before going to the equations obtained when BOT > TOPis assumed, we call the attention of the reader to the fact that the values of BOT and TOP have to be obtained from the two above equations. Substitution of one into the other would result in an equation of degree higher than at least 5th degree, unsuitable for direct solution. As will be later exemplified, the solution is here obtained by assigning values to either one of BOT and TOP and through the two equations, we obtain the respective values for TOP and BOT. The ploting of these values BOT vs TOP will give one line for each of the two equations. The intersection of the two lines thus obtained allows the solution to be read from the plot.

This solution will be acceptable if the intersection lies in the sector TOP> BOT otherwise the intersection must be rejected.

Assuming now BOT > TOP we make TS = BOT and obtain:

$$DIBOT = \frac{D^* (B^*TOP + D^*BOT)}{(2^*D + B)^*BOT + B^*TOP}$$

$$DITOP = \frac{D^* (B + D)^*BOT}{Same \ denominator}$$

$$I = 4^*D^*D^* \frac{(2^*B^*D + D^*D)^* (BOT)^2 + (2^*B^*D + 3^*B^*B)^*TOP^*BOT}{Same \ denominator}$$

$$TOP = \frac{(B + D)^* (BOT)^3 - D^*G^*DST^*BOT}{B^*G^*DST}$$

$$BOT = \frac{12^* (B + D) - (A + C)^*DST^*TOP}{(C + F)^*DST}$$

In this form the equations can be used in a very simple computer program that will give the set of values TOP vs BOT suitable for ploting. At this stage we are hoping that if the intersection obtained in the situation where we assumed TOP> BOT is acceptable, the two lines resulting from the case BOT> TOP will not intersect or if they do that the intersection must be rejected due to the fact that they will violate the assumption from which they were derived

As can be observed from the several cases run in the computer, the case where two acceptable solutions exist never happened and it can only happen if TOP = BOT where then both solutions are acceptable and coincide as in the case of one of the following runs.

In the following pages the computer printouts are included. The first run is explained in detail to make the interested reader familiar with the problems encountered in determining the intersections and the respective thicknesses.



The other runs are here presented as well to serve as proof that a simple solution can always be obtained and also to give an idea of the range of thicknesses expected in each case.

In all runs only a bending moment acting in hogging was considered.

The program used is a direct application of the equations here derived to a particular set of values chosen as the input. From the results obtained, some conclusions were drawn that allowed for the improvements made in following sections.

No further explanation on the program shall here be given because it is self explanatory in the comment statements included.



```
*AL* IS THE LENGHT
27:4
        C
2164
              AL=502.
2120
              P=4L/8.
              +DRA+ IS THE DRAFT
118
        С
              D=A=8/3+
113
2.24
              D=11/9.
              *POI* IS THE POISSON'S RATIO OF THE MATERIAL
2:30
1.2.1
        C
              FOR STEEL
              PO1=2.3
1.3.1
2:35
        С
              * THE YOUNG'S MODULUS OF THE MATERIAL
        С
3.35
              FOR STEEL
2737
              ==37 + ×17 + ×6
        0
              *DST* IS THE DESIGN STRESS
2-40
1140
              - 3T=2V072+
2754
              FEV IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
        С
7 22
              3=1 ? .
· = C
              . BM* IS THE RENDING MOMENT
----
              RY=(8×0RA×AL+AL*2+75)/(85+×35+)
5-18
              >= 7 • 3/396*S*S*(1 • +POI*POI)/E
- ---
              A===+=+=+=/(142++=M)
2000
              (MEX+5+0+0/(78+MBM)
1 . ...
              == ++ D+ ++ D/(14. +++ +)
1120
              THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
        Ω.
2.20
              ARTIE(5,12)
           17 FORMAT(111,20X, TOP ASS MED LARGER THAN BOTTOMI)
1:47
1. 6.
        C
              *TOP* IS THE THICKNESS OF THE TOP PLATING
2165
               POOTY IS THE THICKNESS OF THE BOTTOM PLATING
        Ç
** 62
              30T1=2+1
           11 TCP1=P+R0T1+R0T1+BCT1/((B+D)*G*DST+D*B0T1*B0T1)
2.75
2.00
               RITE(5,20)TCP1, ROT1
2.20
           20 FORMAT(! ',25X, 'TOP(=)FO.4,5X, 'EOT(=)F9.4)
1211 3
              -CT1=BQ71+2.225
1216
              ·= (POT1 ·GT · 0.2) GO TO 32
2223
              30 TO 11
2230
           31 TOP2=1.1
1234
           31 PTTP=TOP2*(12**D+(C+F)*DST*TOP2)/(DST*(A+C)*TOP2+12**B)
774.7
              NRITE(5,40)TOP2,9072
775.4
           40 FORMAT(1 1,25%, TOP2=1F0.4,5%, 180T2=1F9.4)
2-00
              T0P2=T0P2=1 . /5
~252
              ·F(TOPP+6T+1+)60 TO 50
PPEA
              AD TO 21
2255
           EC PONTINI,E
2755
        C
              THICKNESS OF BOTTOM ASSUMED LARGER THAN TOP
22FE
              NRT F(5,60)
2712
           60 PORMAT('1', 20X, 'BOTTOM ASSUMED LARGER THAN TOP')
2340
              a073=7.1
2348
           61 TCP3=((B+D)*FOT3*POT3*BCT3*D*G*DST*BOT3)/(B*G*DST)
2794
              WRITE(5,7%)TOP3, POTA
RAES
           70 FORMAT(1 1,25X, 1TOPA=1F9.4,5X, 180T3=1F9.4)
835S
              BOT3=BOT3+4+25
2350
              TF(80T3.GT.1.)G0 TO 80
33F=
              GO TO 61
```

6465		80	TOP4=(2 • 1					_					
840A		81	$POT^{4}=(12 \cdot * (R+D) - (A+C) * DST * TOP 4) / ((C+F) * DST)$											
844E			WRITE	(5,90)1	CP4,BCT4									
8472		96	FORMAT(! ',25X, 'TOP4='F9+4,5X, 'BOT4='F9+4)											
:49A			T()04=	TOP4+I*•	·	_								
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2658			60 TO	81										
0-8C	1	60	CONTI	NUE										
0845			ドンワ											
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EVEVE	FOI		-4ER[1	VJ E	8670	[5]	• R	0	4F8[V]	DS-	Г	0500 (V)	S	
14 EV3	BM		0518C	V] G	8524	[V]	А	0	52C(V)	С		2534[V]	F	
4 " (L)	12		086620	SI @I	0538	[V]	BOT1	Ø	176(L)	11		8540 [V]	TOP1	
52(F)	2.2		~55C []	L] 3N	0554	[V]	TOP2	01	234 (L)	31		0558 (V)	80T2	
34 [2]	49		72FF[]	L1 57	0312	5L0	67	0	56CtVj	BO	3	03485L]	61	
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Sacas														
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2605	ALUG		CAA4	• RARG	2402	• 5		2166	AEXP		2800	• ERCNI	CAUD	きろ
1200	• 0		CROF	• ()	3036									
NTRY-F	PINTS	:												
2550	• R		275C	• Δ	2605	ALO	G	27E6	AEXP		27E6	EXP	296C	1 I A
2905	• W		2430	• COMP	5465	\$6		2444	• RARG		SAD6	\$8	282Ø	• 5
2524	·ZERC		2868	• ERCNT	2824	• 0		5860	• MES		SBEA	٠U	2010	• V
2014	θI													
04401-	RIDER	c •												
ONE		J •												
NDEFIN	ED SI	BRC	UTINES	s:										
ONE	00		0.2.000											
	•													
RAVISE	R ACD	RES	5= 2071	8										
ECUTIO	N BEG	INS	5:											

PAGE 2

OP	ASSUMED	LARGER THAN	BOTTOM		
	TOP1=	0.0385	BOT1=	0 • 1 0 0 0	
	TOP1=	0.0462	BOT1=	8.1250	
	TOP1=	0.0553	BOT1=	0.1100	
	TOP1=	7 • 2659	BOT1=	0.1150	
	TOP1=	8 • 2784	8071=	0.1200	
	TOP1=	2.6933	8071=	0.1250	
	ICP:=	0.1109	8071=	0-1300	T
	TOP1=	ؕ1321	BOT1=	2.1352	
	10P1=	0.1576	8071=	0.1400	
	<u> 같이면 1 = -</u>	8.1889	8071=	0 • 1 4 5 0	
	10P1=	2.5226	50 [*] 1=	2.1500	
	1021=	ؕ2763	BC11=	8.1550	
	10P1=	ؕ3392	80 T 1 =	0.1600	
		0.4225	BC 1 =	Ø • 1450	
	10P1=	2.5374	90 71 =	7•177C	
	1081=	8.7843	8011=	e•1750	1
	IOP1=	2.9669	8071=	0.1800	
	10P1=	1+4359	BCT1=	0.1250	
	<u>10°1</u> =	2.5207	90T1=	0.1300	
	TOP1=	7 • 1867	5071=	2•1950	
	<u> </u>	11 • 9527	BCT1=	Q • 50 4 Q	
	_0_5=	ମ • 1 ଜଣ୍ଡ	80-5=	- Ø• <u>1</u> 738	
	TOPS=	0.1500	8015=	=2 • • 758	
	TOP2=	V • 2920	80TS=	=%•5×%8	
	TOPS=	0.2500	B072=	-2-4765	
	IO55=	8.3000	B072=	-1 • 1361	-
		8.3528	3072=	2•8493	T
	IOPS=	2.4200	90T2=	0.5282	
	T0P2=	0.4520	B015=	0.5563	
	T0P2=	ؕ5008	8072=	2 • 4925	
	INP2=	0.5500	B0T2=	0.0287	4
	10P2=	2.6220	B072=	= ؕ0534	
	1022=	0.6500	8072=	=8 • 1244	
	10P2=	2.7223	80-5=	-2.1487	
	1025=	0.7500	8072=	=ؕ1888	
	+0P2=	8.8288	8015=	-0.5560	
	1055=	0.8500	8072≃	-0.5615	
	10P2=	2.9000	BCIS=	-2.2950	
	10P2=	0.9500	8072=	-2-3276	
	_055=	1.0000	B015=	=Ø·3593	

T

	DOTT	OM ACCI		THAN TOD			33
	DUTT	TOPA-	PED LARGER	HAN TUP	0 . 0.00	H	
		Topos	V • 7 1 3 5		N•1000		
		TOPOE	V • C 1 C +	BU13=	N•1500	Ц	
		TOPOE	1,0703	5013= BOT2-	VI • 27 VIV)		
		TOPDE	1.3783	B() 3=	2.0000		
		TOPor	F • 4 9 9 0	8013F	7.3700		
		TOPOE	4.0007		7.3400		
		TOPOL	8 00/1	50°3=	0.47.00		
		Topo-	12.5506	50 3F	V • 4580		
		Topor	14.55000	DU-0=	0.5666		
		TOPSE	21.5020	50 3m	0.000		
		ToPo=	27.5527	B073-	0.6200		
		TOPOE	24.5121	90 34 BOT3-	0.5000		
		Topo-	57 · DICI	DOT2=	2.7780		
		TOPSE	46+24/9	50 3= F072-	V • 7500		
		TOPAL	CO 1507	50 3=	2.3770		
		- U137 - TARA-	02+1007 70 9701	80135	8 • <u>85</u> 8 0		
		Topol	/3•0/31	50°3≓ Do ⊼O	0.9000		
			101 5454	BC (3=	0.9500		
		TOD: -	141+5434	원U 3부	1.0720	IT	
		TODI -	V • 1000	80'4= 00Th	2.0961		
		700/-	V • 1570	원인 ' 4 =	2 • 9031		
		1094= Topis	N 2700	5014= 0074	0.8161		
		TOPLE	V • 25 V 9	90 4 = Do 7 4	· · 71/0		
		TOPLE	7 • 32V V	50 A=	V • 6240		
		Top	N • 3DNN	8014=	0.5310		
		10245 Topus	2.4000	8014=	2.4379		
		- 1084 = - Top	(* + 4590 C + 690	명인 '4 =	8.•3449	Ц	
		ToD	7 • 5720	8014=	0 • 2519		
		1054 <u>5</u> Topis	7.5590	80-4=	Q•1589		
		ToP4=	7.6070	8014=	2.0458		
		· · · · · · · · · · · · · · · · · · ·	2 • 6578	BC 4=	-0.0515		
		1094=	8.7290	BC 4=	-8 • 1202		
		Top	9 • 7580 9 • 7580	8014=	-0.5133		
		10P4= Tup:	2 • 8 2 7 9	80-4=	• <i>7</i> •3 63		
		1084= Top:	2.7520	B014=	-0.2093		
		7084= Top.	2.9287	8014=	-2+4923		
		1024= ToD	V • 9520	8014=	•0.5=54		
r-HO		1384=	1.1220	80-4=	- 2•6784		
END							
CE VIC	OPERATING SYSTEM	1 VEPSI	ON 1 REVISI	ON 012	03/04/74	GENERATED	35/06/74 6
JU8 -	ANDLING CHARGE	\$.35	/ JOB	• 35			
1/5 L	INES PRIVIED PR2	\$ 1.25	/ K LN	•55			
67 C	ARDS READ	\$ 1.57	/ K CD	•10			
KØ D	LOTTER VECTORS	3 .25	/ 1777	• 8 8			
15 0	UDEL 70 SECONDS	\$25.27	/ HOUR	• 1 0			
68 r	UDEL 80 SECONDS	\$12.57	N HOUR	• 92			
		TOTAL	CHARGE \$	•77			

RREIR 490 14731 LOGGED OUT (5/06/74 15:14. \$ 14.10 LEFT AFTER 17 LOGINS.





From these lists of thickness values printed by the computer, we can see that the acceptable ones are those marked with a sign. Plotting these corresponding pairs of values properly, as is next exemplified, allows for one to read from the intersection of the two lines, which falls within the range set by the assumption that originated it, the values of thicknesses at the top and at the bottom which satisfy the model we started with.




We can see that the thickness values are easily read from the intersection obtained and they are acceptable because they fall within the range assumed to derive the formulas that originated them namely TOP> BOT.

Next will be plotted the case BOT>TOP and as can be seen, again an intersection is obtained which in this case is not acceptable because it occurs within the range TOP>BOT contrary to the assumed BOT>TOP that originated it.

With a little more experience, this can be seen immediatly from the computer printouts, thus avoiding loss of time doing a plot that will lead to a nonacceptable result.



.



Now having obtained the values for the thicknesses from the plots, we verify them through the use of the next program based on the formulation previously derived. As can be noted, we obtain an acceptable value for the stress at the top (since we are considering a hogging bending moment) which we said before in the derivation of the equations should not exceed the design stress in tension. In this case the design stress was DST=20000 psi and we see that the stress at the top STH=20037.5 the 37.5 coming possibly from inaccuracy when reading the thicknesses from the plot, and computer roundoffs.

Note that the stress at the bottom, since there was no limit placed on it except the Bryan formula to resist buckling caused by compressive inplane loading, is attaining a too large value which is unacceptable and unrealistic. Here again there should be no difference between SBH and SBCRIT and the difference that can be noted is also due to inaccuracy in reading the thicknesses from the plot and computer round-offs.

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ALA IS THE LENGAL
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 6 .14
                                            11=500.1.
 6 . 4
 4º 40
                                            F=V1 /2.
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 6 15
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 8 26
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       3
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                                            FUR CTEFF
 8:3
                                            P01=1 + 7
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      35
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 63.
                                            ECR STREE
                         r^{*}
 1 3.
                                            c==, + + 1 + a + F
                                            FOT . IN THE DESIGN STRESS
 6 45
 6 45
                                            ISTER 1
                                            SA IN THE SPACE S OF LEGITIDIMAL STIFFELING LEMBERS
 1 54
     26
 0
                                            c = 1
 6 -0
                                            A TEA TO THE THE THE
                                                                                                             - NY EMT
     15
                                           F^{\mathcal{M}} = \left( - \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right) + \frac{1}{2} \left( \frac{1}{2} \right) + \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right) + \frac{1}{2} \left( 
 8
 6 - -
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                                            ALLA IS THE THEORE & THE THE THE PLATING
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 6 E -
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 8:40
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                                           FORMAT( 1,81x, 1974=151 .3)
 8.74
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 8: : A
                                            · CENN IN THE STRESS ON SOT DUE TO SOCIEGING
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 8'66
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                                  0. = CEPAI(1 1, 200, 15 (4=101".2)
 6152
                                            *SECULT: IN THE CRITICAL STRESS (N KOT
 CIFC
 6:20
                                           SPICIT = - T + AT /'.
 2225
                                            WRITE(C+11 )SACHTE
 8224
                               110 FIRMAT(1 1,17V, 1030FIT=1F10+3)
 8244
                                           P#P+= + F > F + B+ (T + F + F - T)
                                            PITCHA IS THE LISTA AND THE TOP FROM THE NEUTRAL AXIS
 8260
 6261
                                           NITCHE * (H*HAT+T*THD)/F
 6220
                                            .RITE (DI W) . ITCS
 8248
                                 A=C4
                                            DIFCI- IS THE INTAGE OF THE BOILTOM FROM THE NEUTRAL AXIS
                        C
 11204
                                           NIF(T=1+( »T(D+ »T(P))F
 4:= E S
                                           VHITE (FAM ) STOCT
                                  F F C F M AT ( 1 , 1 A > , 1 T I A T = 1 F 1 7 + 4 )
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365 [V] ....
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R-EIP 407 11731 180080 017 15/74/74 15:43. $ 11.79 LEFT AFTER
                                                                    : M LOGINS.
```

SUMMARY FOR THE PRECEDING CASE

Length	=	500 ft
Beam	=	AL/8
Draft	=	в/3
Depth	=	AL/9
DST	=	20000 psi
S	=	10 inches
Material	-	STEEL
TOP	=	0.468 inches
ВОТ	=	0.166 inches
STH	=	20037.45
SBH	=	30434.89
SBCRIT	=	29886.80
DITOP	=	22.06 ft
DIBOT	=	33.50 ft

We can already notice here that the stress in the bottom is attaining a too large value due to the fact that, since no limit was imposed on it, it is dependent only on the chosen value for S and the respective capacity to resist buckling provided by S and BOT while at the same time stressing the top plate to its maximum allowed DST.

In the following two cases only the spacing S between the longitudinal stiffening members will be allowed to change and the results obtained are simply stated as previously exemplified and were determined in a similar way.

From the results obtained we can note the effect caused by the change of S.

```
2224
              *AL* IS THE LENGHT
       С
              AL=522.
2:24
              9=AL/8.
032C
              *DRA* IS THE DRAFT
       С
2-18
              DRA=8/3.
2/18
              D=AL/9.
2:24
              *POI* IS THE POISSON'S RATIO OF THE MATERIAL
       С
2:32
       C
             FOR STEEL
13.
              P01=C . 3
37
              .E. IS THE YOUNG'S MODULUS OF THE MATERIAL
       C
- 33
       C
             FOR STEEL
213R
132
              *DST# IS THE DESIGN STRESS
2-45
245
              +57#2: NY:2+
       C
              *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
-54
2-54
              3=>%.
              #BM# IS THE RENDING MOMENT
1.50
2750
              ·M=(B×DRA×AL×AL×8・75)/(35・×35・)
2789
              G=0.30394*S*S*(1.-POI*POI)/E
-24
              A=9.*B+5*D/(142.*K5M)
100
              =====D=D=D/(14/+*PM)
212 -
2120
             THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
       0
1120
             WRITE(5,17)
2 . 617
          10 FORMAT('1',25X,'TOP ASSUMED LARGER THAN BOTTOM')
1.6=
              -TOP* IS THE THICKNESS OF THE TOP PLATING
       С
7. 45
              #20T* IS THE THICKNESS OF THE BOTTOM PLATING
       \hat{\phantom{a}}
2.55
              QCT1=0-1
2.75
          11 TOP1=RMEOT1*ROT1*ROT1/((3+D)*G*DST=D*BOT1*BOT1)
---
              97TE(5,20)TOP1,80T1
2:50
          20 FORMAT(1 1,25X, TOP1=1F9+4,5X, 190T1=1F9+4)
7723
              BCT1=80T1+2+25
2215
              TE(BOT1+GT+1+)GO TO 30
7729
              GO TO 11
2255
          30 TOP2=0.1
7234
          31 POT2=TOP2*(12+*D+(C+F)*OST*TOP2)/(DST*(A+C)*TOP2=12+*B)
2200
              WRITE(5,40) TOP2, HOT2
          40 = ORMAT(1 1,25X, 1TOP2=1F9.4,5X, 1B0T2=1F9.4)
7224
2225
              T0P2=T0P2+0+25
22ER
              TF(TOP2+GT+1+)G0 T0 50
SSEE
              GO TO 31
22FF
          50 -ONTINUE
SSEE
       С
              THICKNESS OF BOTTOM ASSUMED LARGER THAN TOP
335F
              WRITE(5,60)
2312
          60 FORMAT('1',25%,'BOTTOM ASSUMED LARGER THAN TOP')
8455
              BCT3=0.1
2348
          61 TCP3=((E+D)*POT3*POT3*BOT3*D*G*DST*BOT3)/(B*G*DST)
2394
              WRITE(5,70) TOP3, BOT3
2388
           70 FORMAT(' ', 25X, 'TOP3=+F9+4, 5X, 'BOT3=+F9+4)
83E8
              ROT3=BOT3+, +25
7355
              TE(BOT3+GT+1.)GO TO 82
335F
              GO TO 61
```



0402 0402 044E 044E 0472 049A		80 81 90	TOP4=0 ROT4=0 RTTE0 FORMAT	0+1 (12+*((5,90) r(' ', roP4+?	R+D) TOP4 25X; +75	-(A+C ,BOT4 !TOP4) ≠DS == †F <	5T×TOF 9•495)	°4)∕ <,'₿	((от	C+F)*[4=1F9;	ST)				
2486 2488 2480 2480 2480 2480 2480	• U	100	IF (TOP GO TO CONTIN END 04CPEV	94•GT• 81 NUE ∕J AL	1.)6	0 то 04С8	100	В		Ø4	DØ (V)	DRA		04D8(V)	D	
E? (V) 24 (V) 47 (L) E2 (L) B4 (L) 6° (V) 7° (V) ×EQ OF	POI BM 12 22 42 TOP3 BCT4	L	04E8EV 0518EV 0000E3 0220EL 0255EL 0358EL 0472EL	/] E /] G [] 90 [] 50 [] 50 [] 50 [] 92		0000 0524 0538 255 231 231 2402 7490	(S) (V) (V) (L) (L) (L)	• F A BCT1 TCP2 62 82 120		04 05 02 05 05 05 02	F8[V] 2C(V) 76(L) 34(L) 64(V) 6C(V) 20(S)	DST C 11 31 BOT TOF • V	Э 4	0500[V] 0534[V] 0542[V] 0554[V] 0348[L] 0404[L]	S F TOP1 BOT2 61 81	
ROGRAM 2070 2454 2606 2870	LAR *MAI \$6 ALCG •0	ELS:	2004 2624 2490 2806	• V • A • R A R G • U		2434 2858 2458 3025	• CON • MES • 5	1P 5	201 290 270	2 6 E	@I •₩ AEXP		25E4 27DE 2800	•R EXP •ERCNT	2 A F C 2 9 6 4 2 A C E	• ZF AIN \$8
NTRY-P 2584 2906 2450 -C12	OINT •2 •7 •7 61	s: c	2624 2434 2800	• A • Comp • Ercn	т	2606 2454 2872	ALD(\$6 •0	3	27D 2A9 2B5	E C 8	AEXP •RARG •MES		27DE 28E2	EXP \$8 •U	2964 2AF 8 2C28	AIN •5 •V
0440%-	BLOC	KS:														
NOFFIN	ED S	BRC	DUTINES	5:												
PUNSEE Ecutio	IR AD	DRES	5 2°79 5:	?												

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PAGE 2



TOP AS	SUMED LARGER	THAN B	OTTOM	
TOP1=	2.2033	BOT1=	0.1200	
TOP1=	2.2115	BOT1=	0.1500	
TOP1=	2+2288	BGT1=	0. 2788	
TCP1=	1 626	8071=	0.2502	
TOP1=	2 • 1156	80T1=	0.3200	
T0P1=	2.20.96	B071=	0.3508	H
T0P1=	7 . 3737	B071=	2.4102	
ToPia	2.4827	B071=	0 - 4520	
TCP1=	1-3697	8071=	N.5208	
「こちょー	3-7326	8071=	2.5528	
TPAH	=33+1585	8071=	2.6138	P
TOP:=	-4-4245	8071=	8-6578	
TCP1,≃	-2-2099	5071=	8-7/22	
TOP:=	-8-2619	8071=	0. 7520	
50P1=	-2-7%47	B0T1≃	8-8/22	
T n P t =	-1-8681	30714	2-8528	
To P1 =	-1-7933	3071 +	2-9222	
೯೧೪೭=	-1-7543	B071=	2-9522	
T0P1=	-1-7379	8071=	1-0020	
<u> </u>	2-1927	3072=	= @ + 1 / 38	
TOP2=	2-15-V	B072≍	-7-1758	
=S=	2 - 2722	3075=	-2-2898	
70=2=	0 - 2577	=ST0E	-2-1765	
<u></u>	0-4128	50 <u></u> 5≈	-1-1361	
<u> </u>	7-3577	3072=	2-8493	17
_0=S=	2-422%	B075=	8-5222	
_ 다 문 영 =	これをうだ。	B072=	2-2263	-
_055=	2-5222	=ST08	2+1925	- 11
_0_55=	2-5522	3015=	7 - 2387	
_0P2= _	8-6212	3072=	-7-2534	- pet
_0555=	0.6500	8015=	= 7 · 1 7 4 4	
TOPS=	P. 7929	8015=	-8-1487	
TOP5=	0.7500	B072=	-0.1888	
.C⊳S=	6.2466	8072=	-0.02260	
ICPS=	2.8502	5072=	-7-2612	
TOP2=	2.9200	80T2=	-0.2950	
TOP2=	2 • 9500	8072=	-2.3276	
TOP2=	1.0220	8072=	-0.3593	



X



,



	BOTTOM	ASSIMED	LARGER THA	N TOP		
	TOP3=	=0.2775	8073=	0.1000		
	TOP3=	-8.0949	BOT3=	0.1500		
	ThP3=	-2.0867	BOT3=	0.2000		
	TOP3=	-7.7444	8073=	2.2500		
	TOP3=	0.0406	8013=	2.3700	П	
	TOP3=	0.1769	B073=	2.0500		
	TOP3=	0.3729	BOT3=	2 • 4 300		
	TOPSE	2.6371	8073=	0.1.529		
	TOPOE	2.9782	8073=	0.5720	LI	
	TOPRE	1.49.47	8073=	2.5500		
	Topa=	1.9250	B013=	0.6700		
	TOPRE	2.5478	8013=	2.6528		
	Topam	3.2816	8073=	2.7700		
	TOPSE	4.1349	8013-	0.7500		
	Topa=	5.1162	80-3-	0.000		
	TOP3=	6.2340	B0 3=	2.8520		
	TUP3=	7.4970	BCT3=	0.0000		
	TrP3=	8.9137	8073=	2.0582		
	These	10.4925	BOT3=	1.0220		
	TOPHE	0.1000	8074=	0.0061	П	
	T0P4=	0.1500	BOT4E	9.9731		
	TOP4=	0.2012	B074=	2.2101		
	TOP4=	2.2522	9074=	2.7170		
	TOPLE	2.3000	ROT4=	2.6240		
	TOP4=	2.3500	BOT4=	2.5310		
	TOPLE	2.4922	BOT4=	8.4379		
	TOP4=	2.4502	8074=	0.3449		
	TOPAE	2.5202	8074±	2.2519	1	
	TOP4=	0.5500	R074=	2.1589		
	TOP4=	8.62.20	8074=	2.0658		
	T_P4=	8.6500	80-4=	-2.0272		
	TOP4=	8.7222	80-4=	-8-1202		
	TOP4=	2.7598	B074=	-2.2133		
	TOP4=	7.8990	B0*4=	-7.3763		
	T0P4=	2.8500	8074=	-2.3993		
	T⊖P4=	1.9770	B0~4=	-8.4023		
	TOP4=	7.9500	8074=	-0.5854		
	TOP4=	1.0000	BC*4=	-8.6784		
END						
F VIC OPERATING SYSTE	MERSIC	DN 1 REVI	ISION 012	03184174	GENERATED	05/06/74
LOB HANDLING CHARGE	s .35	/ JOB	•35			
173 LINES PRINTED PRA	\$ 1.25	/ K LN	• 5 5			
67 CARDS READ	\$ 1.52	/ K CD	• 1 Ø			
DO PLOTTER VECTORS	a •52	1 1070	• 6 ?			
CONDEL 70 SECONDS	=25.82	N HOUR	• 1 4			
WE MODEL SU SECONDS	\$12.52	V HOUR	•87			
	TOTAL	CHARGE 4	• 81			

EIR 490 14731 LOGGED OUT 25/26/74 15:20. \$ 13.29 LEFT AFTER 18 LOGINS.

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STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

3224	С		+AL* IS THE LENGHT
8724			$\Lambda L = 5 \otimes \mathcal{D}$.
377C			-3=AL/8•
3718	С		SURA* IS THE DRAFT
3718			DRA=B/3.
1-24			1)=AL/9.
132	C		*POI* IS THE POISSON'S RATIO OF THE MATERIAL
1 37	С		FOR STEEL
32	~		PULED + 3
1.33	C		REN IS THE TOUND'S MUDULUS OF THE MATERIAL
38	Ċ		
· 35	~		1/730+710+750 - 10tu to t c destan stress
	~		2014 10 14C 05010N 01N500
	~		CONTRACTOR CONCINCION CONCILINAL STICCENING MEMBERS
54 7~54	-		SERIE LAE SPACING OF FONGILODINAL SLIFFENING DEDOCKS
504	r		STAR - IS THE DENDING MOMEN'S
1	5		20
			0=2-2/20444846*/1D01_P01//F
	~		*TOPE IS THE INTOVIESS OF THE TOP PLATING
3	~		*BOT* IS THE THICKNESS OF THE BOTTOM PLATING
1	Ť		TODER.4125
1730			
			NERGR # # MM (R # 80T # D # TOP)
1 50			-EN=D+(3.*3*P*T0P*80T+2.*8*D*T0P*(T0P+80T)+(0*D*T0P*T0P))
140	0		*STH* IS THE STRESS ON TOP DUE TO HOGGING
2160	-		STHEAZDEN
3152			RITE(5,60)STH
174		60	#0RMAT(! ',22X, 'STH='F12+3)
1187			0=560+×500×100+0±100)
194	С		WSPH* IS THE STRESS ON BOT DUE TO HOGGING
1184			SEV=C/DEN
2126			RITE(5,90)SBH
2: 23		99	FCRMAT(1 1,20X,1884=1F10+3)
2:50	Ç		*SBORIT* IS THE CRITICAL STRESS ON BOT
7:50			SPCRIT=BCT*BCT/S
272			RITE(5,110)SPCRIT
1258	1	10	<pre>present (' ',17X,'SPCRIT='F10+3)</pre>
.264			P=2.*()*TOP+R*(TOP+POT)
2268	C		PRITORY IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
203			DITOP=D*(E*BOT+D*TOP)/P
1:51			WRITE(5,4%)DITOP
Par .		46	FORMAI(' ',18X,'DITOP='F10+4)
para .	C		* THOMA IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
1224			DIBUIEU*(8*I0P+U*T(0P)/P
2321		5.0	
2220		26	FURMAIL' '#1888#'UIBUI#'F10+#}
2. [5]			
+6 (V)	POT		
SECVI	5.5		
14 EV1	DEL		
	~ ~ · · · ·		

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49 STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION PAGE 2 030, (V) SBCRIT 0228(L) 110 03C4(V) P 01E2(L) 98 CEVI SAH 0300EV1 DIBOT 0304EL1 50 0000151 .V 02A8(L) 48 SEVI DITOP >FQ L F OGR | LABELS: 2890 .COMP 2AGE OIL 2440 .R 2160 ·V 2958 • ZE POTI +MAIN+ 2486 · A 2984 .MES 2832 ·W 263A EXP 2700 AIN 280h 56 263A AEXP 28F8 .RARG 2954 .5 295C +ERCNT 292A \$8 2532 ALCG 2951. .0 3884 1. SEAS TRY-FOINTS: 2488 · A 263A AEXP 263A EXP 27CØ AIN 244" .R 2532 ALOG 2890 .COMP 2886 \$6 23F8 .RARG 292A \$8 2954 .5 2831 . 4 2950 .ERC.T SA3E .U 2464 ·V 295E .O 2984 .MES 2950 .ZERO 2465 MI MO -PLOCKS: E. PEFINED SUBROUTINES: 15 ANSFER ADDRESS 2270 CUTION REGINS: STH= 2:037.113 SBH= 2/037.113 SBCRIT= 20505.348 DITOP= 27.7778 DIBOT= 27.7778 END. F VIC OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74 0 OB HANDLING CHARGE \$.35 / JOB +35 85 LINES PPINTED PR2 \$ 1.25 / K LN •11 54 CARDS READ \$ 1.5% / K CD .13 28 PLOTTER VECTORS \$.25 / 1722 .00 13 MODEL 70 SECONDS \$25.07 / HOUR . 9.9 20 MODEL 80 SECONDS \$12.57 / HOUR .20 TOTAL CHARGE \$ • 63 TEIR 490 14731 LOGGED OUT 05/06/74 15:46. \$ 11.16 LEFT AFTER 21 LOGINS.



Length	= 500 ft
Beam	= AL/8
Draft	= B/3
Depth	= AL/9
DST	= 20000 psi
S	= 30"
Material	- STEEL
ТОР	= 0.4125"
BOT	= 0.4125"
STH	= 20037.11
SBH	= 20037.11
SBCRIT	= 20505.43
DITOP	= 27.78
DIBOT	= 27.78'

Note that this is the case where two acceptable solutions exist although they end up being the same because TOP=BOT.

Note that the neutral axis is located half way between top and bottom and the stress is the same at the top and at the bottom, as it was expected beforehand.

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

```
*AL* IS THE LENGHT
1984
       С
             AL=500.
1224
             B=AL/8.
226 d
             *DRA* IS THE DRAFT
       С
1218
             DRA=B/3+
218
             D=AL/9.
1224
             *POI* IS THE POISSON'S RATIO OF THE MATERIAL
0130
       С
1739
       С
             FOR STEEL
-33
             POI=C+3
             *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
732
       С
. 38
             FOR STEEL
       C
             E=32+×10+*+6
135
240
             *DST* IS THE DESIGN STRESS
       C
~40
             DST=2(?: V.
             *SH IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
       С
254
             S=120.
754
             JEM* IS THE BENDING MOMENT
17EC
150
             >M=(B+DRA=AL+2+7+75)/(35++35+)
1982
             h=2+30396*5*s*(1++P0I*P0I)/E
-P4
             A=9+*E=8*D/(14/+*PM)
1000
             ~=3+++++D+D/(72++BM)
             F=3.=D=D=D/(14/.==BM)
114
             THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
120
       C
             NRITE(5,12)
1120
          10 FORMATI 11,25%, TOP ASSUMED LARGER THAN BOTTOM!)
:40
1:65
       C
             *TOP* IS THE THICKNESS OF THE TOP PLATING
: 45
             #POTH IS THE THICKNESS OF THE BOTTOM PLATING
       C
1165
             2011-1.
1.75
          WRITE(5,20)TOP1,BOT1
1.90
1:52
          20 FORMAT(! ',25X, 'TOP1='F9+4,5X, 'BOT1='F9+4)
201
             >OT1=R0T1+0+25
214
             1F(ROT1+GT+2+)GO TO 30
225
             GO TO 11
225
          30 TOP2=4+02
234
          31 POT2=TOP2*(12**D+(C+F)*DST*TOP2)/(DST*(A+C)*TOP2+12**B)
1200
             WRITE(5,4P)TOP2,80T2
274
          40 FORMAT(! ',25X,'TOP2=!F9.4,5X,'BOT2=!F9.4)
1200
             +0P2=70P2+0+22
12E 2
             TF(TOP2+GT+1+)GO TO 52
PEA
             GC TC 31
PARE
          50 CONTINUE
255
             THICKNESS OF BOTTOM ASSUMED LARGER THAN TOP
       С
PEF
             WRTTE(5,60)
1312
          60 FORMATI'1', 25X, 'BOTTOM ASSUMED LARGER THAN TOP')
1260
             90T3=1 +
1248
          61 TOP3=((P+D)*#0T3*B0T3*B0T3=D*G*DST*B0T3)/(B*G*DST)
1294
             WRITE(5,78)TOP3,BOT3
358
          70 FORMAT( 1,25X, 10P3=1F9.4,5X, 180T3=1F9.4)
1326
             BOT3=80T3+0.25
1350
             TF(B0T3+GT+2+)60 TO 80
SEE
             GO TO 61
```

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PAGE

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

402		5	30	TOP4=(
14.00 4		8	31	POT4=(12.*(8-	+D) = (A+C)) * DS	ST + TOP	94)/(((C+F)*[DST)				
1445			-	WRITE	5,98170	P4 POT									
1.70		c	na.	FORMAT		5X. TTOP/		9.4.5	. IB01		. 4.)				
1.0.		•	10	TOD/-1				J • +) J /		r 21	• • •				
149A					10F4+9+,										
34A6				TF (10F	24 • G I • 1	•)GU TO	100								
346×				GO TO	81										
348C		10	20	CONTIN	UE										
148C				END											
00[5]	٠U			24CPICV	D AL	£4C8	3 E V J -	8	01	DUCVJ	DRA	7	04D8[V]	D	
O EVJ	PO	I		2458 [V	/] E	6220	2 (S)	• R	04	F8(V)	DST		0500[V]	S	
REVI	RM.			251CEV	1 6	0528	Rrv1	А	ØF	530 EV1	С		0538 (V)	F	
0.01.7	17			ANDATO	ะ ดา	0520	" rv1	BOTI	21	17611	11		05405V1	TOP1	
	20			10200 FL	1 00	055		TOP2	0.2	270 (HJ	21		0550 [V]	5104	
	20			WEEGIL	34	4 3 5 4	4 L V J -	- FUP C	00	こうてににし、	21		2000101	DUIE	
34 463	4%	<i>.</i>		MEFELL	1 50	\$313	242	62	0	56U(V]	801	3	034×1LJ	61	
78 SV 3	TO	P3		N3B5 (C	1 76	2483	SILI	82	8:	574 [V]	IUF	4	040A[L]	81	
78 EV]	80	T 4		2475 (L	. 96	24P(C[]	122	Ø i	200[S]	• V				
XEQ			L												
)F															
	- 1-		s:												
2070				2000	• V	2420		м₽	2014	ØĬ		2550	. P	2804	. 71
24.14	- 1°E	ATC		2676	• •	CASU	• (0)		2UIA	(* 1		2520	T N D	2007	+ 4. t.
FABC	ā. 6			2626	• /1	CREW	• ME	5	SADE	• W		2160	EXP	2960	AIC
26DE	AL	OG		2444	• RARG	2300	• 5		27E6	AEXP		2808	• ERCNT	2406	\$8
2805	• 0			2BDE	• U	3D36									
NTRY-F	TOP	NTS													
2550				2420		2405	41.0	~	2756	AEVP		2756	FYD	2940	ATE
DODE	• 7			2.00	CoMo		ALU:	G	2720	PLAI DADA		6/50		2,200	H 1 '
270-	• W			2230	• CUMP	· CAE2	*5		2444	• KARG		ZAUG	⇒ŏ	2800	• 🖸
5504	• Z	ERO		2808	• ERCNT	282A	• 0		2860	• MF S		SBEA	• U	2010	• V
2014	θI														
DMMON.	BL	OCKS	s :												
DNE	_														
ore to	-			Taura											
NOEFIL	ED	SUE	BRC	INTINES	5:										
ONE															
RANSFE	ER	ADDA	RES	S 2870	2										
ECUTIO	CN.	BEG	INS												
				•											
				•											

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PAGE 2



TOP A	SSUMED L	ARGER THAN	BOTTOM
TOP1=	E • 242	3 BOT1=	1.0000
TGP1=	P - 286	8 BOT1=	1 • 0500
T^P1=	£ • 337	8 BOT1=	1 • 1 200
TCP1=	· 2.396	0 BCT1=	1 • 1 5 0 0
TOP1=	0.462	6 BCT1=	1.2000
TOP1=	· 0.538!	5 50T1=	1.2500
TOP1=	2.625	3 BOT1=	1.0700
TOP1=	0.724	5 BOT1-	1.5000
TOPIE	2 . F 3 8		1.1000
TOPIE	7.949	R POTI-	4 4 7 9 9 9
TOPAR		D DUNAR 1 DOTAR	1 • 4 5 0 0
TOPA	1.119	1 30°1=	1.5400
TOPLE	1.6446	7 50°1= 7 50°1=	1.5500
1051-	1 • 4 9 4	N RC-1=	1.626.6
	1.730	D BCT1=	1.6500
_CP1=	2.0078	8 8071=	1.7000
TOP1=	2 • 336	6 BCT1=	1.7500
TCP1=	2.7305	5 BCT1=	1 • 8 2 0 0
TOP1=	3.208	1 8071=	1.8500
TCP1=	3 • 7 9 5 9	9 BCT1=	1.9290
TCP1=	4.532	7 BCT1=	1.9400
TOPIE	5.478	3 BOT1=	2.0700
TOP2=	0.0200	80T2=	+C+C182
TCP2=	2.0400	80T2-	-0.0075
TrP2=	7.7600		-0.0579
TOPOE	0.7870	A BOT2-	• 0 • 0 7 9 9
TOPOE	0.4000	2 DOTA- 2 DOTA-	-0.000
2- 7089-	0.1020	ະ ສະຫະລ	-V•1030
- 290 Topo-	V:•1278	9 80'Z=	***1381
10525 Toba-	2 • <u>1</u> 4 6 ¥	9 BOIZ=	•0•1595
1085=	2 • 168 %	8015=	= ؕ1932
-0P2=	0 • 1 8 7 9	90-2=	≈% • 5 358
10P2=	6.5066	8072=	808S • 24
_0 _E 5=	. 6.5565	9 BCT2=	·2·3417
TCP5=	2.2489	B0*2=	- 2•4234
TOPPE	2.7682) B072=	-0.5421
-CbS=	9.2898	BOT2=	-0.7376
TOP2=	2.3000	B072=	-1 • 1361
10p5=	0.3222) BCT2=	-2.4815
TOP2=	8.3428	BC*2=	10.9162
TOP2=	0.2600	9072=	1+6081
TOP2=	0.3800	BOT2=	0.8255
TOP2=	0.1000	BOT2=	0.5282
TOP2=	0.4200		0.000
TOPOE	0.1100		0.0155
TOPO-	V • + + ¥ ¥.		V • 2655
TOPO-	2 • • • 6 2 K	BU 2=	N • 1959
10-2- ToDo-	0 • 4 8 0 0	9 9012=	0+3/1
0P2= ToD	N • 5 4 2 4	8012=	0.0925
1025	V • 5228	8072=	0.0553
1048=	2.5408	80*2=	0.0533
CDS=	2.5622	B015=	~2.0250
ICPS=	2.5802	B072=	-2.6323
10P2=	2.4072	B0*2≈	
-cb5=	2.622.0	8072=	2.2748
TOP2=	8.6490	B072=	-2.7948
OP2=	8.6688	B072=	-7.1136
ICP2=	2.6900	B072-	= 0 • • 215
0 L			1910
TcP2=	0.7000	8072=	-0.1487
-------	-----------	-------	---------
TOP2=	0.7200	8072=	-0.1651
T0P2=	1.7498	B072=	-0.1910
TCP2=	0.7600	B072=	-2-1964
TOP2=	0.7800	B072=	-0.2114
TOP2=	0-8002	8072=	-2.2260
TOP2=	0.8580	8072=	-0.2403
TOP2=	0.8400	BCT2=	-0.2543
TOP2=	0.8697	8072=	-7.2681
TOP2=	8.8808	8072=	-0.2816
TOP2=	2.9000	B072=	-0.2950
TOP2=	0.03E · D	B072=	-0.2081
TOP2=	0.9490	B072=	-2.3511
TOP2=	0.9620	8072=	-2.3340
TOPP=	0.9802	8072=	-0.3467
TOP2=	1.0000	8072=	•0.3593

Note that in this case by simple inspection of the coordinates of the points to be ploted we can see that the intersection will occur outside the acceptable range.

Note also that in order to obtain the coordinates of the points within a range of interest where the intersection may occur, different ranges and increments are considered in each program. This could be improved if at that time these printouts were available and a better idea of the thicknesses that should be expected existed.

BOTTOM	ASSUMED	LARGER THAN	TOP	
TOP3=	-0.1776	BOT3=	1.0000	
T0P3=	-0.1099	BDT3=	1.0200	
T0P3=	-C•0310	ROT3=	1 • 1 2 2 2	
TOP3=	0.0596	8073=	1 • 1 500	- 11
TCP3=	0.1625	B0T3=	1.2%0.0	- 11
Topg=	0.2782	3073=	1.2500	
T023=	6.4072	B013=	1.30.00	- 11
10°3=	0.5501	3073=	1.3528	
1023=	8.7074	5073=	1.4978	
TCP3=	P + 8797	8073=	1.4582	
7073=	1 = 2674	8073=	1 + 5 / 2%	
1023-	1.2711	3073=	1 = 55 7 2	
7022=	1 = 4914	3013-	1. + 67.2%	
1093=	1 . 7287	8073=	6522	
	1.9836	5013=	: .7213	11
T A P A R	2.2567	90TR#	. 757	Ц
****	2-5484		18122	
7079 ·	2 8544	27792	1 2 2 2 7 7 7	
7 7 9 H	3.1901	51702		
	3 5440	2 7 7 7 2	10400	
	3 01419	- U 0	1 - 3	
	3:2120	20 34	1	Π
44 50	- V - V - Z X A 	r (j 🖣 🖛	1.01.47	
4	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5 - 1 A	11111	
4	101.4561	1. 1	1.1773	
- 4	- V ~ 7 8 V / /	그는 유부로 가지까지	111333	
4 4 =='	1 1 1 1 1 1 2 6	11. 4 - F	0.9051	
- 4	120 M	80 4 =	0-9589	
1 J · 4 m	1 + 1 4 × 2	22년 11 월 포 이 가지 가	0.921/	
4		±. 4 =	1.8245	
· · · · · · · · · · · · · · · · · · ·	1.18:2	21.4=	W= 8,473	
4 =	1.2672	80 4 m	0 <u>2101</u>	
1	• 2 2 · · ·	:: 1 4 ==	0 7728	11
AL T	124.0	··	2-7356	
	02624	· • · · · · · · · · · · · · · · · · · ·	a 6984	- 11
=	~ P. S. 2 - 1	1 _, 11 4. m	0-6612	
ų, π ų, π	7 - 343	N	C 524 1	
<u> </u>	° - 3 € ?	왕 477 4 =	014868	
T - P., =	2-34 3	B07+=	Ø15496	
	3 -36 32	B⊕74=	2-5124	- 11
	1430 C	BC‴≁≠	0-4752	
	-4.5-	3° - =	0°4379	
	~ 42 P	ల 💭 ్ ఈ జ	7-4277	11
T 가 P / 프	2~4457	관 이 키쓰 =	013435	
	7-45 E	30 ¹ 4±	019263	
⊇ん二	2-4330	BC74#	0-2991	
70₽⊭≓	0 - 5 3 ° 7	50 ° 4=	212519	
T_?₽4=	2-5200	3074 =	8-2147	
-~₽ <i>i</i> ⊈=	T-5470	3074=	0-1775	
_05r=	0-5602	BC74=	2-1403	
T0P4=	C+5220	8074=	2-1232	
TOP4=	2-4323	3074=	2-2-58	
-0P4=	7 227	3014=	8-7286	
T <u>o</u> P4=	7 = 477.	3074=	-2-7786	
T074=	2-652	3074=	-2-7452	
T074=	2-6323	3074=	-2-3:32	
		1		



20P1 =	2 - 7727	3074=	-201202	
ె ి సిగా	7-7257	3074=	-2-1574	
P I. =	C . 7477	2074 <i>=</i>	+p-1946	
T () P // =	1-7622	BC74=	=2 • 2319	
T0P4=	1 7000	3074=	-2-2691	
T0P4=	0.1007	3074=	-7-3-63	
	2.929%	3074=	-7-3435	
「今日ルヨ	7.5492	3074=	+2.03097	
T094=	7 + = 677	8074=	-2-4179	
$\Box \Box \Box =$	11-0072	B074=	-2-4551	
T0P4=	7 100 8	30 ⁻ 4=	-8.1953	
	1.0200	30-4=	*? * 5296	
- CPL =	0.0400	3074=	-2-5269	
TOP4=	9 24.99.	R074=	-7 21142	
T ~ P 4 =	11. 28.77	R074=	-7 . 412	
TCP4=	1.0002	3074=	-7-6784	
*				

CF VID OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74 0

JOB	HANDLING CHARGE	¢ ,35	/ JOB	• 35
239	LINES PRINTED PR2	\$ 1.25	/ K LN	•30
67	CARDS READ	\$ 1.50	/ K CD	• 1 2
00	PLOTTER VECTORS	s .25	1 1902	• 0 ?
17	MODEL 72 SECONDS	\$25.00	/ មុយមុទ	•12
09	MODEL 80 SECONDS	\$12.52	/ 4002	• 00
		TOTAL	CHARGE	\$.87

END

IRFEIR 490 14731 LOGGED OUT 25/26/74 15:25. \$ 12.42 LEFT AFTER 19 LOGINS.

/

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(4	C		+ PL + IN THE LEN " T
1 1 K			
°C			
1 4	<u>^</u>		ALEAN TO FLE OR T
1 8			
24			
3			ALLA L THE BUILDIG WATTE BE THE PATERIAL
1			
31	~		
1 4 2			PER LA THE THE TA COLUMN OF THE CATEMIAL
30			
1 5	~		E CT V TE TUE NE STOL GYEROP
41			INTER A
66	~		-S. IS THE SULATE OF EXIMATION AL STTEPENTING FEMRERS
54			CHARLE AND
10	~		ATTACK TO THE WELT CONTRACT
20			
			T = I + T - 2T + 2 + 2 + 2 + 1 + - 2 + - 2 + - 1 + 2 + - 2 + 2 + 2 + 2 + 2 +
E L	¢		ATTEND THE THE THE THE THE THESE
F L	-		ALCINE THE THICKNERS OF THE OUTLIN PLATING
2 6			ICHE + M
===			
r 6			$\lambda = [A + w] + (E + m)(T + D + n(T + D))$
£			OF! = (+([++,++),T,-+,+]) + (-) + 2 + x + (-) + 3 + (T + (-) + (
. 4.	~		ATHA TO THE ON LSS CALLOR DUD TO POGING
147			
155			-FITE(S+C,)STU
1176		L	$\varphi(-1/7)(1-1/2-y) + (1/2-1/2)$
* 5 F			$\mathbb{C} = \{ \mathbf{v} \in \mathcal{V} : \mathbf{v} \in \{ \{ \mathbf{v} \in \mathcal{L} \} \mid \mathbf{v} \in \mathcal{L} \} $
* F. L.	~		-SEE IN THE ATERS ON BOT DUE TO LOGGING
124			
° (F			k) Tr (-> + C() 40 J
157		C. 17	c(-1) = (-1) +
1. E(<u> </u>		ASICALLIS THE CRITICAL STRESS ON BOT
F FC			$c_{\pm}(\pm 1) = 0 [\pm 0] \times 1$
		11	
	~		$\frac{2\pi}{2} + \frac{2\pi}{2} $
6.	ι <u>.</u>		CITCER IS THE TATA OF THE TUP PROF THE NECTRAL AXIS
20			
-19		,	$= \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_$
- 64	r	-	FIGURE IS THE ISTA OF OF THE BUILDIN FROM THE NEUTRAL AVIS
204			WIETEDR(SEICHE KADT) A
-54			
12.12		Ę	r(FY) = (1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
1.51			
[5]	• []		224 EVI 01 320 EVI 8 EVI 024 10 EVI 0
- [1]	COL		1940(V) - 112(n) .P 3=0(V) DST 2364(V) 9
R_[1]	- · · ·		-34: (V) 380 (V) TOP (304 (V) PGT 7390 (V- A
ar (v)	12-12		2001V3 STA 17412 69 (2253 @I 23021V3 C

ľ	()	• 6 1	184 (V)	ا در	320171	8	(324 LV L	しらせ	NABCEN
-	[/]	COL	1340 (N)	5	1.10 [0]	• F	3=C[V]	DST	2364 CV
k'	- [V 3 -	· · ·	-341 (V)	1	Bar SV2	TOP	(304 FV)	PGT	2390 EV
11'	CV3	14 m N.	21 C (V)	STH	174517	6%	CP 2 [5]	tār 🗓	23C. LV

PAGE 1

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60
        SINC ALT OF SHPRONT THE FILTON AXIS LOCATION
                                                                                                                                                                                             PAGE 2
  - [1] 51 -
                                    TEPTUS PT
                                                                                 300 NJ SECRIT (203 11)
                                                                                                                                                                       ABCCEVI P
                                                                                                                                                                        203255 .V
                                  The FIN Let
                                                                                 304 (V) DISCT (3.4 (L) 50
  · (\] 1100
  . 4.5
                   L.
CFA'LAFEL
                                                                                                                  276 I
                                       ** * 65 · · · ·
                                                                                                                                                          2445 .R
2647 F.YD
                                                                                                                                                                                                  2160 .11
                                                                            CHAR PURD
  178 + + · · · · · · · ·
                                       747 ...
                                                                            -1 35 + 14 5
                                                                                                                                                                                                  77C8 AL
                                                                                                                     1 . 45
  15 E . 6
                                                                                                                                                         2964 FRONT
                                                                                                                                                                                                2132 12
                                                                            - 40 · 54
                                                                                                                     2.42 EXP
  27A 11-1
                                       Tely and Real
                                       5131 .
                                                                             = 1·2
  - 1 4 0 7
 123-11-1-1-1
                                                                                                                                                         2642 5XP
                                                                                                                                                                                                  2708 AT
                                       167 - -
                                                                              0-31 /103 2142 /EXP
    644 . -
                                                                            5 AL 6 6
                                                                                                                   2516 .2283
                                       255 - CAR
                                                                                                                                                          2932 $4
                                                                                                                                                                                                  2956 .4
    . . .
                                       2030 .MER
                                                                                                                                                         2140 .10
                                                                                                                                                                                                   266C .
    Cr. + + 7" 1
   67 - 7
   111-1-1 .
    5
 · EETON ON STILVES:
  -
ELTI FAIST
                                               51 -= 15771.577
                                             - - Fran - - - 7 7 . - - 11
                                       SECALTE 6742.775
                                       (ITC = 37,4202
                                                                 15.1723
                                         ( <u>[</u> +( *=
   1
CE VID ODERATING DRETS (FORIDO ) EVISION 112 3/04/74 GENERATED (5/16/74
    1 - - - IT , 1-1-12 S . 25 / 10"
                                                                                                                   . ว ะ
    54 CHARTER AND STREET AND A STR
                                                                                                                   .11
                                                                                                                   · 71
    I PLATT, JECIARE
                                                             . . . . . .
                                                                                                                   • 1
     10 "APT 7 SECOND ALSON / 10 -
                                                                                                                   • 1 1
      " "TEL " SECON IN
                                                           12.51/ 51
                                                                                                                   • n.
                                                                TOTAL CHER P
                                                                                                                   \bullet : \mathcal{E}_{Y}
* EIF 902 14031 LIGS (UT 5/44/74 15:40) # 14.51 LEFT AFTER $2 LOGINS.
```

Length	=	500
Beam	=	AL/8
Draft	=	в/3
Depth	=	AL/9
DST	=	20000 psi
S	=	120"
Material	-	STEEL
TOP	=	0.03"
вот	=	1.14"
STH	=	19771.88
SBH	=	9579.87
SBCRIT	=	9788.37
DITOP	=	37.42'
DIBOT	=	18.13'

Note in this case the large value chosen for S and associated with it the large value required for the thickness at the bottom to avoid buckling which nevertheless does not resist stresses larger than 9788 psi in compression.



If we look now at these three cases, all for the same material and set of dimensions (same bending moment) we can see how the thicknesses and neutral axis position changed as the value of S was changed.

CASE	S inches	TOP inches	BOT inches	SBH psi	SBCRIT psi	DITOP ft	DIBOT ft
1	10	0.468	0.166	30000	30000	22.06	33.05
2	30	0.4125	0.4125	20000	20000	27.78	27.78
3	120	0.03	1.14	9700	9700	37.43	18.13

In this table, we can more readily make conclusions on the influence of the value chosen for S on the neutral axis location, and also a quick look at the resulting values for the thicknesses may give an idea of the weight associated with each case.

In the following cases the dimension parameters are changed (increased) and consequently the bending moment and the thicknesses of plating will be higher.

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

```
С
             *AL* IS THE LENGHT
:24
             AL=1020.
:24
             B=AL/5.75
1: C
             +DRA+ IS THE DRAFT
       C
18
             DRA=8/3.3
113
             D=AL/14 .
24
             *POI* IS THE POISSON'S RATIO OF THE MATERIAL
       C
 3.7
             FOR STEEL
1 3 7
       С
             POI=0.3
131
      C
             *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
33
             FOR STELL
33
      C
             ==30·=10.**6
12
       C
             *DST* IS THE DESIGN STRESS
140
             DST=18442+
40
             *SF IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
54
      C
E 4
             9=38+
-50
             *BM* IS THE BENDING MOMENT
150
             3Y=(B+DRA+AL+AL+0+75)/(35++35+)
+ 2
             6=0+3/396*5*5*(1++POI*POI)/E
-
             ∴=9·*8×8×0/(142·*84)
1-0
             C=R+=B=D=D/(70++BM)
             打===+(+(++)+D)(++++日M)
 . .
             THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
25
     0
 :0
             WRITE(5,1?)
 60
          10 FORMAT('1',25X,'TOP ASSUMED LARGER THAN BOTTOM')
 6=
             -TOPH IS THE THICKNESS OF THE TOP PLATING
      C
 45
      C
             FOOTH IS THE THICKNESS OF THE BOTTOM PLATING
45
             -CT1=0+1
 75
          11 TOP1=5*BOT1*BOT1*BOT1/((3+D)*G*DST+D*BOT1*BOT1)
 01
             WRITE(5,20)TOP1,80T1
 50
          20 FORMAT(' ',25X,'TOP1='F9+4,5X,'BOT1='F9+4)
1. 1
             POT1=POT1+1+25
F:5
             +F(BOT1+67+2+)60 TO 30
122
             GC TO 11
220
          30 TOP2=1 -
134
          31 PCT2=TOP2*(12+=D+(C+F)*OST*TOP2)/(DST*(A+C)*TOP2=12+*B)
100
              RITE(5,40) TOP2, BOT2
2=4
          40 FORMATL' ',25X, 'TOPP= 'F9.4,5X, 'BOT2= 'F9.4)
200
             TOP2=70P2+0+5
229
             IF(TOP2+GT+15+)GO TO 50
FFA
             GO TO 31
292
          50 CONTINUE
PFE
       С
             THICKNESS OF BOTTOM ASSUMED LARGER THAN TOP
1:5
             WRITE(5,60)
513
          60 FORMAT('1',25%, 'BOTTOM ASSUMED LARGER THAN TOP')
549
             a0T3=0.1
848
          61 TOP3=((B+D)*BOT3*BOT3*BOT3*D*G*DST*BOT3)/(B*G*DST)
P94
             WRITE(5,70)TOP3, POT3
29.8
          70 FORMAT(' ',2+X, 'TOP3='F9+4,5X, 'BOT3='F9+4)
939
             90T3=80T3+M+25
BEC
             1F(POT3+GT.3.)GO TO 80
BEE
             30 TO 61
```

63

PAGE 1

ST	RENGHT (DE SHIF	PS-0N 1	THE NEUT	RAL	AXIS L	DCAT	[ON		F	PAGE	5
42 • A • E 72	80 F1 90	TOP4=1 ROT4=0 WRITE0 FORMAT	(+ 12+*(F 5+90)1 (+ 1+2	3+D)-(∆+ [gP4,¤gT 25X,'TQP	C) +[4 4 = ! F)ST×TOF 59+4≠5)	P4)/() (≠'B01	(C+F)*[[4=!F9]	9ST) .4)			
9A 46 50 50	100	IF (TOP GD TO CONTIN	24 • GT • 1 81 NUE	•5 15•160 ⊤	0 10	9 (A						
(S) (V) (V) (L) (L) (L) (L)	•U POI BM 12 20 42 TOP3	-4000 04580 05180 02000 022000 22550 038800	/] AL /] E /] G 3] @I .] 30 .] 50 .] 70	940 969 959 954 955 931 849	8 [V] 8 [V] 8 [S] 8 [V] 8 [V] 8 [V] 8 [V] 8 [L] 2 [L]	B • R • A • BOT1 • TOP2 • 67 • 82	0 9 9 9 9 9 9 9 9 9 9 9 9 9 9	+D0(V) +F8(V) 530(V) 176(L) 234(L) 578(V) 580(V)	DRA DST C 11 31 BOT3 TOP4	04D8[V] 0500[V] 053C[V] 0548[V] 0560[V] 0348[L] 0404[L]	D S F TOP1 90T2 61 81	
EQ EQ	BOT4 LARELS	\$472 <u>1</u>	. 90	Ø 4 <u>B</u>	C(L)	120	Ø	200 (S)	• V			
654 814	• MAI'. = *6 ALOG •0	2018 2638 2480 2884	• V • A • R A R G • U	2448 2860 2800 3042	• C 0 • ME • 5)MP S	2026 29EA 27F2	@I •₩ AEXP	25F8 27F2 2B14	•R EXP •ERCNT	2810 2978 2AE2	• ZE AIM \$88
DY-F	OINTS:	2638	• A	-26EA	ALC)G	27F2	ΔΕΧΡ	27F2	EXP	2978	AIN
°EA 81.7 C26	•W •ZERC @I	2A48 2B14	• CoMP • E ₩ C N1	246 <u>6</u> 2816	\$6 •0		2450 2860	•RARG •MES	24E2 28F6	\$8 •U	280C 2C1C	•5 •V
моч • Е	BLOCKS:											
EFIN	ED SUBRO	DUTINES	5:									
VTIC	R ADDRES	65 2072 5:	0									

.

TUT AS	SOUTED LARGER	THAN E	NUTION	
TOP1=	2.0048	BOT1 =	0 • 1 2 0 0	
TOP1=	2.0168	BOT1=	0.1500	
T0P1=	7.0412	BOT1=	0.5300	
T0P1=	2.7844	90T1=	0.2500	
T <u></u> P <u>1</u> =	9.1554	50T1=	8.3200	
TOP1=	2.2673	BOT1=	0.3500	+
TOP1=	0.4414	BOT1=	2.4200	
1051=	2.7145	BOT1=	0.1520	
TOP1=	1.1570	8071=	0.5000	
TOPA	1.9240	ROTIE	M.ERMO	
ToPA=	3.4344	BOTI	0.0000	
TOPIE	7.3949	BOT1-	V + 6700	
TIPLE	36 3430	50 1=	0.2260	_
Table	30 + 24 34	3011=	0.7000	
Tople	=20+76×8	BC11=	0.7500	
10P1=	=9•×191	4011=	0.8200	
- CM1=	-7.1387	8071=	0• <u>8</u> 500	
TOP1=	-5.9771	B071=	0.9460	
T-)P:=	-5.3601	8071=	2.9560	
TOP1=	-5.0000	8071=	1.0200	
T0P1=	-4.7816	8071=	1.0500	
TOP1=	-4.6498	8071=	1.1000	
TOP1=	-4.5747	BCT1=	1.1500	
TOP1=	-4.6388	8071=	1.2000	
TOPAL	-4.5313	8071=	1.0500	
TOP1=	-4.5450	BOT1-	1.0000	
TOP1=	=4.5748	90-1E	1.3000	
TOP1=	=4.6173		1.3500	
Tropie		00 1= 0074	1.4720	
	-4.5790	5011×	1 4500	
	-4.7309	80.7=	1.5200	
-0-1- Tabi-	-4 • / 7%0	8011=	1.5500	
10515 Top/-	=4+8720 	R011=	1.6200	
Tople	= 4 • 9502	8011=	1.6500	
I GP1 =	-5.0325	8011=	1. 7200	
1021=	=5+1183	80T1=	1•7500	
IOP1=	-5.2071	8071=	1•8200	
10P1=	- 5•2986	BCT1=	1.8500	
TOP1=	-5•3924	8071=	1.9700	
TOP:=	-5.4883	8071=	1.9500	
TOPIE	-5.5860	8071=	2.0200	
TOP2=	1.2002	80-2=	-8.4673	
TOP2=	1.5002	B0-2=	-8.7727	
TOP2=	2.2002	8072=	-1+1829	
TOP2=	2.5002	B072=	-1.8315	
TOPPE	3.2202	8072=	=3.2461	
TOP2=	3.5222	B072= 1	=11.0071	
TIPPE	4.7772	BOT2-	5.0010	++
TOPOR	4.5007	BOTR	1.0050	
TOP2=	5.0000	8072-	1 · 2 2 3 7	
InPo=	5.5000	BOTO	0.8127	
TOPO-	5.5000	50°2=	0.52218	44
Topo	6.7720	20.5=	-0.1140	
Top	6.2600	80TS=	-2-4000	
1055=	1.7770	80-2=	-8.6389	
ICP2=	7.5299	8072=	-0.8495	
CP2=	8.2992	80.5=	-1.9488	
10P5=	8.5778	8072=	-1.2195	



























10b5=	9.2000	8072=	-1.3890
T0P2≖	9.5000	B072=	=1.5516
TOP2=	10.0000	BOT2=	-1-7290
TUP2=	19.5900	B072=	=1.9623
TOPP=	11 • 2200	8072=	-2.0124
TOPS=	11.5002	8072=	-2.1599
-Cb5=	15.2020	BCIS=	-2+3252
T-P2=	12.5000	8072=	-2.4487
TOP2=	13.0000	8072=	-2.5907
TOP2=	13.5000	B0T2=	-2.7314
IUb5=	14 . 2000	80*2=	-2.8711
TOP2=	14.5000	B072=	-3.0098
IUPS=	15.2000	50T2=	-3 • 1477





BOTTO	M ASSUMED	LARGER THAN	тОр
TOP3=	<i>-</i> Ø∙∵316	B0T3=	0.1000
TOP3=	-8.297	B0T3=	0.1500
TOP3=	-0.066	BOT3=	0.2000
ToP3=	1.449	B013=	2.5268
TOP3=	1.1318	R073=	0.3-00
Top3=	0.2612	B073=	1.3520
ThP3=	0.4442	3073=	8-4000
TOP3=	2.6758	30T3=	2-4577
-~ D 3=	0,9752	3073=	2.5222
-453=	1-3455	Rr73=	1.5522
TrP3=	1-79-6	9073=	9-6172
T)P0=	2-3268	3073=	2.6522
TOP3=	2-9524	EnT3=	2 . 7238
TIPOR	3-6764	BOTPE	7-7522
Тороц	4-50.71	2013-	7.00120
TOP:=	5-4511	30-3-	200577
TODE	6.5155	2010L	200000
Treas	7.7.74	20-2-	200=77
Trobe	9.7339	20 0 -	107120
Those	10.5001		1-2-22
rous Herson	10.11.001	2022-	1-1-60
70204 70204	10 00+7	20 CH 2072	1-1666
Trophel	15.2020	55 CH 2072	111520
5 - 5 - 5	1000000	D_13=	1-2000
5 t = 1	17.0337	ವರಿ ತ=	1.2200
1000000 Topolo	20-2157	3013=	1.3722
	00-00-00-00 00-01-07	80 Jan	// 6
r viet. Teiden	00 1070	01. CH	204/34
్ సౌ చాల నెంటింటి	21 0501	11 J J =	1 4 5 4 0
「シンゴー		70 3F 2070-	1-5-20
	3400334 30 074	20 3F	
191 また。 下へ戸った。	41.7450	70 CF	
TrPps.	45.7704	20794 10 25	1-2-2-6
	49.8076	2072-	- 7 1 40
ToPort	54.3497	2012-	
1089=	50,0308	20-2-	
TOPOE	62.0900	BOTO	1.0200
TOPOR	69.0223	POT2-	1.0500
7000-	37 9000 D		
ToPo=	V4 · / 3 7 7	50 2F	2.0000
1000a	56.4002	DU 3=	2.2500
TOPas	92.9702	00 3× 8073×	C 1000
TOPOS	99.6674	POT3-	2.15%0
TOP2=	106.6504	00 0- 072-	2-2700
TORS=	112,9452	2072-	C 2200
TOPOE	121.4029	00 04 P070-	2.3720
ThPp=	129.5705		2.3256
1-03=	137.9812	B072-	2.4700
TOP2=	146.5416		21-4000
TOP2-	155-5554	20-3= Poz2	2.2000
InPam	164,00/6	00 3= 8073-	2.2260
TORDE	174.6679	20 JE 2073-	2.6700
InPor	184.70/2	50 3= Po73-	C 5500
TOP2=	195.2022	50°3#	2.7700
IOPo=	206.1706		2.7500
0.2-	r.0.1150	50 3m	C . 85.00

-

	TOP4= 12.50V0	B074= -28+>213	
	T-P4= 13.2020	BOT4= =30 .1511	
	TOPL=' 12.5020	8074- =32+0208	
	T		
	1 14= 14 + 22 20	BC 4= = 34 • 0106	
	TOP4= 14.5000	BCT4= -35·9404	
	TOP4= 15.2020	80-4= -37.8702	
*•D			
VIC OPERATING SYSTE	M PERSIAN 1 REVISI	ON 012 03/0//74 GENERATE	D 05/06/74 0
	H TEKOION I NETIOT	ON OIL COVERNMENTED	
DA HANDLING CHARGE	* 25 / 100	25	
ER LINER DRI TER RDR	5 , 35 / JUB	• 30	
DA LINES PRIMIED PRE	5 1.25 / K LN	+35	
57 CARDS READ	\$ 1.5% / K CD	• 1 0	
P2 PLOTTER VECTORS	\$.25 / 1222	• 0 0	
17 COFL 78 OFCONDS	\$25.07 / HOUR	• 12	
PA MODEL PA DECONDO	\$12 57 / UCUD	00	
The OUTL BY SELUNDS	alc.b/ / HUUK	• 6. 6	•
	TUTAL CHARGE \$	• 8 9	
EIR 490 14731 LOGGE	D GUT 25/26/74 17:	26. \$ 9.62 LEFT AFTER	23 LOGINS.

=5407	217.4581	8013=	2.8266
TOPSE	229.1475	8073=	2.9200
TCP3=	241.2473	B0T3=	2.9500
TAP3=	253.7654	B073=	3.0460
TOP4=	1.0000	B074=	16 • 1639
TOP4=	1.5020	8074=	14.2342
TCPLE	2.2020	BCT4=	12.3744
TOPLE	2.5020	B074=	10.3746
T. 7 P 4 =	3.2072	B0-4=	8 • 4 4 4 8
TOP4=	3.6021	80-4=	6.5150
T ~ D 4 =	4.8828	8074=	4.5952
ThP4=	4.5020	3074=	2.6554
TOP4=	5.2021	8074=	0.7256
TOP4=	5.5000	B074=	-1.2242
TOP4=	6.1790	90T4=	-3.1340
TOP4=	6.5710	80 ⁻ 4=	-5.0438
TOPLE	7.7228	90 ⁷⁴ =	-6.9936
TOPUE	7.5000	BC74=	-8-9234
TOP4=	8.0000	B074=	-10-8532
TOP4=	8.5000	8074=	-12.7829
T-P4=	9.0220	90T4=	-14 .7127
T094=	9.5272	BC-4=	-16.6425
* ~ P 4 =	12.0099	80-4=	-18-5723
TOPAS	10.5200	B074=	-20.5021
TCP4=	11.7792	B0T4=	-22.4319
* (°₽4=	11.5292	3074=	-24.3617
TOPAE	12.2202	80 ⁻ 4=	-26.2015
T 3P4=	12.50/0	B074=	-28.2213
TOP4=	13.2020	BOT4=	-30-1511
TOPAE	13.5220	8074=	-32.2808
TNDAE	: 4 . 2222	BCT4=	-34-9106
TOP4=	14.5222	BC-4=	-35-9404
TAPA	15.2000	8074=	-37.0702



STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

+AL+ IS THE LENGHT 0-04 C AL=1000. 0-04 B=AL/5.75 0.º2C *DRA* IS THE DRAFT 2 18 С DRA=8/3.3 2218 D=AL/14. 2.24 *POI* IS THE POISSON'S RATIO OF THE MATERIAL 2:32 С FOR STEEL 1 37 С P01=0.3 131 *E* IS THE YOUNG'S MODULUS OF THE MATERIAL 2738 С FOR STEEL С 138 F=30.=10.+*6 3:38 +DST + IS THE DESIGN STRESS 2 4 C С DST=18020. 1 4C *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS 2154 С 5=30. 2 34 *BM* IS THE BENDING MOMENT 2:50 С $B^{M=}(B=DRA*AL*AL*0*75)/(35*35*)$ JC55 G=0.30396*S*S*(1.-POI_POI)/E 2 88 2 84 *TOP* IS THE THICKNESS OF THE TOP PLATING С 2 84 C *BOT* IS THE THICKNESS OF THE BOTTOM PLATING T0P=5+12 2 34 2190 S0+0=T08 2164 $A = 560 \cdot + BM + (B + ROT + D + TOp)$ 3315 $pEN=D*(3 \cdot + B + B + TOP + BOT_2 \cdot + B + D + TOP + (TOP + BOT) + (D + D + TOP + TOP))$ *STH* IS THE STRESS ON TOP DUE TO HOGGING 3:40 С 2+15 STH=A/DEN 2158 WRITE(5,60)STH 3:74 60 FORMATI' ', 20x, 'STH= 'F10.3) 3816 $C=560 \cdot +PM + (B + TOP + D + TOD)$ 2:84 *SBH* IS THE STRESS ON BOT DUE TO HOGGING С 20:5 SBH=C/DEN WRITE (5,90) SBH 2:06 53:55 90 FURMAT(' ',27x, 'SBH='F10.3) 2:50 C *5BCRIT* IS THE CRITICAL STRESS ON BOT J.I.S.C. SBCRIT=BOT+BOT/G 2228 WRITE(5+110)SACRIT 3258 110 FORMAT(' ',17x, 'SBCRIT='F10.3) 2266 P=2.*D=TOP+B*(TOP+BOT) 2962 *DITOP* IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS С 8928 DITOP=D*(8+BOT+D=TOP)/P 2555 WRITE(5,49)DITOP RASS 40 FORMAT(' , 18x, 'DITOP= 'F10.4) 1328 С *DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS 1358 DIBOT=D=(B+TOD+D+TOP)/P 8355 WRITE(5,50)DIGOT 2326 50 FORMAT(' ',18x, 'DIBOT='F10.4) 33555 FND 11. (S) 15 2324 [V] AL 032C(v) B P334 [V] DRA 033C[V] D + [V] POI 0002(5) .R 234C(V) E 035C(V) DST 0364 [V-S 5- (V) 84 037C[V] G 2388[V] TOP P3=P(V) BOT 0398 (V) A APCVI DEN 23BC [V] STH 2000(S) @I 03C0[V] C 0174613 60

70

PAGE 1

STRENGHT OF SHIPS-ON THE NEUTPAL AXIS LOCATION PAGE 2 03C8(V) SBCRIT 0228(L) 110 0300(V) P 01E2(L) 90 (V) SaH 0000(S) .V 02A8(L) 40 0304(v) DIBOT 0304(L) 50 DOLAS DILOP L VEQ 15 ROGRAM LABELS: 2468 ·V 2898 . COMP 2476 01 2448 •R 2960 .2 2070 *MAIN* 298C .MES 883A .W 2642 EXP 2488 · A 27C8 AI 258E 56 2900 .RARG 2950 .5 2642 AEXP 2964 • ERCNT 2932 \$8 253A ALOG 0. AEAS 3892 2964 .0 TRY-POINTS: 2488 · A 2534 AL 0G 2642 AEXP 2642 EXP 2708 AT 2448 .2 2932 \$8 2950 .5 2898 .COMP 28BE \$6 2900 .RARG 2834 .W 2960 .ZERO 2966 .0 29BC .MES 2A46 .U 246C .V 2964 .ERCNT 2476 PT MMON-BLOCKS: NE DEFINED SUBROUTINES: NE LANSFER ADDRESS 2070 CUTION BEGINS: STH= 18085.023 SBH= 47973.711 SBCRIT= 46323.625 DITOP= 19.5551 DIBOT= 51.8734 END F VIO OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74 JOB HANDLING CHARGE \$.35 / JOB • 35 85 LINES PRINTED PRI \$ 1.25 / K LM •11 54 CARDS READ \$ 1.50 / K CD .08 20 PLOTTER VECTORS \$.25 / 1020 .00 13 MODEL 70 SECONDS \$25.70 / HOUR .09 RE MODEL 82 SECONDS \$12.50 / HOUR . 0.0. TOTAL CHARGE \$ •63 REIR 498 14731 LOGGED OUT 25/06/74 17:36. \$ 8.11 LEFT AFTER 25 LOGINS.


SUMMARY

Length	= 1000 ft
Beam	= AL/5.75
Draft	= B/3.3
Depth	= AL/14
DST	= 18000 psi
S	= 30"
Material	- STEEL
TOP	= 5,12"
вот	= 0.62"
STH	= 18085.02
SBH	= 47973.71
SBCRIT	= 46323.82
DITOP	= 19.55'
DIBOT	= 51.87'

We might say here that the value chosen for S is small and this accounts for the compression at the bottom to reach such a high value.

In the next case, the value chosen for S is increased to 60 inches.



```
*AL* IS THE LENGHT
2294
       С
              AL=1000.
2724
              R=AL/5.75
12220
              +DRA# IS THE DRAFT
0718
       C
              DRA=B/3+3
3 18
              D=41/14 .
1 24
              *POI* IS THE POISSON'S RATIO OF THE MATERIAL
0.30
       C
              FOR STEEL
132
       C
              P01=0.3
2132
              *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
1738
       C
1733
              FOR STEEL
       C
              F=30.=10.=+6
2 38
              #DST # IS THE DESIGN STRESS
LAC.
       C
              DST=18070.
1º 4C
1.54
              *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
       С
              5=68.
1 54
              *BM* IS THE BENDING MOMENT
175C
       C
              RM=(B*DRA*AL*AL*4.75)/(35.*35.)
1 50
              G=0+30396+S+S+(1+=P0I+P0I)/E
2288
              A=9.=B+E+D/(140.=BM)
1.64
              C=3++8+D+D/(7d.+BH)
1 OC
              F=3.*D+D+D/(140.*3M)
1124
              THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
2514
       C
              WRITE(5,10)
2514
           10 FORMAT('1', 25x, 'TOP ASSUMED LARGER THAN BOTTOM')
1:42
116E
              *TOP* IS THE THICKNESS OF THE TOP PLATING
       С
              *BOT* IS THE THICKNESS OF THE BOTTOM PLATING
P16E
       C
              2011=0.82
1:6E
:: 76
           11 TOP1=8*80T1*80T1*80T1/((3+0)*G*0ST-0*80T1*P0T1)
L' DE
              WRITE(5,20)TOP1,80T1
5319
           29 FORMAT(' ',25x, 'TOP1=+F9+4,5X, 'BOT1=+F9+4)
1274
              BOT1=8071+0.02
              1F(BOT1+GT+2+)GO TO 30
1716
85¢3
              GO TO 11
1225
           30 TOP2=1.
2234
           31 BOT2=TOP2+(12.*D~(C+F)*DST*TOP2)/(DST*(A+C)*TOP2=12.*B)
2053
              WRITE(5,40)TOP2,80T2
4651
           40 FORMAT(' ',25x,'TOP2=+F9+4,5X,'BOT2='F9+4)
2054
              5 · 0+5401=5401
22E8
              IF (TOP2 . GT . 6. ) GO TO 50
AZEN
              GO TO 31
DALE
           50 CONTINUE
BOFE
       C
              THICKNESS OF BOTTOM ASSUMED LARGER THAN TOP
BPFE
              WRITE(5,60)
5151
           60 FORMAT('1', 25x, 'BOTTOM ASSUMED LARGER THAN TOP')
0348
              ACT3=0.4
8453
           61 TOP3=((8+D)*B0T3*B0T3*BUT3*D*G*DST*B0T3)/(8*G*DST)
1294
              WRITE (5,70) TOP3, BOT3
395
           70 FORMAT( 1,25x, 'TOP3= (F9.4,5X, 'BOT3= 'F9.4)
B3E0
              BOT3=BOT3+0.02
DEC
              IF (BOT3+GT++85)GO TO 80
BBFE
           80 TOP4=1.
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PAGE

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

1486		81	B014=	(12.*(8	+n) = (A+C)) *DST*T)P4)/((C+F)*1	DSTI			
1.4 4 A			WRITE	(5,90)1	004,8074							
146E		30	FORMA	T(' ',2'	5x, 10P4	=+F9+4,	5X, 180	T4= F9	• 4 }			
1496			TOP4=	TOP'4 + 0 + 0	2							
1642			IF(TOP	P4+GT+5	•5)GO TO	100						
1484			GO TO	81								
1468	1	00	CONTIN	NUE								
148			END									
(5)	• U		04BCC	V) AL	04C4	[√] В	Ø	4CC[V]	DRA	Ø404[V]	D	
C [V]	POI		04E4C	V) E	2000	(s) R	e.	4F4[V]	DST	04FCEVn	S	
- [V] -	BM		0518 C	V) G	0524	LVJ A	Q.	530(V)	С	Ø53C[V]	F	
1111	10		2000019	5] @I	0540	(V) BOT	1 0	176(L)	11	0548[V]	TOP1	
2113	20		222011	_) 30	0558	(V) TOP	2 0:	234 (L)	31	Ø55C(V)	8012	
6 11 1	40		02FEIL	1 50	0312	(1) 60	2	574 (V)	вотз	0348 (L)	61	
CTV1	TOP3		038811	1 70	ØJEE	(1) 80	0	584[V]	TOP4	04061L1	81	
	BOT4		0465 EL	1 90	0488	(1) 100	e	000(51	• V	··· · · · · · · · · · · · · · · · · ·	.	
	0011	1	0.0011		- · · · · ·			010100				
5		L	•									
GRAM	1 LABE	La										
2270	*MATN	. ••• 1 • #	2020	• V	2120	• COMP	SUSE	e I	2600	• R	2818	• 7
2376	SL	•	2640	• A	2874	• MFS	29F2	W	27FA	FXP	2980	ΔΤ
26F2	ALOG		2488	RARG	2814	• 6	27FA	AEXP	2810	FRONT	ZAEA	- 5 9
2010	-200		2852		3044	2	L / · /			121.011		
FOIL	• 0		COF C	•0	JIJTA							
TRY-F	DINTO											
2600	*5 •1413	*	2640	• 4	2652	A. 0G	2754	AFYP	275 4	EYP	2980	Λт
2952	• 15		2152	COMP	2176	UUU	2148	. PAPG	2454	2.2	2014	
12215			2010	- COMP	2015	+ 6	2074	MEC		* C)	2024	
2010	· / E · ())	6016	• CRUNI	COTE	• 0	28/7	1000	COPE	•0	ELLY	• •
-LCC	61											
MAN.	BL OCH	c .										
N.F.	ULUCK	:										
CEFTA	IED S	1800		5 !								
15		10RC	0.146									
2												

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PAGE

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2

ANSFER ADDRESS 2070 CUTION BEGINS:



TOP AS	SUMED LARGER	THAN BO	TTOM
TOP1=	3.2020	BOT1=	0.0200
TOP1=	$0 \cdot 2k \alpha 1$	BOT1=	0.0400
T0P1=	0.0023	BOT1=	0.2600
TOPIE	0.7006	BOT1=	0.2300
T021-	0.20.2	80T1=	3.1000
TOPI	2.00.1	2071-	2.1200
TOPLE	0.0021	2071-	0 1400
	v. • v.v. 33		VI • 1 400
1001=	0.00.49	BOTIE	0.1600
1021=	0.0270	BOT1=	0.1800
T0P1=	0.0097	8071=	0.5000
T0P1=	0.0129	BOT1=	0.5500
TOP1=	0.0169	BOT1=	0.2408
TOP1=	0.0216	80T1=	0.2600
TOP1=	0.0271	80T1=	0.2800
TOPI-	0.23.5	8071=	0.3000
TOP1_	0.0409	8011	0.3200
TOPI	Ø ohet	2071-	2.21.00
T071=	0 • 0 + 9 + 7		0.3400
TOPIE	0.0091	BUILE	0.3000
1071=	0.0100	8011=	0.3800
TOP1 =	0.0824	8071=	0.4000
TOP1=	0.0962	BOT1=	0.4200
T0P1=	0.1116	BOT1=	0.4400
TOP1=	0.1288	80T1=	0.4600
TOP1=	0.1478	BOT1=	0.4800
TOP1 =	0.1609	BOT1=	0.5000
TOP1	0.1901	8071=	0.5200
TOPI	0-01-8	BOTIE	2.5422
TOPA	0 24 70	2071-	0 5400
ToOL	0.2453	2011-	0.5000
1001=	0.2169	BOTIE	0.5600
1021=	0.3108	80T1=	0.6000
1091=	0.3479	BOTIE	0.6500
T0P1=	0.3886	B071=	0.6400
TOP1=	0.4338	8071=	0.6600
TOP1=	0.4816	8071=	0.6800
T0P1=	0.5346	BOT1=	2.7000
TOP1=	0.59.5	80-1=	0.7200
TOP1_	0.6558	BOTI=	0.7400
TOP1 =	0.7218	80T1=	0.7600
TOPI	0.8403	8071=	0.7800
TOPI	0.8828	BOTIE	2.8020
TOP:	2 07.0	0071-	2 8222
TOPIE	0.9/30	00114	0.000
1071=	1.0/1/	BUTIE	1.8400
1091=	1.1/99	BOTT=	0.8600
T0P1=	1.2985	BOTIE	0.8802
TOP1	1.42,9	8071=	0.9000
TOP1=	1.5724	BOT1=	8.9288
TOP1=	1.7306	80T1=	0.9400
TOP1=	1.9054	BOT1=	0.9600
TOP1=	2.0900	BOT1=	0.9800
TOP1-	2.31.1	BOT1=	1.0000
TOPI-	2.5527	8071=	1.0200
TOP1-	2.82.8	BOTIE	1.0400
TOP	3.1209	8011=	1.2600
1024	3.16-6	9071-	1 2222
TAP	3.4020	BUTTE	1.0000
1071=	3+8+80	0011=	1.1000

TOP1=	4.2878	BOT1=	1.1200
TOP1=	4.7931	BOT1=	1.1400
TOP1=	5.3786	B0T1=	1.1600
TOP1=	6.9632	8071=	1.1800
TOP1=	6.8726	8071=	1.2000
TOP1=	7.84.9	8071=	1.2200
TOP1-	9.02.2	8071=	1.2402
TOP1-	10.48.3	8071=	1.2602
TOPI	12 2208	2011-	1.2200
TOPI	14 76-9		1 2000
TOPIE	· · · · · · · · · · · · · · · · · · ·	BU 1-	1.3000
ToDi	.0.01766	0011-	1.3200
TOPIE	22.8310	8011=	1.3400
1071=	30.2304	BOTAE	1.3600
1001=	43.2943	BOT1=	1.3802
TOP1=	72.46.9	BOTI=	1.4000
TOP1=	194.7422	BOT1=	1.4202
TOP1=	339.7143	80T1=	1.4400
T0P1=	-95-43-2	8071=	1.4600
T0P1=	=57.11.3	8071=	1.4800
TOP1=	-41.5440	8071=	1.5000
T0P1=	=33.1158	8071=	1.5200
TOP1=	-27.84.2	8071=	1.5400
TOP1-	=24.23=6	8071=	1.5600
TOPI	-21 (1-9	2011-	1 5200
TOP1-	-19.73-4		1 4 4 4 7 2
TOPI	-12-6294		1.0000
1051=	-10.0200	8014=	1.6200
1001=	=10+8492	BOT1=	1.6400
1001=	=15.8337	8071=	1.6600
T0P1=	=14.9894	B071=	1.6800
T0P1=	-14-2780	8071=	1.7002
T0P1=	-13.6717	8071=	1.7200
TOP1=	-13.1500	8071=	1.7400
T0P1=	-12.6974	BOT1=	1.7600
TOP1=	-12.3021	BOTI=	1.7802
TOP1=	=11.9546	B071=	1.8000
TOP1=	-11-64-5	8071=	1.8200
TOP1=	=11.3750	80T1=	1.8400
TOP1=	=11.1322	8071=	1.8600
TOP1-	#10.91m1	8011=	1.8802
TOP1-	=10.7223	8071=	1.9002
TOP1_	=10.54=3	8011=	1.9200
TOPA	-10 09 5	0011-	1.01.00
TOP1=	-10-3075	B011=	1.9400
TOPIE	-10.2452	B011=	1.9600
IUPIE	-10-1145	8017=	1.9800
TOP1=	-10.2001	B0T1=	5.0000
102=	1.00000	B0T2=	-0.4673
T0P2=	1.2000	8012≖	-0.5810
TOP2=	1.40,0	B072=	-0.7055
TOP2=	1.68.08	B072=	-0.8440
TOP2=	1.8000	8072=	-1.0009
TOP2=	2.0200	=S108	-1.1829
TOP2=	2.28.20	B072=	-1.4002
TOP2.	2.4402	B0T2=	-1.6693
TOP2-	2.60.00	8072=	-2.0190
TOP2-	2.80.20	8072=	-2.5045
TOP2	3.02.00	8072-	-3.2440
		0012#	5.2.700

TOP2=	3.2000	8072=	=4.5652
TOP2=	3.4000	BOT2=	-7.7108
TOP2=	3.6000	B0T2=	-26.8087
TOP2=	3.8000	=5T08	16.3226
TOP2=	4.0000	B012=	5.8811
T0P2=	4.2800	=2106	3.3945
T0P2=	4.4808	=5108	2.2560
T0P2=	4.6070	80T2=	1.5888
TOP2=	4.8820	8072=	1.1408
TOP2=	5.0200	=S108	0.8127
10P2=	5.2000	B0T2=	0.5572
T0P2=	5-48-20	8012=	0.3490
T0P2=	5.60,00	80.2=	ؕ1733
TOP2=	5.2000	BOT2=	0.0210
TOP2=	6.00,00	BOT2=	=0.1140



BOTTON	ASSUMED	LAPGER THA	N TOP		
TOP3 _#	-0.0172	BOT3=	0.4000		
. TOP4=	1.2400	BOT4=	16.1639		
TOP4=	1.2000	BOT4=	15.3920		
TOP4=	1.4000	BOT4=	14.6201		
TOP4=	1.68 20	8074=	13.8482		
TOP4=	1.8690	8074=	13.0763		
TOP4=	2.0800	BOT4=	12.3044		
TOP4=	2.21.00	BOT4=	11.5324		
TOP4=	2.40,00	8074=	10.7605		
TOP4=	2.62.00	BOT4=	9.9886		
TOP4=	2.2000	80T4=	9.2167		
TOP4=	3.00,00	80T4=	8.4448		
TOP4=	3.2200	B074=	7.6729		
TOP4=	3.4000	8014=	6.9010		
TOP4=	3.68.00	8074=	6.1290		
TOP4=	3.2120	BOT4=	5.3571		
TOP4=	4.0800	8074=	4.5852		
T024=	4.2200	BOT4=	3.8133		
TOP4=	4.4020	8074=	3.0414		
TOP4=	4.62.00	8074=	2.2695		
TOP4=	4.8000	B074=	1.4975		
TOP4=	5.0002	B0T4=	0.7256		
TOP4=	5.2020	B074=	-0.0463		
TOP4_	5.4800	8074=	-0.8182		
END					
VIO OPERATING SYSTEM VERSI	ION 1 REV	ISION 012	03/04/74	GENERATED	\$5/06/74
JOB HANDLING CHARGE \$.35	5 / JOB	•35			
PAG LINES PRINTED PR1 \$ 1.25	5 / K LN	• 31			
66 CARDS READ \$ 1.50	M / K Cn	• 1 0			
PR PLOTTER VECTORS \$.25	5 / 1020	• 0 0			

88	PLOTTER	، آ	ECTORS	\$.25	1	1020	• 00
17	MODEL 7	72	SECONDS	\$25.00	1	HNUP	•12
69	MODEL	30	SECONDS	\$12.50	1	HOUS	•00
				TOTAL	CI	HARGE	\$ •88

PEIR 490 14731 LOGGED OUT 05/06/74 17:28. \$ 8.74 LEFT AFTER 24 LOGINS.

STRENGHT OF SHIPS ON THE NEUTRAL AXIS LOCATION

+AL+ IS THE LENGHT 84 С AL=1000. 24 B=AL/5.75 20 .DRA = IS THE DRAFT С 18 DRA=8/3.3 18 D=AL/14. 24 *POI* IS THE POISSON'S RATIO OF THE MATERIAL 32 C FOR STEEL 36 С p01=0.3 32 *E* IS THE YOUNG'S MODULUS OF THE MATERIAL 3.8 С 38 Ċ FOR STELL 38 E=30.+12.++6 *DST* IS THE DESIGN STRESS 40 С DST=180/0. 40 *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS 54 С 54 S=66 . 50 *BM* IS THE BENDING MOMENT C $B^{M=}(B*DRA*AL*AL*0*75)/(35**35*)$ 50 G=0.30396*S*S*(1.=POI+POI)/E 82 *TOP* IS THE THICKNESS OF THE TOP PLATING 84 C .BOT. IS THE THICKNESS OF THE BOTTOM PLATING 84 C 84 TUP=4.79 30 BOT=1+15 C 4 $A = 560 \bullet \pm 3M \pm (B \pm ROT + D \pm TOP)$ DEN=D*(3**B*B*TOP*BOT+2**B*D*TOP*(TOP+BOT)+(D*D*TOP*TOF))FP 4C *STH* IS THE STRESS ON TOP DUE TO HOGGING C 40 STH=A/DEN 58 WRITE(5,60)STH 60 FURMAT(' ', 20x, 'STH='=10.3) 74 $C=560 \cdot *BM = (B * TOP + D * TOP)$ SE 84 *SBH* IS THE STRESS ON BOT DUE TO HOGGING С BA. SBH=C/DEN C6 WRITE(5,90)SBH 90 FORMAT(' ',20x, 'SBH='F10.3) 55 FC *SBCRIT* IS THE CRITICAL STRESS ON BOT C FC SBCRIT=BOT+BOT/G 32 WRITE(5,110)SRCFIT 52 110 FORMAT(' ',17x, 'SBCRIT='F10'3) 144 P=2 + + D = TOP + B + (TOP + BOT) *DITOP IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS 68 С -62 DITOP=D=(B+BOT+D+TOP)/P Eac WRITE(5,40)DITOP SAP 42 FORMAT(' ', 18x, 'DITOP= 'F10.4) 204 *DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS C PC4 DIBOT=D=(B=TOP+D=TOP)/P 928 WRITE(5,50)DIROT 458 50 FORMAT(' ',18x, 'DIBOT='F10.4) 556 END (S) .U 2324 (V) AL 032C(v) B 0334 (V) DPA Ø33C(V) D - [V] POI 0364 [V] 234C(V) E 0000(5) .R 035C(V) DST S CEVI BM 2382 [V] G 038C[V] TOP 0394(V) BOT Ø39C(V) Α C(V) DEN B3CB[V] STH 0000[S] @I 03C4 (V) С 8174[] 60

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PAGE

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION PAGE 2 01E2(L) 90 SA(V) SAH 03CC(V) SBCRIT 0228(L) 110 0300(V) P J4 (V) DTTOP 22A8(L) 40 03D8(V) DIBOT 0304(L) 50 0000(S- .V .XEQ L 35 ROGRAM LARELS: 2070 *MAIN* 249C • A 910 - 0885 2A7A MI 244C .R 2964 .2 248C .A 2802 \$6 2900 .MES 283E .W 2646 EXP 27CC AI 253E ALOG 2984 .RARG 2960 .5 2646 AEXP 2968 .ERCNT 2936 \$8 2A3E .U 2968 .0 3896 ITRY-PUINTS: 244C .R 248C .A 253E A1 0G 2446 LEXP 2646 EXP 27CC AI 283E .W 289C .COMP 2802 \$6 2904 .RARG 2936 \$8 2960 .5 2964 +7ER0 2968 .ERCNT C• 4965 29CF MES 0. 44AS 2170 .V 2A7A @T MON-BLOCKS: I'E DEFINED SUBPOUTINES: NE ANSFER ADDRESS 2070 CUTION BEGINS: STH= 18017.242 SBH= 39055.434 SBCRIT= 39843.250 DITOP= 22.5492 DIBOT= 48.8793 =ND F VID OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74 JOB HANDLING CHARGE \$.35 / JOB • 35 85 LINES PRINTED PRI \$ 1.25 / K LN • 11 54 CARDS READ \$ 1.50 / K CD • 08 20 PLOTTER VECTORS \$.25 / 10%3 .00 13 MODEL 70 SECONDS \$25.00 / HOUR .09 00 MODEL 80 SECONDS \$12.50 / HOUR .02 TOTAL CHARGE \$ •63 EIR 490 14731 LOGGED OUT 05/06/74 17:37. \$ 7.48 LEFT AFTER 26 LOGINS.

SUMMARY

Length	= 1000
Beam	= AL/5.75
Draft	= B/3.3
Depth	= AL/14
DST	= 18000 ps:
S	= 60"
Material	- STEEL
TOP	= 4.79"
BOT	= 1.15"
STH	= 18017.24
SBH	= 39055.43
SBCRIT	= 39843.44
DITOP	= 22.55
DIBOT	= 48.88'

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Since sometimes it is desirable to use aluminum alloys in the structure of ships, due to their light weight, high corrosion resistance and non-magnetic characteristics, in the following runs, the material considered is aluminum. The necessary change is made in the input to account for the properties of this material.

When considering aluminum as the structural material, we must keep in mind that the aluminum hull will be more flexible than a corresponding steel ship. The modulus of elasticity of aluminum is about one third that of steel, and if scantlings were identical, the deflection of an aluminum ship, under a given load, would be three times those of a steel ship.

However, to obtain a factor of safety on ultimate strength equal to that in steel, the area of an aluminum member in direct stress, or the section modulus of an aluminum member in bending would be about 1.5 times that of the corresponding steel member (based on an ultimate strength of about 60000 psi in medium steel and of about 40000 psi across the welds of a welded aluminum structure).

A section modulus of 1.5 times that in steel, with the same depth being considered in both cases, would result in a deflection in aluminum about twice that in steel. However, the lower modulus of elasticity of aluminum reduces its ability to resist buckling, and for the same factor of safety both the section modulus and the moment of inertia in aluminum would in

general be somewhat more than 1.5 times those in steel, so that the deflection of the aluminum structure would in general be somewhat less than twice that of the steel structure.

The greater deflection would reduce the natural frequency of hull vibration, and sowould affect the interaction of slamming stress and bending moment stress. It could also affect shaft bearing pressures. It has been proposed as an arbitrary basis of design that aluminum ships be designed for a deflection about 1.5 times that of steel ships. This would require a moment of inertia of twice the value of that in the steel hull girder, and would automatically result in a section modulus substantially more than 1.5 times that in steel, and a factor of safety correspondingly greater than in steel.

2004	С		*AL* IS THE LENGHT
2 94			$\Delta L = 1 \ \ell^{\alpha} \ell^{\alpha} \ell^{\beta} \cdot$
200			B=AL/5./5
2 18	С		+DRA IS THE OPAFT
2.18			Drv=F13·3
: 24			$D = \Lambda \lfloor / \rfloor 4 \cdot$
1. 36	С		*PUI IS THE POISSON'S PATIO OF THE MATERIAL
: 32	С		FOR ALUMINUM
1.32			PCI=0+33
: 38	С		*E. IS THE YOUNG'S MODULUS OF THE MATERIAL
: 38	С		FUR ALUMINUM
: 38			E=1V · *1: · **6
4C	С		DST & IS THE DESIGN STRESS
. 4C	-		$0 \le 1 = 13 (0) C \bullet$
	C		S. IS THE SPACING OF LONGITUDINAL STIFFENING NEMBERS
. = 4	-		S=10.
50	C		-BET IS THE BENDING MOMENT
2 2 6	6		$R^{T} = (R * P \land A * A \bot * A \bot * A \bot * B \cdot 75) / (35 • * 35 •)$
5.8			c=2+30296*\$*\$*(1+=P01_P01)/F
. 24			$A = 9 \cdot \mathbf{w} + \mathbf{w} = D / (1 \cdot M \cdot \mathbf{w} + M)$
S.F.C.			C=3+*8*(*0/(7),*0)
			$E = \exists \cdot \mathbf{v} D \mathbf{v} [\mathbf{v} D \mathbf{v} (1 \mathbf{v} \mathbf{v} \cdot \mathbf{v} \mathbf{H} \mathbf{M})$
1120	C		THICKNESS OF THE ASCHUED LARGER THAN BOTTOM THICKNESS
	6		white (5,10)
			MUTEL VIEW MORMAT/141.26. ITOD ASSUMED LADGED THAN DOTTOMIN
C 401	~	10	TOP IS THE HICKNESS OF THE TOP LIATING
	6		THE THE HETCKNESS OF THE SOTTOM DEATING
2115	L		ACTIVE TO THE THICKNEYS OF THE SOTTOR FEATING
6.00			
6.10		11	TELIEVENONITORA DOTA
LICE D		20	
C.CC		26	POT/=PO14.40.2.
1216			$\frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \sum_{i=1}^{2} \sum_{i=1}^{2} \sum_{i=1}^{2} \sum_{j=1}^$
11225			$\frac{1}{10} 1001101000000000000000000000000000000$
LEEG		~	
226		30	
207		-1	2012=1012+112,*UT12+F)+US1+10F277(151+(ATL)+10F2=12++0
1-51			WOITE(0)44)10021012
12200		49	-000-10H040-0
1071JC			
1-7.0			JE (1045+01+2+) CO IO 20
C = A		-	
LADEE		۳ (·	
OFFE	С		THICKNESS OF ADITOM ASSUMED LARGER THAN TUP
ICTE INT			WATE(5)60)
e ile		61	FURMATICE 1', 25%, 'BUTTUM ASSUMED LARGER THAN TOP!)
2342			B013=6.1
12001		6.	TUP3=((1+D)*80T3*MOT3*D*G*DST*BOT3)/(B*G*CST)
2:00			WRITE(5,78)1003,8013
33.0		70	FURMAT(' ',25v,'TOP3=+F9.4,5X,'BOT3='F9.4)
6 22			BUT3=B0+3+0+2+

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IF (BOT3.GT. . 24) GU TO 80 3355 3 4 ES 60 TU 61

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STRENGHT OF SHIPSTON THE PEUTRAL AXIS LOCATION

Pr TOP4=1 . 5000 =1 BCT4=(12.*(B+~)-(A+C)+DST*TOP4)/((C+F)*DST) 1494 WRITE(5,90) TC-4, POTA 214E 9. FORMAT(' ',25x, 'TOPL=: F9.4,5X, 'BOTL='F9.4) : . 72 T0P4=T0P4+0.2 1005 1F(TOP4.GT.5.5)GO TO 100 1 "AF GO TO 81 26EB 10 CONTINUE . - - C END 7 43 C +4CCEVI AL C4CPEVJ B M4r0[V] DRA 0408 (V) D : (S] •[] E (V) PAI 2428[V] E APPle] .R 04F4[V] DST 04FC[V] S 2 EV3 11 2514[V] G V52PLVJ A 052C(V) C 2538 (V) F 4 (L) 17 19 (2) 15V PI 0544 [V-153C(V) BOT1 0176[L] 11 TOP1 2550(F) 36 2550 (V) TOP2 2234(L) 31 05501V- BCT2 c (L) 27 PEFEILI SO 2312613 62 0570 (V) BOT3 2348[L] 61 = (L) 47 040A [L. 81 1 IVI TOP3 23351L1 70 1402113 80 0520[V] TOP4 · IV: AFT4 24721L1 90 04BCG 3 100 8663[S] .V F C. L 01 R GFA- LIFELS: 2010 ·V 2446 . - OMP I.0 AS35 25FC .R 2814 .7 2,78 ** 21 1* 27F6 EXP 263C .A 2770 .MES 29EF .W 291C AI :472 51 2AB4 .HARG 2810 .5 27F6 AEXP OT LA 373 2B18 .ERCNT 2AE6 \$8 -515 .0 2BEE .U 3046 NTRY-FOINTS: 27F6 AEXP SFC .= A. 2635 26EE ALOG 27F6 EXP 2970 AI 2955 .r. 244C .CUMP 2472 \$6 2484 .RARG 2AE6 \$8 2810 .5 2518 . ERCNT 2414 .7FFD 281A . 0 2878 .MES 2BFA .U SC50 .1 10 4535 C MON-BI DEKS: - F N EFINER SUBROUTINES: O E FANSFER ADDFESS 2270 ECUTION EEGINS:

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PAGE

TOP ASS	UMED LARGER	THAN B	INTTOM	
TOP1=	8.1558	BOT1=	0.5000	
TOP1=	2.18.28	BOTI=	0.5100	
TOP1=	7.2177	BOT1=	0.2200	
TCP1=	1.25.96	8071=	0.2302	
TOP1=	3.3124	8071=	2. 2408	
TOP1=	7.3624	8011=	0.2500	
T0P1=	1.4225	8071=	6.5600	
TCP1=	7.54128	8071=	2.2700	
TOP1=	7.6 71	8071=	0.2808	
T0P1=	1.7123	BOT1=	7.2922	
TOP1=	1.8427	B071=	0.3002	
TCP1=	1.0164	BOTI=	8.3100	
TCP1=	1-2263	8071=	2.3200	
TOP1=	1-4941	ROT1=	8.3300	
TCP1=	1.8456	8071=	0.3400	
TOP1=	3155.5	BOTI=	0.3500	
TOP1=	3-08-33	8071=	8.3682	
TOP1=	4.2353	BOT1=	8.3708	1
T0P1=	5.79-1	BOT1=	0.3800	
TOP1=	9.4496	3071=	0.3902	
TOP1=	20.3501	8071=	0.4002	
TOPP=	1.0000	=S108	-2.4673	
=5901	1.21.48	8072=	-0.5810	
=590T	1.4.08	=S108	-0.7055	
TCP2=	1.61-6	8072=	-0.8440	
=SQ0T	1.2000	8012=	-1.0009	
=540T	2.04.00	=S~08	-1.1829	
TOP2=	2.21 28	B0T2=	-1.4002	
TOP2=	2.40000	B0T2=	-1.6693	
TOP2=	2.6120	80T2=	-2.1190	
T0P2=	8-52-8	8072=	-2.5045	
T022=.	3.0000	8072=	-3.2460	
TOP2=	3.2.00	B072=	-4.5652	
TOP2=	3.4" .8	B0T2=	-7.7108	
TGP2=	3.68 28	8072=	-26-8087	
TOP2=	3.2108	B072=	16.3226	
TOP2=	4.0108	8072=	5.8811	
TCP2=	4.2.78	=2T08	3.3945	
TOP2=	4.48-8	B072=	2.2560	
TOP2=	4.6.2.78	=S108	1.5888	
T022=	4.2872	8072=	1.1408	
TOP2=	5.04 28	B072=	0.8127	
TOP 2=	5,5000	BOT 2=	0.2578	
• • • • • • • • • • • • • • • • • • • •				

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TOP3= $-9 \cdot c1 p1$ BOT3= $0 \cdot 1000$ TOP3= $-0 \cdot cV < 7$ BOT3= $0 \cdot 1000$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1200$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1200$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1200$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1200$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1200$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1600$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1600$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $0 \cdot 1600$ TOP3= $0 \cdot 2 \cdot p7$ BOT3= $2 \cdot 2000$ TOP3= $0 \cdot 16 \cdot 17$ BOT3= $2 \cdot 2000$ TOP3= $0 \cdot 16 \cdot 17$ BOT3= $0 \cdot 22000$ TOP3= $0 \cdot 2 \cdot 177$ BOT3= $0 \cdot 22000$ TOP3= $0 \cdot 2 \cdot 177$ BOT3= $0 \cdot 22000$ TOP3= $0 \cdot 2 \cdot 177$ BOT3= $0 \cdot 22000$ TOP3= $0 \cdot 2 \cdot 177$ BOT3= $0 \cdot 22000$ TOP4= $1 \cdot 0 \cdot 100$ BOT4= $16 \cdot 1639$ TOP4= $1 \cdot 0 \cdot 100$ BOT4= $13 \cdot 0763$ TOP4= $1 \cdot 0 \cdot 100$ BOT4= $13 \cdot 0763$ TOP4= $1 \cdot 0 \cdot 100$ BOT4= $19 \cdot 7605$ TOP4= $2 \cdot 2 \cdot 000$ BOT4= $19 \cdot 28 \cdot 0016$ TOP4= $2 \cdot 2 \cdot 000$ BOT4= $9 \cdot 28 \cdot 0016$ TOP4= $3 \cdot 0 \cdot 0 \cdot 000$ BOT4= $5 \cdot 3571$ TOP4= $3 \cdot 0 \cdot 0000$ BOT4= $3 \cdot 02 \cdot 00000$ TOP4= $4 \cdot 0 \cdot 0000000000000000000000000000000$	ROTTOM	ASSUMED	LARGER THAN	TOP
TOP3= $-0.2\%67$ BOT3= 0.110% TOP3= $0.2\%77$ BOT3= 0.12% TOP3= 0.2772 BOT3= 0.12% TOP3= 0.2772 BOT3= 0.14% TOP3= 0.25% BOT3= 0.14% TOP3= 0.25% BOT3= 0.16% TOP3= 0.16% BOT3= 0.20% TOP3= 0.25% BOT3= 0.22% TOP3= 0.25% BOT3= 0.22% TOP3= 0.25% BOT3= 0.23% TOP4= $1.0\%\%$ BOT4= 16.163% TOP4= $1.0\%\%$ BOT4= 13.27% TOP4= $1.0\%\%$ BOT4= 13.27% TOP4= $1.6\%\%$ BOT4= 19.84% TOP4= $1.2\%\%$ BOT4= 19.84% TOP4= $2.2\%\%$ BOT4= 19.84% TOP4= $2.2\%\%$ BOT4= 9.88% TOP4= $2.2\%\%$ BOT4= 9.98% TOP4= $3.6\%\%$ BOT4= 9.98% TOP4=	TOP3=	-0.0121	ВОТЗ≖	0.1000
TOP3= $0.2.97$ BOT3= 0.1200 TOP3= 0.212 BOT3= 0.1300 TOP3= 0.249 BOT3= 0.1400 TOP3= 0.2598 BOT3= 0.1600 TOP3= 0.2598 BOT3= 0.2000 TOP3= 0.1817 BOT3= 0.2200 TOP3= 0.2576 BOT3= 0.2200 TOP3= 0.2576 BOT4= 16.1639 TOP4= 1.9000 BOT4= 15.3920 TOP4= 1.9000 BOT4= 13.8482 TOP4= 1.9000 BOT4= 13.8482 TOP4= 1.9000 BOT4= 13.8482 TOP4= 1.9000 BOT4= 13.8482 TOP4= 2.9000 BOT4= 13.92600 TOP4= 2.9000 BOT4= 19.9886 TOP4= 2.9000 BOT4= 9.9886 TOP4= 2.9000 BOT4= 9.9886 TOP4= 2.9000 BOT4= 9.9886 TOP4= 2.9000 BOT4= 9.9886 TOP4= 3.97000 BOT4= 9.9886 TOP4= 3.97000 BOT4= 9.9886 TOP4= 3.97000 BOT4= 9.9886 TOP4= 3.97000 BOT4= 9.9886 TOP4= 3.970000 <	TOP3=	-0.2167	BOT3=	0.1100
TCP3 = $0.21-2$ $BOT3 =$ 0.1300 $TOP3 =$ 0.249 $BOT3 =$ 0.1400 $TOP3 =$ 0.2528 $BOT3 =$ 0.1600 $TOP3 =$ 0.1204 $BOT3 =$ 0.2000 $TOP3 =$ 0.1617 $BOT3 =$ 0.2000 $TOP3 =$ 0.2576 $BOT3 =$ 0.2300 $TOP4 =$ 1.9000 $BOT4 =$ 16.1639 $TOP4 =$ 1.9200 $BOT4 =$ 13.8482 $TOP4 =$ 1.4000 $BOT4 =$ 13.8482 $TOP4 =$ 1.4000 $BOT4 =$ 13.8482 $TOP4 =$ 1.4000 $BOT4 =$ 13.8482 $TOP4 =$ 2.2002 $BOT4 =$ 19.9886 $TOP4 =$ 2.2002 $BOT4 =$ 9.9886 $TOP4 =$ 2.2002 $BOT4 =$ 9.9886 $TOP4 =$ 2.2002 $BOT4 =$ 9.9886 $TOP4 =$ 3.2002 $BOT4 =$ 9.9886 $TOP4 =$ 3.2002 $BOT4 =$ 9.9267 $TOP4 =$ 3.20	TOP3=	3.2.27	B∩T3=	0.1200
TOP3= $0.02+9$ $BOT3=$ 0.1400 $TOP3=$ $0.02+9$ $BOT3=$ 2.1500 $TOP3=$ $0.25p8$ $BOT3=$ 0.1600 $TOP3=$ $0.07p3$ $BOT3=$ 0.1600 $TOP3=$ $0.07p3$ $BOT3=$ 0.1600 $TOP3=$ $0.07p3$ $BOT3=$ 0.1700 $TOP3=$ $0.07p3$ $BOT3=$ 0.1800 $TOP3=$ 0.1204 $BOT3=$ 0.2000 $TOP3=$ 0.1617 $BOT3=$ 0.2200 $TOP3=$ 0.2576 $BOT3=$ 0.2200 $TOP3=$ 0.2576 $BOT3=$ 0.2300 $TOP3=$ 0.2576 $BOT3=$ 0.2400 $TOP3=$ 0.2576 $BOT3=$ 0.2300 $TOP3=$ 0.2576 $BOT4=$ 16.1639 $TOP4=$ 1.0200 $BOT4=$ 15.3920 $TOP4=$ 1.2200 $BOT4=$ 13.8482 $TOP4=$ 1.400 $BOT4=$ 19.9886 $TOP4=$ 2.2002 $BOT4=$ 9.9886 $TOP4=$ 2.2002 $BOT4=$ 9.9886 $TOP4=$ 3.2002 $BOT4=$ 9.9267 $TOP4=$ 3.2002 $BOT4=$ 9.9267 $TOP4=$ 3.2002 $BOT4=$ 3.2102 $TOP4=$ 3.2002 $BOT4=$ 3.2102	TOP3=	0.71-2	80T3=	0.130.0
TOP3= 0360 BOT3= 2.1500 TOP3= 0.2528 BOT3= 0.1600 TOP3= 0.2723 BOT3= 0.1600 TOP3= 0.7723 BOT3= 0.1700 TOP3= 0.7723 BOT3= 0.1800 TOP3= 0.1224 BOT3= 2.1900 TOP3= 0.1617 BOT3= 2.2000 TOP3= 0.1617 BOT3= 0.2200 TOP3= 0.2576 BOT3= 0.2200 TOP4= 0.600 BOT4= 15.3920 TOP4= 1.6200 BOT4= 15.3920 TOP4= 1.6200 BOT4= 13.8482 TOP4= 1.6200 BOT4= 13.8482 TOP4= 1.6200 BOT4= 13.8482 TOP4= 2.6000 BOT4= 19.7605 TOP4= 2.6000 BOT4= 19.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 3.6000 BOT4= 9.9886 TOP4= 3.6000 BOT4= 9.9886 TOP4= 3.6000 BOT	T0P3=	0.0219	BOT3=	0.1400
TOP3 = $0.25p8$ BOT3 = 0.1600 TOP3 = 0.723 BOT3 = 0.1700 TOP3 = 0.723 BOT3 = 0.1700 TOP3 = $0.12a4$ BOT3 = 2.1900 TOP3 = $0.12a4$ BOT3 = 2.2000 TOP3 = $0.12a7$ BOT3 = 0.2200 TOP3 = 0.1517 BOT3 = 0.2200 TOP3 = 0.2576 BOT3 = 0.2200 TOP3 = 0.2576 BOT3 = 0.2200 TOP3 = 0.2576 BOT3 = 0.2200 TOP4 = 1.600 BOT4 = 16.1639 TOP4 = 1.600 BOT4 = 14.6201 TOP4 = $1.22a0$ BOT4 = 13.82482 TOP4 = 1.4000 BOT4 = 13.8763 TOP4 = 1.4000 BOT4 = 13.8763 TOP4 = 1.6000 BOT4 = 13.8763 TOP4 = 2.2000 BOT4 = 19.9886 TOP4 = 2.2000 BOT4 = 9.9886 TOP4 = 2.2000 BOT4 = 9.9886 TOP4 = 2.2000 BOT4 = 9.9886 TOP4 = 3.6000 BOT4 = 9.9886 TOP4 = 3.6000 BOT4 = 4.5852 TOP4 = 3.6000 BOT4 = 4.5852 TOP4 = 3.6000 BOT4 = 3.6133 TOP4 = 4.6000 BOT4 = 3.6	TOP3=	0360	80T3=	2.1500
TOP3= 0.0723 BOT3= 0.1700 TOP3= 1.0948 BOT3= 0.1800 TOP3= 0.1204 BOT3= 0.1800 TOP3= 0.1204 BOT3= 0.2000 TOP3= 0.1204 BOT3= 0.2000 TOP3= 0.1277 BOT3= 0.2200 TOP3= 0.2576 BOT3= 0.2200 TOP3= 0.3014 BOT3= 0.2200 TOP4= $1.0.00$ BOT4= 16.1639 TOP4= 1.400 BOT4= 13.8482 TOP4= 1.400 BOT4= 13.8482 TOP4= 1.400 BOT4= 13.8482 TOP4= 1.400 BOT4= 13.8482 TOP4= 1.400 BOT4= 13.8763 TOP4= 2.2002 BOT4= 1.6201 TOP4= 2.2002 BOT4= 1.92002 TOP4= 2.2002 BOT4= 1.92002 TOP4= 2.2002 BOT4= 1.92002 TOP4= 2.2002 BOT4= 1.92022 TOP4= 2.2002 BOT4= 1.92022 TOP4= 2.2002 BOT4= 1.92022 TOP4= 3.60022 BOT4= 4.920222 TOP4= 3.6002222 BOT4= 3.6133222 TOP4= 4.9202222222222222 BOT4= $3.81332222222222222222222222222222222222$	TOP3=	1.2528	B073=	0.1600
TOP3= $4 \cdot c948$ $80T3=$ 0.1800 TOP3= $3.12a4$ $80T3=$ 2.1902 TOP3= $3.12a4$ $80T3=$ 2.2002 TOP3= 0.1617 $80T3=$ 2.2002 TOP3= 0.2576 $80T3=$ 0.22002 TOP3= 0.2576 $80T3=$ 0.23002 TOP3= 0.2576 $80T3=$ 0.22002 TOP4= $1.0.a02$ $80T4=$ 16.16392 TOP4= $1.0.a02$ $80T4=$ 14.62012 TOP4= $1.22a02$ $80T4=$ 13.84822 TOP4= $1.42a02$ $80T4=$ 13.84822 TOP4= $1.42a02$ $80T4=$ 13.84822 TOP4= $1.42a02$ $80T4=$ 13.84822 TOP4= $1.42a02$ $80T4=$ 13.84822 TOP4= $2.22a02$ $80T4=$ 19.7632 TOP4= $2.22a02$ $80T4=$ 19.7632 TOP4= $2.22a02$ $80T4=$ 19.7632 TOP4= $3.22aa2$ $8074=$ 9.98862 TOP4= $3.22aa2$ $8074=$ 9.98862 TOP4= $3.22aa2$ $8074=$ 9.98862 TOP4= $3.22aa2$ $8074=$ 9.98862 TOP4= $3.22aa2$ $8074=$ 9.9262 TOP4= $3.22aa2$ $8074=$ 9.9262 TOP4	TOP3=	1.0723	8073=	1700
TOP3= $3 \cdot 1204$ BOT3= $2 \cdot 1900$ TOP3= $3 \cdot 1403$ BOT3= 22000 TOP3= $0 \cdot 1617$ BOT3= 22000 TOP3= $0 \cdot 2576$ BOT3= $0 \cdot 2200$ TOP3= $0 \cdot 2576$ BOT3= $0 \cdot 2300$ TOP3= $0 \cdot 2576$ BOT3= $0 \cdot 2200$ TOP3= $0 \cdot 2576$ BOT4= $0 \cdot 2400$ TOP4= $1 \cdot 9177$ BOT4= $16 \cdot 1639$ TOP4= $1 \cdot 9170$ BOT4= $15 \cdot 3920$ TOP4= $1 \cdot 9170$ BOT4= $13 \cdot 8482$ TOP4= $2 \cdot 9170$ BOT4= $13 \cdot 8482$ TOP4= $2 \cdot 9170$ BOT4= $19 \cdot 9886$ TOP4= $2 \cdot 9170$ BOT4= $9 \cdot 9886$ TOP4= $2 \cdot 9170$ BOT4= $9 \cdot 9886$ TOP4= $3 \cdot 9170$ BOT4= $3 \cdot 8133$ TOP4= $3 \cdot 9170$ BOT4= $3 \cdot 8133$ TOP4= $4 \cdot 9170$ BOT4= $3 \cdot 8133$ TOP4= $4 \cdot 9170$ BOT4= $3 \cdot 9174$ TOP4= $4 \cdot 9170$ BOT4= $1 \cdot 9755$	T023=	4.0948	8013=	0.1800
TOP3= $3 \cdot 14 \circ 3$ BOT3= $2 \cdot 200\%$ TOP3= $0 \cdot 18 \cdot 17$ BOT3= $2 \cdot 210\%$ TOP3= $0 \cdot 2177$ BOT3= $0 \cdot 220\%$ TOP3= $0 \cdot 2576$ BOT3= $0 \cdot 230\%$ TOP3= $0 \cdot 3\% \cdot 4$ ROT3= $0 \cdot 240\%$ TOP4= $1 \cdot 0 \cdot 0\%$ BOT4= $16 \cdot 1639$ TOP4= $1 \cdot 2\% \cdot 0\%$ BOT4= $15 \cdot 392\%$ TOP4= $1 \cdot 2\% \cdot 0\%$ BOT4= $13 \cdot 848\%$ TOP4= $1 \cdot 2\% \cdot 0\%$ BOT4= $13 \cdot 848\%$ TOP4= $1 \cdot 2\% \cdot 0\%$ BOT4= $13 \cdot 848\%$ TOP4= $1 \cdot 2\% \cdot 0\%$ BOT4= $13 \cdot 8763\%$ TOP4= $2 \cdot 2\% \cdot 0\%$ BOT4= $10 \cdot 7605\%$ TOP4= $2 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $2 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $2 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $2 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $3 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $3 \cdot 2\% \cdot 0\%$ BOT4= $9 \cdot 9886\%$ TOP4= $3 \cdot 2\% \cdot 0\%$ BOT4= $3 \cdot 81 \cdot 3\%$ TOP4= $3 \cdot 2\% \cdot 0\%$ BOT4= $3 \cdot 81 \cdot 3\%$ TOP4= $3 \cdot 81 \cdot 0\%$ BOT4= $3 \cdot 81 \cdot 3\%$ TOP4= $4 \cdot 2\% \cdot 0\%$ BOT4= $3 \cdot 81 \cdot 3\%$ TOP4= $4 \cdot 6\% \cdot 2\%$ BOT4= $3 \cdot 81 \cdot 3\%$ TOP4= $4 \cdot 6\% \cdot 2\%$ BOT4= $1 \cdot 4975\%$ TOP4= $5 \cdot 2\% \cdot 2\%$ BOT4= $-0 \cdot 0463$ TOP4= $5 \cdot 2\% \cdot 2\%$ BOT4= $-0 \cdot $	TOP3=	3.1204	80T3=	2.1900
TOP3= $0.1b17$ BOT3= 2.2102 TOP3= 0.2576 BOT3= 0.2200 TOP3= 0.2576 BOT3= 0.2300 TOP3= 0.3814 BOT3= 0.2402 TOP4= $1.0.00$ BOT4= 16.1639 TOP4= 1.2270 BOT4= 15.3920 TOP4= 1.4170 BOT4= 13.8482 TOP4= 2.2700 BOT4= 13.8482 TOP4= 2.2700 BOT4= 19.8482 TOP4= 2.2700 BOT4= 9.9886 TOP4= 2.2700 BOT4= 9.9886 TOP4= 2.2700 BOT4= 9.9886 TOP4= 2.2700 BOT4= 9.9886 TOP4= 3.6170 BOT4= 9.9886 TOP4= 3.6170 BOT4= 9.9886 TOP4= 3.6170 BOT4= 3.8133 TOP4= 3.6170 BOT4= 3.8133 TOP4= 4.8170 BOT4= 3.6414 TOP4= 4.8170 BOT4= 0.7256 TOP4= 4.8170 BOT4= 0.0463 TOP4= 5.2170 BOT4= 0.0463 TOP4= 5.4170 BOT4= -0.8182	TOP3=	3.1403	80T3=	2.2000
TOP3= 0.2177 $00T3=$ 0.2200 TOP3= 0.2576 $00T3=$ 0.2300 TOP3= 0.3714 $00T3=$ 0.2400 TOP4= $1.0.00$ $00T4=$ 16.1639 TOP4= 1.2700 $00T4=$ 16.1639 TOP4= 1.2700 $00T4=$ 14.6201 TOP4= 1.4000 $00T4=$ 13.8482 TOP4= 1.4000 $00T4=$ 13.8482 TOP4= 1.4000 $00T4=$ 13.8482 TOP4= 1.8000 $00T4=$ 13.8482 TOP4= 2.6700 $00T4=$ 13.8482 TOP4= 2.6700 $00T4=$ 19.8482 TOP4= 2.6700 $00T4=$ 19.8482 TOP4= 2.6700 $00T4=$ 19.8482 TOP4= 2.6700 $00T4=$ 9.9886 TOP4= 2.6700 $00T4=$ 9.9886 TOP4= 2.6700 $00T4=$ 9.9886 TOP4= 2.6700 $00T4=$ 9.9886 TOP4= 3.6700 $00T4=$ 9.92167 TOP4= 4.6700 $00T4=$ 3.6133 TOP4= 4.6700 $00T4=$ <th< td=""><td>TOP3=</td><td>0.1817</td><td>80T3=</td><td>7.2100</td></th<>	TOP3=	0.1817	80T3=	7.2100
TOP3= 0.2576 BOT3= 0.2300 TOP3= 0.3014 BOT3= 0.2400 TOP4= $1.0.00$ BOT4= 16.1639 TOP4= 1.2000 BOT4= 15.3920 TOP4= 1.2000 BOT4= 13.8482 TOP4= 1.4000 BOT4= 13.8482 TOP4= 2.6000 BOT4= 13.8482 TOP4= 2.6000 BOT4= 19.8480 TOP4= 2.6000 BOT4= 19.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 3.6000 BOT4= 3.6133 TOP4= 4.8000 BOT4= 3.6133 TOP4= 4.8000 BOT4= 0.7256 TOP4= 4.8000 BOT4= 0.0463 TOP4= 5.2000 BOT4= 0.0463 TOP4= 5.4000 BOT4= 0.8182	TOP3=	0.2177	8073=	0.5500
TOP3 0.3014 ROT3 0.2402 TOP4 $1.0.00$ BOT4 16.1639 TOP4 1.2200 BOT4 15.3920 TOP4 1.2200 BOT4 15.3920 TOP4 1.400 BOT4 13.8482 TOP4 1.400 BOT4 13.8482 TOP4 1.400 BOT4 13.8482 TOP4 1.4000 BOT4 13.8482 TOP4 1.4000 BOT4 13.8482 TOP4 1.8000 BOT4 13.8482 TOP4 2.2000 BOT4 13.8482 TOP4 2.2000 BOT4 13.8482 TOP4 2.2000 BOT4 13.8482 TOP4 2.2000 BOT4 19.9886 TOP4 2.2000 BOT4 9.9886 TOP4 2.4000 BOT4 9.9886 TOP4 2.8000 BOT4 9.9886 TOP4 3.6000 BOT4 3.6133 TOP4 4.0000 BOT4 3.6133 TOP4 4.0000 BOT4 3.6133 TOP4 4.0000 BOT4 0.7256 TOP4 4.0000 BOT4 0.7256 TOP4 5.0000 BOT4 0.7256 TOP4 5.2000 BOT4 0.98182 TOP4 5.4	TOP3=	1-25-6	BOT3=	0.2300
TOP4=1.0.00BOT4=16.1639TOP4=1.20006074=15.3920TOP4=1.4000BOT4=14.6201TOP4=1.4000BOT4=13.8482TOP4=1.8000BOT4=13.8482TOP4=1.8000BOT4=13.8482TOP4=2.8000BOT4=13.8482TOP4=2.8000BOT4=13.8482TOP4=2.8000BOT4=13.8482TOP4=2.8000BOT4=13.8482TOP4=2.8000BOT4=14.6201TOP4=2.8000BOT4=14.605TOP4=2.8000BOT4=9.9886TOP4=2.8000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=3.6000BOT4=9.9886TOP4=4.0000BOT4=9.9886TOP4=4.8000BOT4=3.8133TOP4=4.6000BOT4=3.8133TOP4=4.6000BOT4=1.4975TOP4=5.0000BOT4=0.7256TOP4=5.2000BOT4=0.0463TOP4=5.4000BOT4=-0.8182	T023=	2.3894	8073=	0.2402
TOP4 = $1 \cdot 2\% \cdot 2\%$ BOT4 = $15 \cdot 392\%$ TOP4 = $1 \cdot 4 \cdot \pi \%$ BOT4 = $14 \cdot 62\%1$ TOP4 = $1 \cdot 6\% \cdot 2\%$ BOT4 = $13 \cdot 8482$ TOP4 = $1 \cdot 8\% \cdot 2\%$ BOT4 = $13 \cdot 8482$ TOP4 = $1 \cdot 8\% \cdot 2\%$ BOT4 = $13 \cdot 8763$ TOP4 = $2 \cdot 6\% \cdot 2\%$ BOT4 = $12 \cdot 3044$ TOP4 = $2 \cdot 2\% \cdot 2\%$ BOT4 = $10 \cdot 7605$ TOP4 = $2 \cdot 2\% \cdot 2\%$ BOT4 = $9 \cdot 9886$ TOP4 = $2 \cdot 6\% \cdot 2\%$ BOT4 = $9 \cdot 9886$ TOP4 = $2 \cdot 6\% \cdot 2\%$ BOT4 = $9 \cdot 2167$ TOP4 = $2 \cdot 2\% \cdot 2\%$ BOT4 = $9 \cdot 2167$ TOP4 = $3 \cdot 2\% \cdot 2\%$ BOT4 = $7 \cdot 6729$ TOP4 = $3 \cdot 2\% \cdot 2\%$ BOT4 = $6 \cdot 201\%$ TOP4 = $3 \cdot 6\% \cdot 2\%$ BOT4 = $5 \cdot 3571$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $3 \cdot 8133$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $3 \cdot 8133$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $3 \cdot 8133$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $1 \cdot 4975$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $1 \cdot 4975$ TOP4 = $4 \cdot 6\% \cdot 2\%$ BOT4 = $1 \cdot 4975$ TOP4 = $5 \cdot 6\% \cdot 2\%$ BOT4 = $0 \cdot 7256$ TOP4 = $5 \cdot 2\% \cdot 2\%$ BOT4 = $-0 \cdot 0463$ TOP4 = $5 \cdot 4\% \cdot 2\%$ BOT4 = $-0 \cdot 8182$	T0P4=	1.0.00	BOT4=	16.1639
TOP4= $1.41.20$ BOT4= 14.6201 TOP4= 1.6220 BOT4= 13.8482 TOP4= 1.8220 BOT4= 13.8482 TOP4= 2.6200 BOT4= 13.8482 TOP4= 2.6000 BOT4= 13.0763 TOP4= 2.6000 BOT4= 12.3044 TOP4= 2.2000 BOT4= 10.7605 TOP4= 2.4200 BOT4= 10.7605 TOP4= 2.4200 BOT4= 9.9886 TOP4= 2.6000 BOT4= 9.9886 TOP4= 2.8000 BOT4= 9.2167 TOP4= 3.6000 BOT4= 9.2167 TOP4= 4.0000 BOT4= 3.6133 TOP4= 4.0000 BOT4= 3.6133 TOP4= 4.0000 BOT4= 0.7256 TOP4= 4.0000 BOT4= 0.0463 TOP4= 5.0000 BOT4= 0.0463 TOP4= 5.2000 BOT4= 0.8182	TOP4=	1.28-0	B0T4=	15.3920
TOP4= 1.4×20 BOT4= 13.8482 TOP4= 1.80×20 BOT4= 13.0763 TOP4= 2.0000 BOT4= 12.3044 TOP4= 2.2000 BOT4= 11.6324 TOP4= 2.2000 BOT4= 10.7605 TOP4= 2.4000 BOT4= 10.7605 TOP4= 2.4000 BOT4= 9.9886 TOP4= 2.4000 BOT4= 9.9886 TOP4= 2.4000 BOT4= 9.2167 TOP4= 2.8000 BOT4= 9.2167 TOP4= 3.0000 BOT4= 6.92000 TOP4= 3.2000 BOT4= 6.92000 TOP4= 3.6000 BOT4= 6.12900 TOP4= 3.6000 BOT4= 4.5852 TOP4= 4.6000 BOT4= 3.8133 TOP4= 4.6000 BOT4= 3.02414 TOP4= 4.6000 BOT4= 1.4975 TOP4= 4.6000 BOT4= 0.7256 TOP4= 5.0000 BOT4= 0.0463 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.4000 BOT4= -0.8182	TOP4=	1.41 -10	B0T4=	14.6201
TOP4= 1.800 BOT4= 13.0763 TOP4= 2.000 BOT4= 12.3044 TOP4= 2.200 BOT4= 11.6324 TOP4= 2.400 BOT4= 10.7605 TOP4= 2.400 BOT4= 10.7605 TOP4= 2.400 BOT4= 9.9886 TOP4= 2.400 BOT4= 9.9886 TOP4= 2.400 BOT4= 9.9886 TOP4= 2.400 BOT4= 9.2167 TOP4= 3.000 BOT4= 9.2167 TOP4= 3.000 BOT4= 6.9010 TOP4= 3.6000 BOT4= 6.9010 TOP4= 3.6000 BOT4= 6.1290 TOP4= 3.6000 BOT4= 6.1290 TOP4= 3.8000 BOT4= 3.8133 TOP4= 4.0000 BOT4= 3.6414 TOP4= 4.6000 BOT4= 3.0414 TOP4= 4.6000 BOT4= 1.4975 TOP4= 5.0000 BOT4= 0.0463 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.4000 BOT4= -0.8182	10P4=	1.64.78	B0T4=	13.8482
$TCP4_{=}$ $? \cdot 0 \forall a \forall$ $BOT4_{=}$ $12 \cdot 3044$ $TOP4_{=}$ $? \cdot 2 \forall a \forall$ $BOT4_{=}$ $11 \cdot 5324$ $TOP4_{=}$ $? \cdot 4 \forall a \emptyset$ $BOT4_{=}$ $10 \cdot 7605$ $TOP4_{=}$ $? \cdot 4 \forall a \emptyset$ $BOT4_{=}$ $9 \cdot 9886$ $TOP4_{=}$ $? \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $9 \cdot 9886$ $TOP4_{=}$ $? \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $9 \cdot 9886$ $TOP4_{=}$ $? \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $9 \cdot 2167$ $TOP4_{=}$ $? \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $9 \cdot 2167$ $TOP4_{=}$ $? \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $6 \cdot 29016$ $TOP4_{=}$ $3 \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $6 \cdot 9016$ $TOP4_{=}$ $3 \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $6 \cdot 1296$ $TOP4_{=}$ $3 \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $5 \cdot 3571$ $TOP4_{=}$ $3 \cdot 6 \forall a \emptyset$ $BOT4_{=}$ $3 \cdot 6133$ $TOP4_{=}$ $4 \cdot 6 \lor a \emptyset$ $BOT4_{=}$ $3 \cdot 6414$ $TOP4_{=}$ $4 \cdot 6 \lor a \emptyset$ $BOT4_{=}$ $1 \cdot 4975$ $TOP4_{=}$ $4 \cdot 6 \lor a \emptyset$ $BOT4_{=}$ $1 \cdot 4975$ $TOP4_{=}$ $5 \cdot 6 \lor a \emptyset$ $BOT4_{=}$ $0 \cdot 7256$ $TOP4_{=}$ $5 \cdot 2 \lor a \emptyset$ $BOT4_{=}$ $0 \cdot 0 \cdot 643$ $TOP4_{=}$ $5 \cdot 4 \lor a \psi$ $BOT4_{=}$ $0 \cdot 643$ $TOP4_{=}$ $5 \cdot 4 \lor a \psi$ $BOT4_{=}$ $0 \cdot 8182$	TOP4=	1.86-0	B0T4=	13.0763
TOP4=2.2002BOT4=11.5324TOP4=2.4000BOT4=10.7605TOP4=2.4000BOT4=9.9886TOP4=2.8000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=3.0000BOT4=9.2167TOP4=4.0000BOT4=9.2167TOP4=4.0000BOT4=3.2010TOP4=4.0000BOT4=3.2133TOP4=4.0000BOT4=3.2695TOP4=4.0000BOT4=0.7256TOP4=5.0000BOT4=0.0463TOP4=5.2000BOT4=-0.0463TOP4=5.4000BOT4=-0.8182	TCP4=	2.00 al	BOT4=	12.3044
TOP4= 2.4800 BOT4= 10.7605 TOP4= 2.6800 BOT4= 9.9886 TOP4= 2.8800 BOT4= 9.2167 TOP4= 3.8800 BOT4= 6.9010 TOP4= 3.8800 BOT4= 5.3571 TOP4= 4.8800 BOT4= 3.8133 TOP4= 4.8800 BOT4= 3.8133 TOP4= 4.8800 BOT4= 3.82695 TOP4= 4.8800 BOT4= 0.7256 TOP4= 5.8800 BOT4= 0.90463 TOP4= 5.8100 BOT4= 0.8182 TOP4=	T0P4=	2.2602	BOT4=	11.5324
TCP4= 2.60000 BOT4= 9.9886 TOP4= 2.8000 BOT4= 9.2167 TOP4= 3.0000 BOT4= 6.9010 TOP4= 3.6000 BOT4= 6.9010 TOP4= 3.6000 BOT4= 4.5852 TOP4= 4.0000 BOT4= 3.8133 TOP4= 4.4000 BOT4= 3.8133 TOP4= 4.6000 BOT4= 3.6414 TOP4= 4.6000 BOT4= 4.975 TOP4= 5.0000 BOT4= 0.7256 TOP4= 5.2000 BOT4= 0.0463 TOP4= 5.4000 BOT4= 0.8182	TCP4=	2.4.000	B0T4=	10.7605
TOP4= 2.8720 BOT4= 9.2167 TOP4= 3.7720 BOT4= 8.4448 TOP4= 3.7720 BOT4= 7.6729 TOP4= 3.4820 BOT4= 6.9010 TOP4= 3.4820 BOT4= 6.9010 TOP4= 3.6820 BOT4= 6.1290 TOP4= 3.8820 BOT4= 5.3571 TOP4= 3.8820 BOT4= 3.8133 TOP4= 4.9200 BOT4= 3.8133 TOP4= 4.4820 BOT4= 3.8133 TOP4= 4.6820 BOT4= 3.8133 TOP4= 4.88200 BOT4= 4.975 TOP4= 5.98200 BOT4= 4.9755 TOP4= 5.98200 BOT4= 4.9756 TOP4= 5.98200 BOT4= 4.9256 TOP4= 5.98200 BOT4= 4.9256 TOP4= 5.98200 BOT4= 4.98433 TOP4= 5.98200 BOT4= 4.98433 TOP4= 5.98200 BOT4= 4.98433 TOP4=	TCP4=	2.60 al	B0T4=	9.9886
TOP4= 3.00000 BOT4= 8.4448 TOP4= 3.00000 BOT4= 7.6729 TOP4= 3.4400 BOT4= 6.9010 TOP4= 3.4400 BOT4= 6.1290 TOP4= 3.64000 BOT4= 5.3571 TOP4= 3.8400 BOT4= 5.3571 TOP4= 4.0000 BOT4= 3.8133 TOP4= 4.9400 BOT4= 3.8133 TOP4= 4.44000 BOT4= 3.8133 TOP4= 4.64000 BOT4= 3.6414 TOP4= 4.64000 BOT4= 1.4975 TOP4= 4.64000 BOT4= 1.4975 TOP4= 5.00000 BOT4= 0.0463 TOP4= 5.2400 BOT4= -0.0463 TOP4= 5.44000 BOT4= -0.8182	T0P4=	2.28100	B0T4=	9.2167
TOP4= 3.2800 BOT4= 7.6729 TOP4= 3.4800 BOT4= 6.9010 TOP4= 3.68000 BOT4= 6.1290 TOP4= 3.88000 BOT4= 5.3571 TOP4= 3.88000 BOT4= 3.8131 TOP4= 4.0000 BOT4= 3.8133 TOP4= 4.48000 BOT4= 3.8133 TOP4= 4.68000 BOT4= 3.8133 TOP4= 4.88000 BOT4= 3.8133 TOP4= 4.68000 BOT4= 3.8133 TOP4= 4.68000 BOT4= 3.8133 TOP4= 4.88000 BOT4= 3.8133 TOP4= 5.96000 BOT4= 3.8137 TOP4= 5.96000 BOT4= 0.7256 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.46000 BOT4= -0.8182	TOP4=	3.0000	B0T4=	8.4448
TOP4= 3.4kc% BOT4= 6.901% TOP4= 3.6kc% BOT4= 6.129% TOP4= 3.6kc% BOT4= 5.3571 TOP4= 4.0cc% BOT4= 5.3571 TOP4= 4.0cc% BOT4= 3.8133 TOP4= 4.0cc% BOT4= 3.8133 TOP4= 4.4cc% BOT4= 3.0414 TOP4= 4.6kc% BOT4= 3.0414 TOP4= 4.6kc% BOT4= 3.0414 TOP4= 4.6kc% BOT4= 3.0414 TOP4= 5.0kc% BOT4= 3.0463 TOP4= 5.4kc% BOT4= -0.0463	TOP4=	3.28-48	80T4=	7.6729
TOP4= 3.60000 BOT4= 6.12900 TOP4= 3.80000 BOT4= 5.3571 TOP4= 4.0000 BOT4= 4.5852 TOP4= 4.0000 BOT4= 3.8133 TOP4= 4.4000 BOT4= 3.8133 TOP4= 4.4000 BOT4= 3.0414 TOP4= 4.6000 BOT4= 2.2695 TOP4= 4.8000 BOT4= 1.4975 TOP4= 5.0000 BOT4= 0.7256 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.4000 BOT4= -0.8182	TOP4=	3.44 08	80T4=	6.3010
TOP4= 3.8000 BOT4= 5.3571 TOP4= 4.0000 BOT4= 4.5852 TOP4= 4.2000 BOT4= 3.8133 TOP4= 4.4000 BOT4= 3.6414 TOP4= 4.6000 BOT4= 2.2695 TOP4= 4.8000 BOT4= 1.4975 TOP4= 5.0000 BOT4= 0.7256 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.4000 BOT4= -0.8182	TOP4=	3.68 78	B0T4=	6.1290
TOP4= 4.0/00 BOT4= 4.5852 TOP4= 4.2/00 BOT4= 3.8133 TOP4= 4.4/00 BOT4= 3.0414 TOP4= 4.6/00 BOT4= 3.0414 TOP4= 4.6/00 BOT4= 2.2695 TOP4= 4.8/00 BOT4= 1.4975 TOP4= 5.0000 BOT4= 0.7256 TOP4= 5.2/00 BOT4= -0.0463 TOP4= 5.4/00 BOT4= -0.8182	TOP4=	3. Rund	BOT4=	5.3571
TOP4= 4.2400 BOT4= 3.8133 TOP4= 4.44000 BOT4= 3.0414 TOP4= 4.64000 BOT4= 2.2695 TOP4= 4.84000 BOT4= 1.4975 TOP4= 5.00000 BOT4= 0.7256 TOP4= 5.24000 BOT4= -0.0463 TOP4= 5.44000 BOT4= -0.8182	TOP4=	4.0:08	B074=	4.5852
TOP4= 4.4vo? BOT4= 3.0414 TOP4= 4.6Vo? BOT4= 2.2695 TOP4= 4.8vo? BOT4= 1.4975 TOP4= 5.0Vo? BOT4= 0.7256 TOP4= 5.2Vo? BOT4= -0.0463 TOP4= 5.4Vo? BOT4= -0.8182	TOP4=	4.2400	B0T4=	3.8133
TOP4= 4.68282 BOT4= 2.2695 TOP4= 4.88292 BOT4= 1.4975 TOP4= 5.98292 BOT4= 0.7256 TOP4= 5.2892 BOT4= -0.0463 TOP4= 5.48292 BOT4= -0.8182	TOP4=	4.48 -8	B0T4=	3.0414
TOP4= 4.8% n0 80T4= 1.4975 TOP4= 5.0% n0 80T4= 0.7256 TOP4= 5.2% n0 80T4= -0.0463 TOP4= 5.4% n0 80T4= -0.8182	TOP4=	4.6828	BOT4=	2.2695
TOP4= 5.0000 BOT4= 0.7256 TOP4= 5.2000 BOT4= -0.0463 TOP4= 5.4000 BOT4= -0.8182	T0P4=	4.84 - 8	8074=	1.4975
TCP4= 5.2100 BOT4= -0.0463 TOP4= 5.4100 BOT4= -0.8182	TOP4=	5.0800	B0T4=	0.7256
TOP4= 5.4800 BOT4= -0.8182	TCP4=	5.21 20	B0T4=	-0.0463
	TOP4=	5.48 78	BOT4=	-0.8182

FEC

F VIO OPFRATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74

JCE	HALDLING CHARGE	\$ • 75	/ JnF	• 35
177	LIFES PEINTED PR1	\$ 1.25	/ K LN	• 22
67	CARDS READ	\$ 1.50	1 V Cn	• 1 9
25	PLOTTER VECTORS	s 25	1 1020	• 13 0
22	MONEL 71 SECONDS	\$25.00	/ HOUR	• 1 4
65	MODEL PA SECONDS	\$12.50	1 HOLD	• 90
		TOTAL	CHARGE	\$ •R1

-EIR 403 14731 LOGGED OUT 25/36/74 19:37. \$ 6.67 LEFT AFTER 27 LOGINS.

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-1-4	С	*AL* IS THE LENGHT
4		AL=100: •
· C		, = AL/5 . 75
1 1	С	+DRA* IN THE DRAFT
10		CKV=4/3+3
24		D=/L/14.
1 25	С	*PCI* IS THE ODISSON'S RATIO OF THE MATERIAL
	Ç	FOR ALU INUM
31		b01=,•33
32	С	. IS THE YO ING'S MODULUS OF THE MATERIAL
5 e.	C	FOR ALL INUM
6		$r = 1 \left(t + \frac{1}{2} \right)^{t} + \frac{1}{2} \left(t + \frac{1}{2} \right)^{t}$
40	C.	DST # 13 THE DESIGN STRESS
4C		OST = 180.00
54	C	-S- IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
54		3=10.
- 6	C.	BI . IS THE BENFING MOMENT
55		$R^{m} = (R * (D \land A * \land L * \cdot L * . 1 \cdot $
p à		G=, .30396*S*S*5.(1POI.P2I)/E
e 19 da	(«TUP» IS THE THICK ERG OF THE TOP PLATING
r in	С	BOTH IS THE THICKNESS OF THE BOTTOM PLATING
- La		TURES.RS
· :C		$\pi \mathcal{O} T = \mathcal{O} * \mathcal{D} \mathcal{F} B$
		$b = 56.2 \cdot - 21 + (B + a O T + D + T U D)$
F.P.		∿EL=D*(?.*8*8*8+TCP*00T+2.*8*0*T∩P*(T0P+80T)+(D*D*T0P*T0P))
4 C	С	STHE IS THE STRESS ON TOP DUE TO HOGGING
14C		STHEAZEN
:55		PITE(5+60)STU
74		5 = FORMAT(' ',224, 15TH='=10.3)
34		0=5KU+*8M*(B*T0F+0*TC=)
34	С	"SCH* IS THE GTRESS ON BOT DUE TO HOGGING
1 4		3UH=C/CEN
1156		, GITE (S, OP) SBU
1 2 2		
	Ç	SECHIT# IS THE CRITICAL STRESS ON BOT
. FC		SPCRITEROTEBOTYR
~ C		+FITE(5,110)SaCHIT
1 2 9	1	1 + FOFMAT(' ', 17y, 'SBCPIT='F10+3)
		F=2.*P*TOP+B*(TOP+POT)
192	С	DITOPH IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
EP		nITGP=C*(P*AC++D>TOP)/P
C C		WHITE(E, 47) PITOP
~ A P		L' FORMAT(' ', 184, 'HITOP_'F10.4)
C 4	С	"DIROT IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
164		DIPCT=0 * (B*T0p+"*T0p) P
E.P.		RITE(5,5))DIANT
174		5^{1} F ⁰ + AT(' ', 187, (LIR)T='F10.4)
151		Ł.D
(3)	• ! !	0324(V) AL 232C(V) B 0334(V) DRA 033C(V) D
	PrI	134C(V) E 2122(3) .R 2358(V) DST 2368(V) S
LV]	2.4	"3721V] S "384[V] TOP 038C[V] BOT 0394[V] A
(V)	DEN	2388(V) STH 2174(1) 60 (0000(S) @I 03BC(V· c

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STRENEHT OF SHIPSTUN THE LEUTRAL AXIS LOCATION PAGE 2 , 162 (L) 92 304 (V) SPORIT P228(L) 110 03C8[V1 P (V) SQL 248 (L) 40 302(V) DIECT (304(L) 50 0000(S) .V EVI DITER 50 1 GRAM LAFFLE: 21.64 · V 2594 . COMP 2172 GI 2444 .R 235C .71 176 # 457 194 263E EXP 2484 . .. 29RY .MES 2036 .W 27C4 AI CRA 36 536 ALCC 28FC .HARG 2052 .5 263E NEXP 2960 • ERCNT 292E \$8 2136 .11 31.85 and . -"X-POI'TO: 7454 .A 2536 ALCG 263E LEXP SER EXP 27C4 AI 444 .0 2574 . COMP 2-3A 36 2958 .5 28FC .RARG 292F \$8 236 . 2961 FPCNT U. 5445 295: .. 2938 .MES 2468 · V -C .75 F. r. \$72 111 MIN-JI DEKC. F EFINED SIERAL TIMES: т. Б NSFER ADDRESS PP71 TID' PEGIS: STH= 18111.109 SBH= 53387.980 SUCPIT= 48640.414 6110P= 18.0932 (1901= 53.3053 · D VIO OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/06/74 OB HANDLING CHANGE \$.35 / JAB .35 25 LIVES PRINTED PRI 3 1.25 / K LN • 11 54 CARNE REAL 3 1.5% / K Ch . 32 PP PLATTER VECTORS \$.25 / 17/2 .09 \$25.20 / HOUS 17 MOREL 75 SECONDS .12 \$12.50 / HOUR CO MONEL 4- SECONDS .20 TOTAL CHARGE \$.66 EIP 432 14731 LOGGED OUT 25/36/74 19:56. \$ 3.43 LEFT AFTER 31 LOGINS.

SUMMARY

Length	=	1000'
Beam	=	AL/5.75
Draft	=	в/3.3
Depth	=	AL/14
DST	=	18000 psi
S	=	10"
Material	-	ALUMINUM
TOP	=	5.35"
BOT	=	0.363"
STH	=	18111.11
SBH	=	53387.98
SBCRIT	=	48648.64
DITOP	=	18.09'
DIBOT	=	53.341



STRENGHT OF SHIPS-ON THE "FUTRAL AXIS LOCATION

1 64	С		*AL* IS THE LENGHT
- + 4			$A = 1 C \omega(r \cdot$
10			$p = A_1 / 5 + 75$
. 6	~		
25	C.		
1 × 1			DEV=2X3+3
24			D=AL/14 •
-3.2	С		*POI* IS THE BOISSON'S RATIO OF THE MATERIAL
32	~		FOR ALUTINUM
	~		P01=0.95
20	~		FR IS THE YOUNDIS MODILIUS OF THE MATERIAL
3 -	5		
* د	L.		
32			$\mathbf{F} = 1V \cdot \mathbf{*} 1 \cdot \mathbf{*} \mathbf{*} 5$
4C	С		+UST * IS THE DESIGN STRESS
40			DST=180×0+
54	С		*S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
-4			5=30.
	~		-BM* IS THE BENDING MOMENT
50	-		$(M = (R_{\pm})R_{\pm}(A_{\pm}) + (A_{\pm}) + (A_{\pm})$
~~			
- 2			G-0+3(3)6***5((1+*PO1*PO1)/E
			A=9·*P <= +0/(140·**3M)
CC			$C=3 \cdot * i \times i \times D/(7 \circ \cdot F^{M})$
1:24			F=3·*D= +D/(140··3M)
25	С		THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
1:20			wKITE(5+10)
62		10	FORMATICITI, 25V. TOP ASSUMED LARGER THAN BOTTOMIN
	C	1,	TOP, IS THE THICKNESS OF THE TUP PLATING
0.4	-		POTH IS THE HUICANESS OF THE POTTAM PLATING
02	-		WOIN A 2
6-			HOUTEN + 2
. 15		1.1	TUP1=8*3011*8311*8311/((8+6)*6*051~0*8011*PU11)
IPE .			WRITE(5,20)T001,60T1
53		20	FORMAT(' ',25v,'TOP1=+F9+4,5X,'BCT1='F9+4)
20			g0T1=80+1+0+1
216			1F(8071+GT+2+5)G0 T030
22			60 10 11
-26		~ (7	TÜP2-1.
224			00000010000000000000000000000000000000
		-1	BUICHIUP CALLS, AUTOLA COTA
De			WRI(E(5)40))0P2/FUI2
104		40	FURMAT(' ',25x,'TUP2=(F9.4,5x,'BU12=(F9.4)
201			T0P2=T0P2+C+2
11			IF(TOP2+GT+6+) GO TO 50
FA			GO TO 31
PRE		50	CONTINUE
PFE	C		THICKNESS OF BOTTOM ABSUMED LARGER THAN TOP
255	4		UNITE (5160)
312		1	COMATILIAL 254 IDBTTO, ACCIMEN LADOED THAN TODAY
2.2		01	FORMATE TIRDY, NUTLER ASSURED CARGER THAN TOPY)
147			QUT3=0+1
169		69	TUP3=(("+D)*HOT2*RCT3_BUT3=D*G*DST+BOT3)/(B*G*CST)
.94			WRITE (5,70) T0p3,8013
285		70	FORMAT(' ',25y,'TOP3=+F9+4,5X,'8013=1F9+4)
350			B013=B013+0+01
D3F			1F(B0T3+GT+1+5)60 TO 80
			60 TO 61

93

.12		0.5	TOP4=1.								
. 1 Δ		31	8014=(12.*	(B+n) = (A+C)	DST*TOR	241/(((C+F)*1	DSTI			
48			RITE (5,90	1) TOD4, 2074							
.72		90	FORMATC	,25x, 1TOP4=	189.4,5	x, 1301	[4=1F9	• 4)			
.94			TOP4=TOP4+	-01+2							
.15			IFITOP4+GT	.5.5)60 TO	100						
.53			GO TO SI								
-8C		10.	CONTINUE								
.nC			END								
(5)	• 1 F		CHEVJ AL	. 0408C	VJ B	614	+r Ø [V]	DRA	Ø4D8[V]	D	
[V]	PhI		1453(V) F	(A)	c).R	64	+F4 [V]	DST	M4FCEV1	S	
.:V]	R.M.		H51K(V) G	15241	VJ A	¢ g	534[V]	С	053C(V+	F	
:13	1 ~		AND NOTES OF	75471	V) BOT1	C 1	176(L)	11	21548 (V1	TOP1	
CLJ.	20		-220 (L1 3.	1 .155nt	VJ TOP2	62	234 [L]	31	0566. (V)	BOT2	
.t.J	4 ~		PSEE [1] 50	1 3126	J 60	2 E	574[V]	80T3	1348 [L]	61	
EV3	ThPI	2	-3-1° (L) 70	24020	3 80	6.5	584(V)	TOP4	940AEL	81	
EV3	HAT	•	1472(L) 92	1 34000	1 100	v 6	002(S)	• V			
ER		ŧ.	-		-						
GRA'	4 1 7 1	el si	:								
.70	+~1	NJ #	5053 • M	2450 .	COMP	SCSE	r I	5606	• D	2B18	• ? E
176	54		254 ° • A	2874 .	MES	2aF2	• 11	27FA	EXP	2980	AIT
652	ALO		BARS . PAR	RG 2014 •	5	27FA	AEXP	2B1C	+ ERCNT	ZAEA	\$8
C1C	• ^		26F2 •1	304A							
	20+5.1	5:									
513	• 🖓		2645 .2	25F2 A	DG	27FA	& EXP	27FA	EXP	2980	AIN

		and a set a	the for the tree of the	and her have been as	La Deca Mar
. 536	2A51 COMP	PA76 \$2	2488 .RARG	SAEV #8	2814 .5
-18 -7EFA	2810 +F.RONT	281E • n	2774 , MES	2BFE •U	2024 .1
102F 91					

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MON-BEDCKS:
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1.3

EFIJED SUBDOUTINES:

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1
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SFER AUDRESS 2078 UTION BEGINS:

TOP AS	SSUMED I ARGER	THAN	BOTTOM
T0P1=	8.0123	80T1=	0.2000
TOP1=	2. 3464	BOT1=	0.3000
TOP1=	· 11=7	8071=	0.4000
TOP1=	3.2421	B0T1=	2.5808
T0P1=	· 4504	BOT1=	0.6800
TOP1=	3.2216	80~1=	0.7020
T6P1=	.1.4376	BOT1=	0.8626
TCP1=	2.5468	30T1=	6.9828
TCP1=	4-82-8	80T1=	1.0000
TCP1-	13.9,155	BOT1=	1.1000
TOP1=	62.6411	Bor1=	1.2000
TCP1=	+29.2027	80T1=	1.3000
TCP1_	-14.75-38	80T1=	1.40.20
TOP1-	-116-2	BOT1=	1.502.2
TCP1-	m9.47-4	B0T1=	1.6000
TOP1 -	-8.55.4	8011=	1.7000
TOP1 -	-8.1915	30T1=	1.8000
TCP1=	-7.34.7	8071=	1.9000
TCP1_	-7.91.7	BOT1=	2.0000
TOP1-	=7.7677	30T1=	2.1000
TOPI	•7-7208	-2011-	2 30.00
TCP1-	-7-83-1	8071=	2.2000
TCP1-	-7.01.3	8011-	2.4200
TOP1	-8-02.2	80×1-	2 • • • • • • • •
TCP2-	1.02.20	0011- 03-2-	-0 1670
1022	1.2 06	8012=	
TG22-	1 . 1	2072-	-0. 2355
TOP2	1.4	8072-	
T0P2_	1 - D/ - W	001C-	-1 4229
T.3P2	2 - The all	2012-	-1 1200
TOP2-	2.2	20-2-	-1 4000
TOP2-	2.4 08	80-2-	-1.4002
7022	2.61.6	2072-	-1+6093
TCP2	2.7.2	2072-	-2 50150
1022-	3.2.08	2012-	
TCP2_	3. 7 1 . 8	2072-	-1 6450
TOP2	3.1200	B072=	-++0002
TOP2-	3.4 00	2072-	-701197 -90107
TOP2-	3.80.00	B072-	14 3334
TOP2-	4.02.00	8072=	5.8811
TOP2_	4 0 4 4	001C-	0.0011
TCP2_	4.47.00	8072-	3+3240 2.0570
T022-	4.14.04	8072-	1.5925
TGE2-	4.07.02	B072-	1,1400
TOP2_	5-07-0	30-2-	1 • 1 • 0 5 C 0 4 6 7
TOF2	5.21.0	3072-	0.5570
TOP2	5.1.1.0	8072-	0.00/0
TOPO	5 4 · 10	20-2	0 1700
TCP2	5.80	8072=	V • 1733 C • 224 0
TCP2=	5.0.00	8072=	-C.1140







POTTOM	ASSIN FD	LAFGER THAN	TOP
TCP3=	- 1.05-2	POT3=	0.1000
TCP3=	· ? • 2409	80T3=	8.1100
TCP3=	- 1. 19477	B0T3=	· 1200
TCP3=	- 1. P/ 1.3	ROT3=	1300
TCP3=	- ' - 3457	BOT3=	0.1400
TCP3=		60 3=	v • 1500
TCP3=	-1-2025	80T3=	1602
TCFR=	+ V 548	8CT3=	1702
TCP3=	19.762	8073=	A.1800
TCP3=		8013=	0.1900
TCMBE	- 1 524	K ∩ *3=	6.5000
T0P3=	-1 225	60T3=	1.5166
TCP3=	- 1.25K1	80T3=	1.5506
TCPBE	-7-2543	8073=	.s. • 530%
TCP3=	-3.15,1	80T3=	0.2400
TOF3=		B073=	1.2506
1CP3=	-1.0003	80-3=	1.566%
TGP3=	- 1.9.47E	8073=	ו2700
TCP3=	-13+ 1, 4	8073=	0.085.0
TOP3=	-0 ·8407	B073=	P.•5300
TCP3=	-1-324	B013=	0.3000
TOP3=	-3-9315	Bn73=	2.3100
T0P3=	-9-2261	80~3=	2.3505
TOP3=	- A . 22ak	80T3=	2.3300
T0P3=	- 1.21.3	8573=	8.3402
10P3=	- · · · · · · · · · · · · · · · · · · ·	80T3=	°•3500
T0P3=	2 · 2 × 21	8073=	0.3600
T0P3=	1.0199	80T3=	8.3700
TCP3=	9.0213	8073=	6.3862
T0P3=	2-03-5	80T3=	0.3908
T073=	3.9415	B0T3=	0.4002
TOP3=	3.0235	80T3=	1.4100
TCP3=	3.06a7	BOT3=	8.4506
TOP3=	3.700	8013=	2.4300
TGP3=	3.2935	B0T3=	0.4420
TCP3=	3.1691	80T3=	8.4500
TOP3=	1.1248	B0T3=	7.4603
T0P3=	0.14~8	BCT3=	N.4702
1083 <u>=</u>	7.15-4	B073=	7.4800
1083 <u>-</u>	3-1770	B0T3=	1.4900
T0P3=	2.1965	80T3=	0.5000
TOP3=	2.2176	. BOT3=	0.5100
10P3=	3.2305	6073=	0.5200
1003=	3.2518	80T3=	1.5300
1073=	3.2345	B013=	0.5400
1023	1.3636	BCT3=	0.5500
1083=	2.316	B0T3≖	0.5600
T0P3=	1.3313	=ET05	0.5700
1673=	3.3-91	8073=	0.5800
1023=	.4125	8073=	0.5900
1023=	2.4.4.28	B0T3=	5.0000
1023=	1.4702	80T3=	0.6100
1023=	0.5116	8073=	8.0506
1023=	0.54=1	80T3=	2.639.9.
1043=	8.5709	B073=	0.6488
T0P3=	1.6159	BOT3=	0.650%

TOP3=	8.4575	80⊤3≖	8.6600
TOP3=	0.69.5	80T3=	₹•670€
TOP3=	3.7316	BOT3=	Ø.680P
1083=	10.7728	80T3=	R • 6900
T023=	0.2152	BCT3=	8.7002
TCP3=	1.8501	2013=	V • 7120
TCP3=	1.01.13	BGT3=	0.7202
10P3=	1.0503	80T3=	0.738.8
1023=	1.0353	80×3=	8.7488
TOP3=	1.0403	BnT3=	0.7500
1023±	1.3992	8073=	8.7608
1043=	1+15+5	8773=	Q • 7792
1073±	1.54 = 3	8073=	2.7800
1083=	1.26-6	BULG=	0.7900
1073=	1.3175	80T3=	6.8000
1003=	1.3759	8013=	0.8100
1043=	1.4359	8013=	2.8202
「いだう」	1 • 4 5 - 4	8073=	0.8362
1043=	1.5655	= ET05	2.8400
1053=	1.47.53	POT3=	2.8502
1055	1.591/	3073=	2.8602
1023 <u>-</u>	1.7508	8GT3=	2.8700
1083=	1.8265	8073=	2.8802
1053=	1.9679	60T3=	6.8900
1073=	1.0741	80T3=	2.9696
1053± Toba	2.1428	66T3=	2.9122
1023=	2.1256	80 3=	0.9200
1053=	2.244	8073=	0.9360
1083=	2.2246	8013= 	2.9402
ドレビジェー	2.3.43	R014=	V • 9500
1053=	2.45~1	8019=	0.9600
「しだが」	2 • 5 a m M	8j13≡	2.9704
1053日 エッジウ	. C • 6 C = 4	1911 (J=	0.9800
1053± 7/25	2.71,29	5073= 2022	0.9900
10535	2 . 24 1.3	R013=	1.44000
TOPS	2 • 8276	B013=	1.7102
10535	5.93.25	8()73≠	1.0200
T0P3=	3.00000	013= 013=	1.0300
「ビデビュー	3.1002	8013=	1.0400
1013=	3.2220	B073-	1.0000
10/32	3 1 2 3 1	D() - 3=	1.0000
TOPS	3 • 4 7 GY	B() 3=	1 • 4.7 404.
TOPS	3+6463	B013=	1.0800
TOPS	3 - 3 - 3	B1134	1.0902
10.3=	3.4673	DU13=	1.1000
TOPS	3.0419		1.1100
	4.027	8973=	1.1200
1053=	4 • 1 / 4 /	8013=	1.1306
1023=	4.2948	8073=	1.1400
1073=	4.4171	8073=	1.1500
TOPDE	4. 5. 4 1 /	0013=	1.1600
TOPO	4.6685	8013=	1.1/00
TORS	4 . 7 3 7 5	6073=	1.1800
TOPO	9 • 92 8 8 5	8013=	1.1900
TOPS	5 . 9 5 4	8073=	1.2000
TOPS	5.03.4	R()+3=	1.2104
101.2=	7.3220	0113=	1.500

TOP3=	5.4772	B013=	1.2300
TOP3=	5.6272	8013=	1.2400
TOP3=	5.7656	6nT3=	1.2500
T0P3=	5.9124	B073=	1.2609
T023=	6.2626	20T3=	1.270.0
10P3=	6.0163	80T3=	1.2800
TOP3=	6.3714	80T3=	1.2900
T0P3=	6.5200	5 0 73=	1.3000
TOP3=	6.6892	aor3=	1.3100
TOP3=	5.9518	8073=	1.3200
T0P3=	7.01.70	80T3=	1.3300
TOP3=	7.1848	8j†3=	1.3400
70P3=	7.35=2	80T3=	1.3502
T023=	7.5201	80T3=	1.3628
T023=	7.71.57	BOT3=	1.3720
TOP3=	7.88.9	8073=	1.3800
1023 <u>-</u>	8.7628	8073=	1.3922
TOPS	8.2464	8073=	1.400.2
TOP3=	8.4356	8013=	1.4100
TOP3=	8.62.6	8013=	1.4220
TOP3=	8.01-3	8013=	1.4300
TOP3-	9.2078	8013=	1.4402
TOP3=	9.20ml	8013=	1-4500
TOP3_	9.4/=1	80*3=	1.4622
TOP3-	9.5/08	3073=	4.1700
TOP3=	9.21-7	8013=	1.4800
TOP3=	10.12-3	8073=	1.4900
TOP3=	10.23-7	80-3=	1-5000
TOP4_	1.24.20	8014-	14.1400
TOP4	1.24.20	8074=	15.3930
TCP4-	1.44.00	80-4=	16.6201
TOP4_	1.6.08	80-4-	13 8403
TCP4	1.2.20	8014=	10.0740
TOP4=	2.01.04	8014=	12.201.1
TOP4-	2.2/00	80T4-	41 63047
TOP4-	2.48.00	8074-	10 7(05
TOP4-	2.4/ 22	8074=	10 1000
TOP41	2.8:08	8074=	2 2 2 0 0 0
TOP4-	3.0200	BOT4=	2.1412
TOP4-	3.22.20	8074=	7.4770
TOP4_	3-1-10-20	0074-	1.0123
TOP4_	3.6208		6.9010
TOPAL	3.5/20	00·44	6 J 2 9 0
TOP4_	5 • = 7, 44		5+35/1
TCP4_	4.2/22		4.5852
TCP4_	4 1 1 - 6		3.4133
TOP4-	4.6.200		3.0414
TOP4_	4.0/-1/	2074=	2.0095
TOP	5 0 2 0	8014=	1.4975
T024	5 97-0	BOT4=	0.7256
TOPL	5.42.00	BUT4=	=N+€463
- C+ 7 =	1 K K	DU 4 =	-0.8185

O OPERATING SYSTEM VERGION 1 REVISION 012 03/04/74 GENERATED 05/06/74 0

 CB
 HANDLIES
 CHARGE
 #
 15
 / JOB
 135

 11
 LINES
 COINTED
 PR1
 \$
 1.25
 / K
 LN
 139

 67
 CARDS
 SEAD
 \$
 1.50
 / K
 LN
 139

 67
 CARDS
 SEAD
 \$
 1.50
 / K
 CN
 117

 67
 CARDS
 SEAD
 \$
 1.50
 / K
 CN
 117

 67
 PLOTTER
 VECTORS
 \$
 -25
 / 10/0
 .000

 72
 MOREL
 71
 SECONDS
 \$
 25.300
 / HOUS
 .15

 60
 MOREL
 \$
 SECONDS
 \$
 12.300
 .000
 .15

 61
 MOREL
 \$
 SECONDS
 \$
 12.300
 .000
 .000

 70
 TOTAL
 CHARGE
 \$
 .99
 .99
 .99

EIR 404 14731 LOGGED OUT 05/36/74 19:42. \$ 5.68 LEFT AFTER 28 LOGINS.

46% 14/31 LUGBED OUT (17/35/74 13:42* * 3*66 LLF

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STRENGHT OF SHIPSEON THE NEUTRAL AXIS LOCATION

ç. 4	C.		AL+ IS	THE LENG	ЯнΤ						
24			Vr=10,4.								
.° C			R=AL/5./	່ກ 	- T						
18	С		*UKA* JO	THE RE	. je 1						
1×			UKV=H\3.	. 4							
24			$D = C \begin{bmatrix} X \end{bmatrix} L + C$	71.5 -01			0.05	THE MAY	EDIAL		
34	C		*-61* 10	THE DUI	55011 S	TIA~	0 0+	THE MAI	IERIAL		
24	C		PUP ALL	Term							
58 + 6	~				19 10-						
27	L C		COL ALL'	11.15*	no ch	01-73	UP I		AL		
26	C		c = 1 € • × 1 °	a a se fa							
5	C		DST# 15	THE SES	IGN ST	RESS					
10			0ST#1507	1	1	30					
64	5		+S+ 18 F	HE SHACT	NG OF	LUNGI	TUDT	NAL STIP	FENING	MEMBERS	
6.4	-		9=31 +	· · · ·			- / -		-		
50	C		+HM+ IS	THE RENT	ING MO	MENT					
50	-		RM= (FADA	A*AL*AL*	(.75))	(35	35.)				
52			6=1.3134	6*5*5+(1	PAT.	POI)/	E				
5.4	C		TCFA IS	THE THE	CKYESE	OF T	HE T	OF FLAT	ING		
24	Ç		"BCT» IS	THE THE	CKAESe	ÛF T	HE R	OTTOM PL	ATING		
7.4			$\top \cap \mathbb{P} = 4 + 8.6$								
PA C			F. UT = 1 +								
°C4			1=561. +-	**(E*a01	+D+TCD)					
25			(EN=0*(?	•*E*P*TC	P*FOI+	2 . *8*	D * T O	P*(TOP+6	30T)+(D*	D*TOP*TOP) }
:-C	C		*SIH* IS	THE STR	ESC NA	TOP	DUE	TO FOGG	ING		
• + C			SIM=A/ME	₽ _≠							
55			VHITE(5)	66)STU	_						
174		Fa	FCHEVIL.	1,238,1	S[H=]F	18.3)					
* > E	-		0=561++0	M*(B*TOP	·+D+T()p)	0	TO 000	****		
in a	ſ,		+ or h = 10	THE STR	ESS UN	501	DUE	TU HUGG.	ING		
- 6			STHELZLE	DR. So.							
. 60		0	CIEMATAT	1 20 1 1	CO11 1-	112 - 1					
	~	9.1	SECRITA	TC TUE	1 = = = 0 	10.01	PEcc	ON POT			
	Ç		CBCRIT-H	- ⊥⊇ ⊣⊑ ∩I⇒PC+70	UNITE.	AL SI	NE 33	CN DOI			
270			WRITE (S)	112)5205	T						
228		4.1.15	FURNATI	1.17	SHERIT	= 1 F 1 0	•3)				
- 44		Fr	P=2.+0+1	CP+8+(T)	1-40449	, .	,				
768	С		+DITOP=	IS THE D	ISTANC	E OF	ТНЕ	TOP FROM	THE NE	UTRAL AXI	S
268	-		DITCHEDE	(B×BOT+F	TOP)	P	- Cap				
285			WRITE (S)	40 DITOF							
575		4.7	FOPMATC	1,12x,1	DITOP-	1F10.	4)				
204	С		*DIBOT>	IS THE F	ISTANC	E OF	THE	BOTTOM P	ROM THE	NEUTRAL	AXIS
204			SIBCT=D+	(R+T0=+1	+TOP)	P					
259			WRITE(S)	52)DI201							
38.4		50	FORMATI	1,184,1	DIPOT_	1F10.	4)				
256			END								
(5)	•U		0324[V]	AL	335C [V] B		0334EV	DRA	0330()	D
~ [V]	PrI		234C(V)		. 0.22 [5] •R		0358 (V.	DST	0362 (V)	S
[V]	34		737C[V]	G	3388 EV	J TOP		8302 [V]	BOT	0394 [V.	Δ
- (V)	UEN		\$388[V]	SIN	174 [1 62	1	V002[S]	01	Ø38C(V)	С

101

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PAGE



STRENGHT OF SHIPSTON THE NEUTPAL AXIS LOCATION PAGE 2
 >1FPILJ 90
 '3C4[v] SBCRIT 0228[L] 110
 03C8[V. p

 >2AS[L] 40
 .3D0[v] DIPOT 03"4[L] 50
 0000[S] .v
 112211 92 [V] SaH 0002[S] .V - [V] UITCP L iEl. GRAM LAPEL -: 5036 .W 2444 •R 2894 .- OMP 295C .Z 263F EXP 27C4 AI 263E AEXP 2966 • ERCNT 292E \$3 28FC . TARG 0055 · = 536 ALOG 2126 . 258F 268 . 7 "HY-PCT'TR: 2484 .A 2536 ALOG 2884 .COMP 2884 \$4 444 .--263E VEXA 5263E EXA Sale 263E EXA 2536 ALOG 27C4 AI 2958 .5 336 . 2988 .MES 2142 .0 55C +7=FD 2960 . FACNT 2062 ·n 2468 · V 472 ET · CN-HLOCKS. έ - FINER SUPPONTINES: E SFER AFAFFSS 2878 CUTION FEGINS: STH= 18867.144 SEH= 41334.957 SECRIT= 41021.425 DITOP= 21.7217 DIBCT= 49.7269 5:0 - VIO PERATING SYSTEM VERGICE 1 REVISION 012 03/04/74 GENERATED 05/06/74 LE HANDLING CHARGE \$.35 / JOB .35 85 LI TE FRINTED PRI & 1.25 / K LN •11 54 CADOS READ \$ 1.50 / K CD 22 PLATTER VECTORS \$.25 / 1770 . 38 • (* C* 16 "CHEL 7: SECONDS \$25.70 / HOUR •11 WE MODEL AN SECONDS \$12.50 / HOUD • 19 19 TOTAL CHARGE \$ • 65 "EIR 49 14731 LOGGED OUT 25/26/74 19:58. \$ 2.78 LEFT AFTER 32 LOGINS.

SUMMARY

Length	=	1000'
Beam	=	AL/5.75
Draft	11	в/3.3
Depth	Ħ	AL/14
DST	=	18000 psi
S	=	30"
Material	-	ALUMINUM
TOP	=	4.86"
BOT	=	1.00"
STH	=	18063.18
SBH	=	41334.96
SBCRIT	=	41021.80
DITOP	=	21.72'
DIBOT	=	49.71



```
*AL* IS THE LENGHT
2704
       С
              AL=1000.
1 . 4
. ...
              R=AL/5.15
              +DRA+ IS THE DRAFT
. 1.
       С
              DKA=B/3.3
6 15
              7=AL/14.
. 24
        C
              *PO1* 15 THE POISSON'S RATIO OF THE MATERIAL
. 32
6 37
              FOR ALUMINUM
       C
1 . 3 Y
              p01=2+33
              . A IS THE YOUNG'S MODULUS OF THE MATERIAL
. 35
       0
              FOR ALUNTNUM
1 35
       0
: 35
              ==10++1/+++6
              .DST. IS THE DERIGN STRESS
. 40
       C
. 40
              DST=130 0.
              *S* IS THE SPACING OF LUNGITUDINAL STIFFENING MEMBERS
1 54
       C
54
              3=60 .
: 20
       C
              *B** IS THE BENNING MNENT
              0M=(P*0+A*AL*AL*(**75))(33**35*)
. 55
              3=v.3P3P6*S*S*(1.*P01,PU1)/E
 1 4
              A=0.+P+++0/(14P++B+)
11
              0=3.***=2*0/(70.**4)
              F=3.+11+L+0/(140.+3")
114
. . 20
              THICKNESS OF TOP ASSUMED LARGER THAN BOTTOM THICKNESS
       С
35.1
              WEITE(5/1/)
           15 FORMAT(111,25x, TOP AGSUMED LARGER THAN BOTTOM!)
1 58
              +ICP+ IS THE THICKNESS OF THE TOP PLATING
1.6=
       C
16E
       С
              BOT & IS THE THICKNESS OF THE BOTTOM PLATING
              20T1 = 1 .
. . 65
1.75
           11 TCP1=P*FOT1*BOT1*BOT1/((3+D)*G*DST_D*BOT1*POT1)
1 mc
              WRITE(5+20)TOP1+80T1
53 ..
           22 FORMAT( 1,23x, TOP1=+F9.4,5x, BCT1=+F9.4)
1524
              A0T1=80T1+0+1
215
              IF (20T1 . 6T. 2. 5) GO TO30
              GO TO 11
1 24
25 . 1
           30 1022=3.5
           31 BOTE=TOP2*(12.*>-(C+F)*DST*TOP2)/(CST*(A+C)*TOP2=12.*B)
1-34
1 - 91
              RITE(5,40)T002,80T2
           40 FORMAT( 1,25x, 1000= (F9.4,5x, 180T2=1F9.4)
1-04
1-CC
              T0P2=T0P2+C+2
1 28
              TF(TOP2+GT.6+ ) 60 TO 52
254
              GD TO 31
PFF
           52 CONTINUE
TFE
              THICKNESS OF ROTION ASSUMED LARGER THAN TOP
       С
1 - FE
              RITE(5,60)
51.3
           42 FORMAT('1')25Y, POTTOM ASSUMED LARGER THAN TOP+)
1742
              ACT3=0.7
1362
           61 TCP3=((P+D)*BOT3+BOT3+BUT3-D*G*DST+BOT3)/(B*G*CST)
1:34
              FITE(5,72)TOP3,-OT3
1.28
           72 FORMAT(1 1,25x, 1TOP3=+F9+4,5X, 1BOT3=1F9+4)
3354
              3013=8013+0+35
```

```
IF(POT3+6T+1+5)60 TO 90
G0 TC 61
```

KREC.

CRE

104

402 404 404 404 404 404 404 404 404 404	9. 12: 11 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 2. 10 10 2. 10 10 10 10 10 10 10 10 10 10 10 10 10	TOP4=1 POT4=(PRITE) PRITE(PORM/T TOP4=T IF(TOP GONTIN ENO ACCONTINA ACCONTIN ACCONTIN ACCONTIN ACCONTINA ACCONTINA ACCONTINA ACCONTIN ACCONTINA ACCONTINA ACCONTIN ACCONTINACCONTIN A	1 c + (P + r 1 c + (P + r 5 / 92) 10+ (' ', 25) 10+ 6 + (' + 2 04 + (' + 2) - (A + Q <li< th=""><th>)_FST =,F9. 120 [v] B [c] A [v] A [v] B [v] T [i] A [i] A [i] R [i] 1</th><th>*TOP/ 4,5X. 8 0T1 0P2 0 2 0 2 0 2</th><th>44 94 94 94 95 95 95 90 95 90</th><th>C + F) + C 4 = ' F 9 + F 4 [V] F 4 [V] 76 [L] 76 [L] 78 [V] 57 C [V] 57 C [V] 57 4 [S]</th><th>DRA DST C 11 BOT3 TOP4 • V</th><th></th><th>04D8[V) 34FC[V] 253C[V] 0544[V] 0560[V] 2348[L] 2404[L]</th><th>D 5 F TOP1 B012 61 81</th><th></th></li<>)_FST =,F9. 120 [v] B [c] A [v] A [v] B [v] T [i] A [i] A [i] R [i] 1	*TOP/ 4,5X. 8 0T1 0P2 0 2 0 2 0 2	44 94 94 94 95 95 95 90 95 90	C + F) + C 4 = ' F 9 + F 4 [V] F 4 [V] 76 [L] 76 [L] 78 [V] 57 C [V] 57 C [V] 57 4 [S]	DRA DST C 11 BOT3 TOP4 • V		04D8[V) 34FC[V] 253C[V] 0544[V] 0560[V] 2348[L] 2404[L]	D 5 F TOP1 B012 61 81	
GKA - 271 - 472 - 472 - 474 - 774 - 474 - 774 -		2028 2648 2800 2858	• v • A • F ARG • L	2458 2470 2310 3052	• r 0 * p • v £ S • c		2036 2984 2282	≈I •₩ /EXP	2 E 2 E	88 102 102	•R EXP •ERCNT	2820 2988 2852	• Z A I \$ 8
184- 1688 2954 2820 2036 2036 MCN E	PUJNTO: P 72Fn T -blnCkg, NED Syff	2648 2658 2524	• A • COMP • ERCNT	26FA 247E 2024	ы 0G Ух • 0		2202 2100 2270	AEXP RARG MES	22	302 362 302	EXP \$8 •U	2988 281C 2020	ΔΙ' •5 •V
ANSF Cuti	ER ADERE Di Regi	-SS 227(,S:	7										





TOP ASSUMED LARGER	THAN BOTTOM
TGP1= 1-4842	BOT1= 1.2000
TCP1= **+6725	BOT1= 1.1000
T(F1= 1.9169	8071= 1.2000
TCP1= 1.2259	BOT1= 1.3000
TCF1= 1+6401	8071= 1.4020
TOP1= 2.1747	80T1= 1.5900
TOP1= 2.2751	BCT1= 1.6000
TCP1= 3.8112	BOT1= 1.7848
TCP1= 5.;919	6CT1= 1.8000
TCP1= 6.9147	20T1= 1.9000
TCP1= 9.6.15	BOT1= 2.0200
TCP1= 13.03.2	POT1= 2.1080
TCP1= 21.0105	8071= 2.2000
TCP1= 42.1:43	POT1= 2.3000
TCP1= 125.2754	80-1= 2.4020
T(P1==171.9002	BOT1= 2.5020
TEP= 3.5VAV	80~2= -11.8971
TCP2= 3.7 .1	8072= 91.0296
TCF2= 3.91 -4	8072= 8.7662
TCPP= 4.1 -4	8072= 4.3496
TCP2= 4.2. AV	8072= 2.7380
T(P2= 4 v ~v	8072= 1.8857
T(P2= 4.7v 20	8072= 1.3454
TCP2= 4.0/00	B0+2= 0.9655
TCP2= 5.1/78	8072= 0.6778
TCP2= 5.7.40	8072= 0.4483
TOP2= 5.F1-0	80-2= 0.2578
10P2= 5.7/ -V	BOT2= 0.4947
TCF2= 5.9404	BOT2= -0.2484






		TCP4=
		TCP4=
		TCP4=
		TOP4=
		TCP4=
		TCP4=
		TCP4=
		TCP4_
		TOP4
		TOP4
		TOP4-
		TOP4=
		TOP4-
		TOP4_
Fr C		101 1
	 	E

BOTTOM	ASSUMED	LAFGER THAN	TOP
TOF 3=	~ (* . (* 1 + 8)	B073=	0.7000
10⊦3≞ -	3.0310	8nT3=	0.7500
T(+F3=	1.0809	BOT3=	0.8000
тсрз_	1.1445	80-3=	0.8500
10P3_	1.2123	ACT3=	0.98.08
TUP3= -	1.2909	80T3=	0.9502
T023=	1.3926	8073=	1.5800
TGP3=	1.4972	80T3=	1.0500
10P3₌ -	3.6108	B0T3=	1.1002
TCP3=	1.7531	80T3=	1.1500
TCP3=	J-292K	B0T3=	1.2008
TCP3=	1.0524	8nt3=	1.2500
TCP3=	1.2319	B073=	1.3000
TGF3=	1.46-28	80T3=	1.3500
TOP3_	1.63.5	80T3=	1.4000
T683=	1.2548	8013=	1.4500
TGF3=	2. 2945	8073=	1.5000
TUP4=	1.00 40	BNT4=	16+1639
T(P4=	1.28 24	80×4=	15.3920
TCP4=	1. 4. 1. 164.	B074=	14.6201
TCP4=	1.60-0	80T4=	13.8482
TCP4=	1 + 28 ~1	E0T4=	13.0763
10P4=	2.01. ~8	80T4=	12.3144
TGP4=	5.5 -6	80T4=	11.5324
TCP4=	2.4/28	80T4=	10.7605
TCP4=	5.61.26	80T4=	9886
1024 <u>-</u>	2.56	B0T4=	9.2167
TOP4=	3.2. 1	R074=	8.4448
TCP4=	3.71.4	80T4=	7.6729
TCP4=	3 · 4 * 26	B0T4=	6.9010
TCP4=	3.6106	B074=	6.1290
FCP4=	3.8.000	2014 <i>=</i>	5.3571
1024 <u>-</u>	4. 24 26	B0-4=	4.5852
TOP4 =	4.27 -11	BOT4=	3.8133
TOP4=	4.4. 70	80T4=	3.0414
T0P4=	4.6.02	BOT4=	2.2695
TCP4=	4.24.08	BOT4=	1.4975
TCP4=	5.76.78	80T4=	P.7256

E VID OPERATING SYSTEM VERGION 1 REVISION 12 03/04/74 GENERATED 05/06/74 L

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 JCB
 HANDLING CHARGE
 \$.35 / JOB
 .35

 164
 LINES PRINTED PRISS
 1.55 / K LN
 .21

 67
 CARDS READ
 \$ 1.50 / K CD
 .10

 67
 CARDS READ
 \$ 1.50 / K CD
 .10

 92
 PLOTIFO VECTORS
 \$.25 / 10/0
 .00

 19
 CDEL 7
 SECONDS
 \$ 25.20 / HOUD
 .13

 22
 MODEL RY SECONDS
 \$ 12.50 / HOUD
 .00

 10
 TOTAL CHARGE
 * .79

EIP 4-3 14731 LOGGED OUT 25/26/74 19:48. \$ 4.89 LEFT AFTER 29 LOGINS.



STRENGHT UF SHIPSHON THE NEUTRAL AXIS LOCATION

.2 . 4	С		ANLA IS THE LENGHT
2.4			AL=1000.
2.00			6=4L/5+75
2.12	С		ADRAN IS THE DRAFT
e 12 0			DK7=B\3+3
. 34			$D = \Delta L / 14 +$
1,3,-	C		*POI* IS THE POISSON'S RATIO OF THE MATERIAL
. 32	C		FUR ALUMINUM
6 3 4			PCI=0+33
3 =	С		*E* IS THE YOUNG'S MODULUS OF THE MATERIAL
. 1:	C		FER ALUMINUM
3 5			1=10++10++++6
2.42	C		#JST* IS THE DESIGN STRESS
12			207=18422+
E EA	C		*3. IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
· ·			$G = f_1 f_1^{-1} + \dots$
6 I	C		FOMM IS THE BENDING MOMENT
11-			B"=(R*RRA*AL*AL*2.75)/(35.*35.)
			0=0+3,394×6+S+(1++POI*POI)/E
	2		-TOPH IS THE THICKNESS OF THE FOR PLATING
1	1		PROTH IS THE THICKNERS OF THE BOTTOM PLATING
10 10			T0P=4+50
			B°T=1+74
a			A=540 · × PM * (5 * 60 T + 7 + TOP)
			DET =D*(2.*3*a*TOP*ACT+2.*5*D*TOP*(TOP+BOT)+(D*D*TOP+TOP))
11.10	C		ROTHALIS THE STRESS ON TOP DUE TO HOGGING
1.7			STHEA/DEN
1 1 1			WRITE(S, AC)STH
1.7.		611	ECOMAT(' ',20X, 'STU='F10+3)
1 2 1			C=560+KFM*(8+T0P+C*T0P)
7	Ç		*SEP* IS THE STRESS ON BOT DUE TO HUGGING
1111			SPI = CVDEN
		_	WHITE(5,90)SAH
		91.4	FDN MAT(' ', 20%, 'SBU#'F10+3)
1.5.	C		*RECRITE IS THE CRITICAL STRESS ON BOT
1010			SHIRIT#BOI#POT/G
6-1-			WEITE(5)11)SACRIT
201		119	FORMAT(' ',17X,'SPORIT='F10.3)
67 4 4			P=2+*D+TOP+A*(TOP+90T)
2060	C		FOITOPH TS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
2020			$ \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{$
2210			WHITE (5)48) UI(CH
128 4	~	46	FURMAL(' ')18X/(DITOP='F10+4)
2204	C		TOTOL TO THE DISTANCE OF THE BUILDM FRUM THE NEURAL AXIS
825.4			$\frac{1}{1} \frac{1}{1} \frac{1}$
2311		5.0	$E \cap E \wedge T \setminus \{1, 1, 2\}, \{0, 1, 0, 0\} = \{1, 2\}, \{1, 2\}$
6321		50	
1: [3]			
3.4:47	POT		
32217	AM		
1125/1	DEN		
	ULIN		

4

PAGE 1

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STRENGHT OF SHIPSHON THE NEUTRAL AXIS LOCATION PAGE 2 LEVI SRH 01E2[L] 90 0308[V] SBCRIT 0228(L) 110 0300(V) P 94 ELJ 8459 0304[V] DIBOT 0304[L] 50 0000[S] .V NOVI DITOP L XEG F. "AGRAP" LABELS: 2011 MAINA 2108 .V 2898 .COMP 2476 @I 2448 •R 2960 .ZE 2438 · A 2642 EXP 283A .W 29BC .MES 2708 All 2535 \$6 2914 .RARG 2950 .5 2642 AEXP 2964 .ERCNT 2534 ALOG 84 5665 U. AEAS 36.35 2964 . 0 TRY-FOINTS: 2642 AEXP 7645 .R 2488 • 4 2531 ALOG 2642 EXP 2708 AIN 2898 ·CCMP 2288 \$4 2900 •RARG S**33**S ≉8 2950 +5 2-3- - 4 2964 . ERCNT 29RC MES 2348 ·ZEP0 2964 .0 2A46 .U 246C .V 2376 51 "" " + = = LOCKS: 1.2 SEFILED SUBROUTINES: AUSFER ADORESS 2070 CUTICN REGINS: STH= 18834.023 SBH= 31×31+496 SBCRIT= 31767.121 25.8324 DITOP= DIBOT= 45.5962 ED FVIC OPERATING SYSTEM VERSION 1 REVISION 212 03/04/74 GENERATED 25/06/74 P JOB HANDLING CHARGE \$.35 / JOB •35 85 LINES PRINTED PRE \$ 1.25 / K L' •11 54 CARDS FEAD \$ 1.57 / K CD .08 12 FLOTTER VECTORS \$.25 / 10%7 .00 14 "ODEL 70 RECONDS \$25.17 / HOUR •10 27 MODEL ER SECONDS \$12.52 / INUE .20 TOTAL CHARGE 5 +64 PEIS 498 14731 LOGGED OUT 25/26/74 20:01. \$ 2.14 LEFT AFTER 33 LOGINS.



SUMMARY

Length	=	1000'
Beam	=	AL/5.75
Draft	=	в/3.3
Depth	=	AL/14
DST	=	18000 psi
S	=	60"
Material	-	ALUMINUM
TOP	=	4.53"
BOT	=	1.76"
STH	=	18034.02
SBH	=	31831.49
SBCRIT	=	31767.27
DITOP	=	25.831
DIBOT	=	45.601

,

F

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· (* 4

04 17C 118

18 2 3

35 38

136 38 40

•C

50

120 1+2 10E

· 6E

1.E • 76

· 22

SEL

716

230

230

-34

284 100

-E8

FFA

C

С

C C

C C

C

С

С

С

С

0

ALE IS THE LENGHT
p = A I / b + 7 b
*POIN IS THE DOISSON'S RAILO OF THE MATERIAL
FOR ALU'INUM
PUI=V•33
E IS THE YOUNG'S MODULUS OF THE MATERIAL
FOR ALUTINUM
E=10 + *1 + *6
.UST & IS THE HERIGN STRESS
<pre>[S1=182000.</pre>
S IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
5=120.
* Br & IS THE SENTING MOMENT
FM=(R*0+A*AL*A1*1.75)/(35.*35.)
r=r+3(396*5*3+(1++PCI+PUI)/F
$A = 9 \cdot P \cdot P \cdot P \cdot (1 \wedge 0 \cdot P \otimes P \wedge 1)$
$C = \exists \mathbf{a} \times \mathbf{B} \times \mathbf{b} \times \mathbf{D} / (\mathbf{z}) \times \mathbf{D} / \mathbf{b}$
$m = 2 + m \left[\frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} + \frac{1}{2} \right) \right]$
THICKNESS OF FOR ACCOUNT ARGED THAN BOTTOM THICKNESS
PITERS ARY
POLIEVDZIY)
TOP TO TO THE ACCORD OF THE TOP PLATING
TUPN IN THE THICKNERS OF THE TUP PLATING
* POTA IS THE THICK ESS OF THE BUILDM PLATING
null=2.
- 4 そりにす … に … に た て す ま ぶん やす … 足 か ぞう … と しろ エ ひ き や … い に て … ひ か て す か の ひ て す か

1; TUF1=F*00T1*A0T1*ACT1/((B+C)*G*UST+D*B0T1*BUT1) wFITE(5/20)TOP1/POT; p: cOPMAT(! !,25v,!TOP1=+F9+4,5X,!BOT1=!F9+4)

```
aCT1=BOT1+C+2
IF(POT1+GT+7+)SC TOSA
```

=0 TC 11

```
4 > ≓CRMAT(' ',25v,'TOP2=+E9+4,5X,'BUT2='E9+4)
TOP2=TOM2+C+2
JE(TOP2+GT+6+ ) GC TO 50 .
```

```
30 TO 31
5 CONTINUE
```

```
FE5 * CONTINUEFFETHICKNESS OF ROTTOM ASSUMED LARGER THAN TOPFFEWHITE(5,60)312An ROFMAT('1',25x,'BOTTOM ASSUMED LARGER THAN TOP')342BOTTOM ASSUMED LARGER THAN TOP')343A1 TOPS=((h+0)*HOT3*BOT3*BOT3*D*G*DST*BOT3)/(P*G*DST)344A1 TOPS=((h+0)*HOT3*BOT3*BOT3*D*G*DST*BOT3)/(P*G*DST)
```

```
    194
    __RITE(5+70)TCb3+R0T3

    368
    7- = OEMAT('_',25x,'TOP3=+F9+4,5x,'BOT3='F9+4)

    360
    __BOT3=R0T3+0+2

    360
    IF(BOT3+GT-3+5)30 T0 x0

    376
    __30 T0 61
```

,

```
x~ TOF4=1.
1422
          =1 #014=(12**(B+n)*(A+c)*DST*TOP4)/((C+F)*DST)
620
            L45
         9 * FORMAT( ' 1,25v, 'TOP4=, F9.4,5X, BOT4= 'F9.4)
612
             TOP4=TOP4+0.2
9A
             TF (TUP4 . GT . 4 . 5) 40 TO 100
-16
             60 TO 81
-62
        1 12 CONTINUE
LEC
             FND
L-C
             24CPEVI AL
                             CAROLVI B
                                               R4DUEV] DRA
                                                                0408[V1 D
 [S] •11
                              PAPALGI .R
 (V) FCT
             2488[V] E
                                               84F4[V]
                                                       DST
                                                                04FCLV1 S
             2518 [V] G
                              :524[V] A
                                               0500[V] C
                                                                053C(V) F
. [V] ....
             2006[5] 81
 (L] 1 "
                              2542 CVJ BOT1
                                               @176[L] 11
                                                                0548[V] TOP1
                              550 (V) TOP2
             2220 (L) 30
                                               $224[L]
                                                                9564 (V) BOT2
 ilj al
                                                       31
             22FE(L) 54.
                             31261] 60
                                                                0348[L; 61
· [L] 4 .
                                               0573(V) BOT3
 (V) THP3
                                               RESOLVI TOP4
             2398 [L] 74
                             4021J 32
                                                                040A(L) 81
             2472 (L) 90
                             :4PC(1) 100
.: V3 HOT4
                                               PPCS[S] .V
FG
            L
GRAM LAPPLA:
2173 * MAJ *
              2010 ·V
                            2145 . OHD
                                           1 & AS35
                                                           25FC •R
                                                                          2B14 .Z
2172 56
              263C .A
                             2077 .MES
                                           POEE .N
                                                           27F6 EXP
                                                                          297C AI
                                            27F6 AEXP
EEE ALCG
              EAL4 .PARG
                             FF1 * . 5
                                                           2818 • ERCNT
                                                                          2AE6 $8
-613 • 0
              SELE .C
                             3246
FRY-POTNIS:
PEFC .P
              2630 .4
                             ESEE ALOG
                                           27F6 AEXP
                                                           27F6 EXP
                                                                          297C AI
              2A4C .COMP
                             1 A72 86
-92E · /
                                            PAB4 .RARG
                                                           24E6 $8
                                                                          2810 .5
             2E18 ·ERCNT
                            281A .A
                                            2876 .MES
PE14 .7FR0
                                                           SBEV .
                                                                          v. 0535
TH ASS
```

EFINED SUPROUTINES:

INSFER ADDITESS 2.70 Intign Regins: 113

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PAGE

TOP ASSUMED LARGER	THAN BOTTOM
TCP1= J.0684	BOT1= 2.2000
TGP1= 1.9451	BOT1= 2.2000
TOP1= 1.8328	80+1= 2.4000
TOP1= 2.4658	BOT1= 2.6000
TOP1 3.25,2	BOT1= 2.3000
TOP1= 4.3404	BOT1= 3.0000
TOP1= 5.75+3	2071= 3.2000
TOP1= 7.62,55	8071= 3.4000
TOP1= 11-1-59	BOT1= 3.6000
TCP1= 13.81 ab	BOT1= 3.8000
TOP1= 19+2+22	Bati= 4.0000
TOP1= 27+04+6	BOT1= 4.2000
TOP1= 43.7822	BOT1= 4.4002
TCP1= 37+2119	BOT1= 4.6000
TOP1= 250+5008	BOT1= 4.8000
TOP: == 3+3.7314	80T1= 5.0070
TCP1 =- 117 • 78 g2	BOT1= 5.2020
TOP1 = +15 +9×76	BOT1= 5.4000
TOP1 = -59 + 147	BOT1= 5.6000
TOP1 = -49.87p4	BOT1= 5.8000
TOP1= +44+2485	BOT1= 6.0000
TOP1= +40.5128	BOT1= 6.2000
$70P_{1} = -37.9554$	BOT1= 6.4000
TOP1 - 25.0977	BOTI= 6.6000
TOP1 = + 34 + / 1 15	BOT1= 6.8000
10P1= - 33 · 55aC	80T1= 7.7000
10P2= 3.6000	8072= -11.8971
10P2= 3.72AR	8072= 91.0296
TOP2= 3.0 al	BOT2= \$.7662
TOP2= 4+1 00	BOT2= 4.3496
1042 - 4.37an	8072= 2.7380
1012 4+52×0	BOT2= 1.8850
10P2= 4.7% ok	BOT2= 1.3454
10F2= 4.9k al	BAT2= 0.9655
	8072= 8.6778
	BOT2= ؕ4483
	BOTZ= 0.2578
	BOTZ= 0.0947
1012 5-9/46	HOTZ= =0.0484 '

.





POTION	ASSUED	LARGER THAT	TOP
TOP3=	30 .2	BOT3=	1.2000
TOP3=	-14=6	BOT3=	1.2000
TOP3_	-J. 0226	8013=	1.4000
TOPBE	1.1059	8073=	1.69.09
TOP3=	2.4326	BOT3=	1.8000
TOP3_	1.7821	2113=	2.0000
TOP3=	1.2328	BOT3=	2.2000
TOPC_	1.7928	80T3=	2.42.00
TOPC=	2.4628	80T3=	2.6000
TOPS=	3.2416	8073=	2.8000
TOP5=	4 • 19 = 1	8013=	3.4000
TOP5=	5.27-1	8n13=	3.5000
TOP3=	6.4.12	B013=	3.40,00
TCP4_	1	BOT4=	16.1639
TCP4=	1.240	BOT4=	15.3920
10P4=	$1 \cdot 4 \land \phi V$	EOT4=	14.6291
10P4=	1.5. 1	B0 4=	13.8482
TOP4=	1.7/20	B0T4=	13.8763
T(24 ±	2.3.78	80T4=	12.3044
10P4=	2.2.28	EOT4=	11.5324
ĭ(⊃4=	2.4.76	B0T4=	10.7605
T(⊇4 <u>=</u>	2.6206	80T4=	9•9886
TUP4=	5.8.26	80T4=	9.2167
TC24=	3.7.28	BOT4=	8.4448
TC 24=	3.2108	8074=	7.6729
T024±	3 . 4 . 24	80T4=	6.9010
TCP4=	3.61-2	8CT4=	6 • 1290
TCP4=	3.82 nl	POT4=	5.3571
TCP4=	4.01.34	8074=	4.5852
TCP4=	4.21a8	BOT 4=	3.8133
T0P4=	4.4292	80T4=	3.0414

- .0

F VIO OPERATING SYSTEM VERGICH 1 REVISION 012 03/04/74 GENERATED 05/06/74 0

CF	HANDLI'G CHARGE	\$ • 35	1 JUB	• 3 5
.67	LINES POINTED PRI	\$ 1.25	/ K LN	• 21
67	CARDS READ	\$ 1.50	/ K Cr	• 1 :
20	PLOTTER VECTORS	1 + 25	1 1270	• 12
20	MONEL 77 SECONDS	\$25.92	/ HAUR	• 1 /
97	MONEL IN SECONDS	512.50	/ HOUS	• 🖷 (
		TOTAL	CHARGE	\$ • 80

EIF 40.8 14731 LOGGED OUT 05/06/74 19:52. # 4.09 LEFT AFTER 30 LOGINS.

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STRENCHT OF SHIPSTON THE SEUTEAL AXIS LOCATION

+AL+ IS THE LENGHT C 2.4 AL=1082.** * 14 R=AL/5.78 :-+DRA+ IS THE PRAFT 1: C [HA= 1/3 . 3 13 D=41/14 . 1. POIN IN THE DRISSON'S MATIO OF THE MATERIAL C 7 POP ALUNIALM C 3. 50.-3=10q .F. IS THE YOUGH'S MODULUS OF THE MATERIAL 0 2 キチャーストロケエルした 1 E=10.*12.**6 3 FSTA IS THE AFFIGN SARESS ++ E. 251=112.V.+ SE IS THE SPARTER OF LUNGITUDINAL STIFFENING MEMBERS . l. 0 5=12. may * Dr * 13 THE REMOIND ONENT 51 6.1 DI=(F>0MA+/L>/(~1+75)/(35+*35.) 1=+ .31396*5*9+(1.+P-1.PUI)/E 5 . ICP+ IS THE THICKETS OF THE TOP PLATING \cap - In *POINT IS THE THICKNEYS OF THE ROTTOM PLATING 6.00 m 106=4.27 + d+ -1 1.67=2+95 24 $\Delta = 566 \bullet \star \operatorname{opt} (\operatorname{Berr} (\operatorname{TH}) \star \operatorname{TH})$ DEx=D*(3.*P*1+T(-*+)T+2.*B*D*TCP*(*OP+BOT)+(D*C*TOP*TOF)) 1.1 . 66 STHE IS THE ATESS ON TOP DUE TO DOGGING <u>____</u> 145 STH=A/DEN . 51 WHITE (5+60) STE P. FURLATE! 1,2: V, 18TH= 1010.3) .76 1 + 2 C=56 * + * (Bx+1)=+0.T(3) *SEH* IS THE GTHESS I & BOT DUE TO FOGGING ~ 4 С SPE = C/DEN 31 104 RITE (SIGC)SHL 00 FCATIT(1 1,2/4, 1944=1:10.3) 127 "FC C *SECRIT* IS THE CRITINAL STRESS ON BOT · Fť SPCRIT="OT*BOT/G 15 WRITE(S+11))SHCHIT 110 FURNAT(' 1,17x, 1980@IT='F10+3) 225 (TOP+GOT)+0+GOT+GT+GT+ - 6 L. 68 + UITCE+ IS THE FISTAGE OF THE TOP FROM THE NEUTRAL AXIS С 67 DITCP=P*(0+20++P+TOP)/P 775 VFITE (S)49) DI-(F - 17 4(FCF1AT(' ', 18V, 10ITOF_1F10.4) - 64 C "DIECT & IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS - 24 DIECT=C*(B+TC+++TC+)/P Êć REITE(5,5V)DISCT 364 50 FCFMAT(' ',1284, 'DIBOT_'F10.4) 15 FNC [5] +11 V324EV] AL 232C[V] B P334[V] DPA 033CEV1 D IVJ POI (54C [V] [1260[5] .R. F358[V] DST 0364[V- S [1] 0" PBSVEVI BOT (370 CV) G 2398 (V) J388[V] TOP Δ IVJ LEM 23EC(V) STH 174613 68 CCCCCSJ CI 2362 (V) C

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STARNONT OF SHIPSHON THE PROTAN AVIS LOCATION PAGE 2 3CPLVJ SECRIT P228LJ 110 VIESCEI 90 (V) Sah 0300 (V) P 2020[S- .V (Y) ITT(= 1215[[] 4V 364 (V) DIFOT 63(4(L) 50 6.1 L (AM LAFFLC: 8168 .V. 21.42 . - UNP 2176 CI 2448 .R 2960 .ZF ,70 = 131 JH 2428 .2 2642 EXP POHE .LES D. AERS 2708 AT --E "+ Sear . TVEC 7642 1EXP 2964 • ERCNT ESA NI OC 2956 .5 2912 \$8 c14 . M 31142 2134 .1 HY-FUT Tat 442 · F 248 . .1 2642 NEXP 22 31 1100 2642 EXP 27C8 AI THE TE 2016 .RARG 225× . (CPP) 2032 #3 2950 .5 · 4:5 2564 .54C+T 204C .MES 2146 .U V. JAAS 2266 ... 1,6 1 * MISTEL DEVE. . EFINER S, FEDITINES: e p NOFE- ADDER55 2271 CUTICS LEGITS: STH= 1795-.793 58-= 22852.766 SPCFIT= 22760.1 8 fITCP= 31.4316 FIRCT= 39.917 FIS F /IO OPERATING SYSTEM VERGION 1 REVISION 012 03/04/74 GENERATED 5/06/74 REMANDLI'S CHARGE & . DE / JOF • 35 SE LINES FRINTED PRI & 1. DE / P LU • 1.1 54 CLEDE HEAD \$ 1.= / / Cn • " E VI PLATTER VECTORS 3 . 25 / 10.7 • (* × 16 MEREL 7' SECONES SP5. -; / HOUS • 1 1 12 ME-FL SI SECONDS 112.50 / HOUD · 5 11 TOTAL CHARGE T • 65 EIR 49 14731 LOGGED OUT 25/26/74 20:03. 9 1.49 LEFT AFTER 34 LOGINS.



Length	= 1000*
Beam	= AL/5.75
Draft	= B/3.3
Depth	= AL/14
DST	= 18000 psi
S	= 120"
Material	- ALUMINUM
TOP	= 4.27"
BOT	= 2.98"
STH	= 17958.79
SBH	= 22852.76
SBCRIT	= 22768.12
DITOP	= 31.43'
DIBOT	= 39.99' or 40.00'



Looking at the following table we can also observe for the aluminum the effect of changing S on the neutral axis location and the compressive stresses resulting on thebottom plating.

CASE		S inches	TOP inches	BOT inches	SBH psi	SBCRIT psi	DITOP ft	DIBOT ft
1		10	5.35	0.363	53000	* 49000	18.09	53.34
2		30	4.86	1.00	41000	41000	21.72	49.71
3		60	4.53	1.76	32000	32000	25.83	45.60
4		120	4.27	2.98	23000	23000	31.43	40.00

(*) This difference may result from inaccuracy in reading the plot.

Here again the values of TOP and BOT may allow for a quick evaluation of the weight relationship between the four cases.

One run was also made in the case of the aluminum for AL=500 ft and the results are here included.



STRENGHT OF SHIPSTON THE SEUTONL AXIS LOCATION

.04		С	*AL* IS THE LENCHT
64		Ŭ	AL=50V.
			D#71 /2.
11		~	
17		C	A DEAL DIRE OFFI
1 2			0 · A = 2 / 3 ·
24			
30		С	FCI IS THE POISSON'S FATIO OF THE MATERIAL
(*)		C	FOR ALDITUM
21			₽0I=< • 33
		<u>_</u>	*E* IS THE YOUNG'S MODULUS OF THE MATERIAL
		~	EON ALULTNUM
		•	C=1 . *1 . **6
		~	LITE TO THE PROTON CADEOO
e l		e e	
		-	CLIFIC 1. COLLONG THE MAL OF TREATED AND A CHORDON
5 6		C,	YOW TO THE SHACTLA OF FANGITANT STIFFENING LEWRERS
n he			5=30.
20		-	PLA IS THE BENDING NOMENT
50			B'=([*)4A*AL*AL*AL* •75)/(35•*35•)
22			G= 3'345*5*5*5*(1POI%POI)/E
+ l_1			$\Delta = 9 \cdot * (\cdot * \cup / (1 + i \cdot * B^{*}))$
EC.			C=3*****U/(7***, M)
· 40			E=3. * 14 ×[/[1,
1			THICK JESS OF THE ASSINED LARGER THAN BOTTOM THICKNESS
5 14 1 1 1		<u> </u>	ATTRACTOR AND AND DEPENDENT OF A DEPENDENT OF ANTERALIS
ε -			NULIERDIAN DES INTO CECHNER I DECER THAN DETTEMAN
4		1	TOP TO TO TO A COMER LARDER THAN BUILDED)
~ L	1	C .	* 10P * 15 THE THICKNESS OF THE TOP PLATING
4 E	1	С	REDT. IS THE THICKNESS OF THE POITTM PLATING
15			$c OT 1 = c \cdot 1$
7=		1	<pre>+ TCP1=P*#0T1*90T1*80T1/((3+P)*G*DST*D*B0T1*80T1)</pre>
e E -			whITE(5,2")T051.0011
E2		2	<pre>p FORMAT(! !,25v; !TOP1=;F9.4,5X, !BCT1=!F9.4)</pre>
5 A			B(T1=F0)[1+C+25
16			TE (ADT1+GT+1+VGD TO BO
22			
20		2	
26		0	, TC-C-C-C- , TC-TC-TC-C-C-C-E, *0CT+TCDD)//FCT+(A+C)*TCED=42, *B)
2			1 GUICHIO CTILC. * TUCHT STATUPPIZ (TSTATUTTUTETLE ADT
54		4	0 FLHMAT(' ',25V,'TUP2=:F9+4,5X,'B(T2='F9+4)
υC			TCP2=TOP2+V+VH
50			IF(TCPR+GT+1+)GD TO by
5 4			GC TC 31
FE -		5	CONTINUE DE LA CONTINUE
I.F.	1	С	THICKNESS OF GOTTOM ACSUMED LARGER THAN TOP
FE.			**ITE(5,62)
.12		6	- FORMATC'11, 25Y, POTTON ASSUMED LARGER THAN TOPIN
- 4 -		0	0013=2.1
43		(4 TÜP3=(((+D)*80T3*80T3, P((T3+0+0+0ST+80T3))/(R*6+0ST)
94		Ċ	
202			FURNITI' I DEL ITIDO- ER A EV IDOTO ICO IN
15.7		7	- FORTATION (
60			
26			Ir (S(i3+61+1+)60 10 80
2 2			GU TC 61

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PAGE 1



-92 -92 -94 -94 -94 -96 (*) (*) (*) (*) (*) (*) (*) (*) (*) (*)	• [] • [] • [] •] •] •] •] •] •] •] •	ра ст ст 1 ст ст ст ст ст ст ст ст ст ст ст ст ст	10P4=0.1 pOT4=(12.*(P+n) URITE(5.00)IGP POHNAT(1,1,2nv) TOP4=T(F4+(.000) IF(IOP4.0T.1.)) GOTO(51) CONTINUE ENC -4CC(V) AL :4F8[V] E :518[V] C :4F8[V] C :2F6[U] SC 2F6[U] SC 2F6[U] SC :478[L] SL) = (A+C) (CST = TOP 4 + 10 Y 4 ; TOP 4 = [F9 + 4 + 5) GO TO 100 (CST + 10 + 4 GO TO 100 (ST + 10 + 4 ST + 10 + 2 ST + 10 + 2 ST + 10 + 2 A + 5 + 1 + 3 A + 5 + 1 + 2 A + 5 + 1 + 1 + 2 A + 5 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1	P4)/((C+F)* x, +BOT4= 'F9 C454[V] C52C[V] C176[L] C234[L] C54C[V] P54C[V] P640[S]	DST) •4) DRA DST C 11 31 EOT3 TOP4 •V	04D8[V] 04FC[V1 0534[V] 0544(V) 0554[V- 0554[V- 0343[L] 0404[L]	D S F TOP1 BOT2 61 81	
1 Α ^Ν •70 ΑυΔ Ε1 Α ;	1 1 1 5 x 1 1 0 1 1 1 0	EFLA I * C	2014	2434 • 001 P 2150 • MES 24F2 • 6 302F	2012 I 29D6 .4 27DF AEXP	25E4 27df 2800	•R EXP •ERCNT	24FC 2964 24CE	• Z A I \$
F =	• • • • • • • • • • • • • • • • • • •	T <u>s</u> : Fo	2624 • 4 2434 • COMP 2620 • 69CNT	2606 / LOG 2857 46 2632 • 9	270E /EXP 2A9C .RARG 2858 .MES	270E 270E 270E	EXP \$8 •∪	2964 24F8 2078	A I • <u>•</u> • V
Ξ.	יינר	Cks:							

EFINER SUBOLUTINES:

VSFER ADDEESS 2070 UTION REGINS: PAGE 2

TOP AS	SUMED LANGER	THAN B	OTTOM
TCF1 =	1.0812	BOT1=	0.1000
TCF1 =	3.0.12	BOT1=	1.1500
TCP1=	3.0101	80T1=	5.2025
TOP1=	1.0002	8071=	0.2500
TOP1=	1.1321	80T1=	0.3882
TOP1=	3.05.06	BOT1=	1.3502
TOP1=	3.03-2	80T1=	0.4022
TOP1=	7 . 14 ; 4	80T1=	1.4502
TCP1=	1.2 61	8071=	3.5020
TOP1 =	3.2971	80T1=	2.5502
T6P1=	1. 1. 8 1. 15	BOT1=	0.6802
7081 <u>-</u>	J. K. K.9	20T1=	0.6500
TOP1=	1.8722	80T1=	0.7000
10P1=	1.2529	8071=	0.7500
TCP1=	1.0007	2071=	2.8700
TCP1=	3.25-9	E∩-1=	4.850%
TOP1=	6.44-3	POT1=	7.9404
TCP1=	32.21:9	P071=	8.9500
TCP1=	-16.6511	EOT1=	1.0200
T(P2=	≜1 2°C	=S103	-8.1617
T(PP=	1.150k	=S103	-0.1687
TCPP=	14 - 24 - 41	80-2=	-2.42587
TCPP=	3.2524	9012=	-7.3997
TOP2=	3.2006	Bot 2=	⇒∴.6955
T622=	1.21.21	8015=	-2-1234
TCP2=	A . Law W.	=S 108	1.7868
TCP2=	パ・4 ビット	B072=	0 • 5 333
TOP2=	2.5. 00	80+5=	1.2515
TUP2=	い。ディック	B072=	1:1143
ICP2=	N. Frank	B072=	2.158
16P2=	1.6500	8012=	-0.1403
TGP2=)•72+0	8015=	- ∅•≈944
TOP2=	2.7572	BOT2=	-7.1413
TOP2=	1 · 8 · 2 ·	BUIS=	# ∅•1835
TCP2=	3.8-24	B015=	-7.2224
TOP2=	1. 9V.	8012=	-3-2591
1065=	N • 3.2 ~ K	=ST03	- ؕ2941
TOPS=	1.0:00	501S=	-0.3277



Intersection not accepted; assumed Top>Bot ended up with Bot>Top.



POTTOM	VSSIFED	LARGER THAN	TOP
10P3=	-M. Crat	80T3=	0.1000
TCP3=	- P. • 11 p.F.	BN73=	2.1500
TOP3=	-3-14-53	8073=	9.7908
T623=	-0.15ck	B073=	0.2500
T023-	-11-1: 14	BOT3=	0.3000
1023=	- 1. je 45	BOT3=	0.3500
T(P3=	-3.02 -1	B073=	2.44008
TOP3=	· D . 105 77	80T3=	2.4500
TCP3=	M . 1556	B0~3=	0.5000
T623=	1.2273	B013=	v •5500
T623=	3.3925	B013=	0.6600
TOP3=	3 . F. 6 14 4	80T3=	8.6500
10P3=	0.8543	B0T3=	8.74.9.8
TOP3=	1.14.94	BOT3=	0.7500
T023=	1.4922	8013=	0.8000
10P3=	$1 \cdot \text{Prop} 1$	POT3=	P. 8500
TCP3_	2.40.21	80T3=	2.0000
TCP3=	2.2123	EOT3=	0.9500
70P3=	3.41.8	Bn-3=	1.08822
TCP4=	1 · 1 · ~ ·	80T4=	1.1275
TOP4=	3-15-19	B074=	1.7344
1684 =	3-2108	8nt4=	0.0414
TOP4=	ろ・アミード	BOT4=	1.2484
T(P4=	3.31-4	BOT4=	0.7554
10P4=	3.35 -6	B074=	Ø.6623
TCP'4=	2 . hr al	8nt4=	0.5693
TCP4=	*• 4 € > ('	80T4=	0.4763
TGP4=	1.5108	BOT4=	0.3835
T0P4=	イ・デニースを	B0~4=	
TCP4=	1.41 48	BOT4=	ؕ1972
T0P4=	0.45 af	B0T4=	10.1842
T0P4≞	0.78 78	B074=	0.4111
T0F4=`	0-72-08	B074=	-7.6819
TCP4=	1.94 -2	80T4=	-10-1749
T0P4=	A. 85ak	B074=	•3•5686
TOP4=	7.0602	BOT4=	-0.3610
TOP4=	3.05-8	BOT4=	+@•454Ø
TOP4=	1.01 22	BOT4=	-0.5470

1.13

F VIO OPERATING SYSTEM VERGION 1 HEVISION 012 03/04/74 GENERATED 05/06/74

•

Dev.	HANDLI'S CHARGE	s • 35	1 JUE	• 35
73	LIVES FRINTED PRI	\$ 1.25	/ K LN	•55
57	CARIS READ	\$ 1.50	/ K Cr	• 1
3 - 1 4, +	PLATTER VECTORS	s • 25	1 1040	•97
52	MONEL 7- SECONDS	\$25.70	/ HOUD	•14
22	MONEL PA SECONDS	\$12.50	1 HOUR	• C C
		TOTAL	CHARGE	\$.81

EIR 498 14731 LOGGED OUT 05/06/74 20:09. \$.68 LEFT AFTER 25 LOGINS.






STRENGHT OF SHIPSTON THE SEUTRAL AXIS LOCATION

AL IS THE LENGHT 84 C 24 AL =500. R=AL/X. SC +DHA* IS THE DRIFT 12 C DMA=E/3. 1 4 n=AL/9. 24 POIN IS THE BOISSON'S MATIO OF THE MATERIAL 2. С FOR ALUSINUM C 31 p01=1.35 34 39 *E . IS THE YOUNG'S MODULUS OF THE MATERIAL C FOR ALL INUN 31 C F=10+*10+**t 35 FUSTA IN THE DESIGN STRESS 40 C 40 55T=124 W. 54 *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS 54 5=30. 50 APRIA IS THE BENDING MOMENT C 50 6円=(E×D+A*AL*AL*AL*A*)/(35**35*) G=, .30396*S*S.(...POI.PUI)/E -5. 14 *TUP* IS THE THICKLESS OF THE TOP PLATING C FOTA IS THE THICKLESS OF THE POTTOM PLATING 54 C T02=0+3× - 4 30 801=1+6 CL $\Delta = 562 \cdot \pm 502 \cdot (P \pm 007 + 0) \times 207 + 0$ F. SEP=2*(2.*P*B_TOP*FOT_2.*B*D*POT*(TOP+BOT)+(D*P*BOT*BOT)) 40 *STR* IS THE STRESS ON TOP DUE TO FOGGING C 40 STHEATDEN 58 WRITE (F+49)STU AN FORMAT(! !, 202, 'STH= 'F10.3) 74 55 C=561 + + *** (b* TOF + 0+ 207) *SEH* IS THE STEESS ON BOT DUE TO HOGGING 5 % C 1. 1. SBH=C/DEN WRITE (5,90) SRU 00 22 90 FORMAT(' 1,2(x, 'SBH= 1,10.3) FC \$SECHIT* IS THE CRITICAL STRESS ON BOT C FC SHERITEROTAROTZA 1:0 WRITE(5,110)SocPIT 110 FORMAT(' ', 178, 'SBCPIT='F10.3) 22 44 P=2.*D*00T+B*(T(P+POT; *DITOPA IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS 63 С 6 = DITOP=D*(B*80++'+*60+)/P 80 WRITE(5,40)DITOS 40 FORMAT(1, 18x, 'DITOP= 'F10.4) 13 +DIBOT - IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS C4 С C4 DIBOT=D*(B*TOP+"+BAT)/P EP. WRITE(5+50)DIDO1 124 EA FORMAT(' ', 184, 'DIROT_'F10.4) 20 END [5] 23241V1 AL 033CEV1 D V320[V] 4 0334[V] DRA •]] EVJ POI M34C[V] E , WORLS .R 9358[V] DST 0360[V] S 2370[V] G [1] E.V. CARREVI TOP (300 (V) Ø398[V] BOT Δ IV3 DEN V388[V] STH 17461] 60 PPROISI @I 038C[V] C

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PAGE

128 STRENCHT OF SHIPS-ON THE LEUTHAL AXIS LOCATION PAGE 2 WIESELD 90 D304LV] SBORIT P228[L] 110 03C8(V) P (V) Sa-GRAVIS .V 7248 [L] 40 SOCIVE DIFOT 0304(L) 50 (V) LITCE L. EC . GRAM LAFFLe: 2464 .1 2894 .0012 2172 @I 2444 .R 295C .ZE 1711 KMA] 10 263F EXP 29B2 .MES 2936 .W 27C4 AIT SPA SA 25FC .DAPG 1450 ·5 263E AEXP 2960 .ERCNT 292E \$8 5.76 AL 16 2:36 .1 7885 941 . 7 PY-PIT TO: 644 . 2 2454 ... 2536 M 06 263E AEXP 263F EXP 27C4 ATI 2394 .CATE PARA SEA 2=FC .RARG 555E #8 2958 .5 × 36 + 2960 . 40:1 2962 ... 2108 .V 946 .7=F: 2938 .MES 2142 .0 172 ET NIN-OF DERS. EFINES S REQUEINES: SFER APPEFSS 2070 ITIO MESTAS: STH= 18680.664 SBH= 14570.137 SBCRIT= 14767.777 DITOP= 34.7/37 DIPOT= 24.7'19 N M VIO OPERATING SYSTEM VERSIGN 1 REVISION 012 03/04/74 GENERATED 05/06/74 GE HANDITIG CHARGE & ASS / JOB • 35 ES LIVES PRINTED PRI & 1.05 / K LA • 1 1 54 CARDS READ = 1. ap / K Cn • 19.8 11 PLATTER VECTORS • 00 16 MONEL 70 SECONDS \$25.00 / HOUS • 1 1 W MODEL ST SECONDS \$12.49 / HOUR • C* C* TUTAL CHARGE \$ •65 11F 47: 14731 LOGGED OUT 04/06/74 29:13. \$ 03 LEFT AFTER 36 LOGINS.

SUMMARY

Length	=	500'
Beam	=	AL/8
Draft	=	в/3
Depth	=	AL/9
DST	=	18000 psi
S	=	30"
Material	-	ALUMINUM
TOP	=	0.38"
ВОТ	=	0.6"
STH	=	18089.66
SBH	=	14578.14
SBCRIT	=	14767.85
DITOP	=	30.76"
DIBOT	=	24.79"



HOGGING BENDING MOMENT=SAGGING BENDING MOMENT DESIGN STRESS IN TENSION=DESIGN STRESS IN COMPRESSION

From the preceding section we can understand the need to put some limit on the value of the compressive stresses, and perhaps also the inefficiency of considering the value of S (the spacing between longitudinal stiffening members) as an input to the problem.

In this section we will consider a bending moment of the same magnitude in both hogging and in sagging and the stress in either tension or compression will have as upper limit the design stress.

Since the bending moment is the same, it is intuitive that the thickness required to resist tension on top and compression on bottom (buckling) when the hogging moment is acting will also be respectively the thicknesses to resist tension on bottom and buckling on top when we consider the sagging moment. We would end up then with a thickness on top required by the hogging moment TOPH, a thickness on bottom required by the hogging moment, as well as a thickness on top required by the sagging moment TOPS and a thickness on bottom required by the sagging moment BOTS.

Since HM = SM we must obtain TOPS = BOTH = t1 and BOTS = TOPH = t2 and we will end up considering the largest t1 or t2, to be the thickness of the top and bottom simultaneously. Assume for instance that t1>t2 then if we decide on t1for



thickness of the top as well as at the bottom, we will verify that we have overdesigned because TOPS = t1 corresponds to BOTS = t2 which plugged into the expression for I gives a smaller value than using TOPS = t1 with BOTH = t1 that will give a larger value for I; this larger I value when used in

$$STR = \frac{BM*Y}{T}$$

will give a smaller STR value than the design stress and we could use a smaller thickness, may be between t1 and t2 for both the top and bottom and satisfy the DST requirement.

This means that we must incorporate in this analysis the fact already known that when BM (hogging) is equal to BM (sagging) we will have to consider the neutral axis half way between top and bottom which means that the thickness of the top shall be equal to the thickness of the bottom for a geometrically symmetrical cross section.

Let's determine the formulas that will best serve this case then:

HM = SM = BMDITOP = DIBOT = D*(B*t+D*t)/(2*D*t+B*(2*t)) t = TOP = BOT = TS

 $I = 2*D*D*t* \frac{3*B*B+D*D+4*B*D}{D+B}$

Now we can write





and the instability formula

$$t = S^* \sqrt{0.30396^* \frac{1 - POI^* POI}{E}^* DST}$$

Where S is the spacing between longitudinals.

We see thus that we cannot have more than two equations and so we must seek for two variables. A quick inspection and one can see that knowing BM, B, D, the material properties and the design stress DST we have left to determine what should be the thickness of the plating (t) and the corresponding frame spacing (S). Solving the equations with this in mind, we obtain BM = 1.37143*B*T*AL*AL lb*ft

and from $STR = \frac{BM*Y}{I}$ we obtain $DST = \frac{BM*(D+B)}{4*D*t(3*B*B+D*D+4*B*D)}$

$$t = \frac{BM^{*}(D+B)}{4^{*}D^{*}DST^{*}(3^{*}B^{*}B+D^{*}D+4^{*}B^{*}D)}$$

and also

which gives

$$S = \frac{t}{\sqrt{\frac{0.30396*(1-POI*POI)*DST}{E}}}$$



These formulas will give for a prescribed set of dimensions (ft) and a particular material subject to bending BM (lb*ft) the thickness t (inches) and the spacing of longitudinal stiffening members S (inches) required.



HOGGING MOMENT AND SAGGING MOMENT OF

DIFFERENT MAGNITUDES

THE DESIGN STRESS IS THE SAME IN TENSION AND

IN COMPRESSION

Let's consider now the case where the magnitude of HM is different than the value for SM.

We have in this case:

$$DITOP = \frac{D*(B*BOT+D*TS)}{2*D*TS+B*(TOP+BOT)}$$

 $DIBOT = \frac{D*(B*TOP=D*TS)}{SAME DENOMINATOR}$

$$I = 4*D*D* \frac{3*B*B*TOP*BOT+(D*TS)^{2}+2*B*D*TS*(TOP+BOT)}{SAME DENOMINATOR}$$

$$STH = \frac{HM*DITOP}{I}$$

$$STS = \frac{SM*DITOP}{I}$$

$$SBH = \frac{HM*DIBOT}{I}$$

$$SBS = \frac{SM*DIBOT}{I}$$

$$BOT = \sqrt{G} \sqrt{SBH}$$

$$TOP = \sqrt{G} \sqrt{STS}$$
where
$$G = 0.30396* \frac{S^{2}*(1-POI*POI)}{E}$$



Looking at these equations, we know that the result obtained for the thicknesses is going to determine the value of DITOP, DIBOT and I. If furthermore we restrain the stresses from being larger than DST we will undoubtedly want them to end up being DST otherwise if they are smaller we are not using the material efficiently.

We thus have

DST = STH = HM*K1 DST = STS = SM*K1 where K1 = DITOP/IDST = SBH = HM*K2 DST = SBS = SM*K2 where K2 = DIBOT/IThis tells us that if for instance HM > SM we should be considering DST = STH = HM*K1

and
$$DST = SBH = HM*K2$$

because the other two equations will determine lower stresses and are thus within the requirement of not exceeding the design stress, being automatically satisfied.

Now from these equations we can see that if the design stress required for the top, (in tension for the case of HM > SM; note that for the case SM > HM the other two equations should be considered and the conclusions are similar), is going to be the same one as required for the bottom (in compression), we must have K1 = K2 and so DITOP = DIBOT and the neutral axis will again end up being located halfway between top and bottom for a geometrically symmetrical cross section.

We can here use the same two equations derived in the previous section to determine (t) and (S). The moment to be considered here will be the larger of HM or SM instead of BM.

HOGGING MOMENT LARGER THAN SAGGING MOMENT

DESIGN STRESS IN COMPRESSION LARGER THAN DESIGN STRESS IN TENSION

Thesituation we are analysing in this section

HM > SM

DSC > DST

is perhaps more interesting than the previous ones because its study provided us with a much simpler method for determining the thicknesses and the neutral axis location; we call here the attention of the reader to fully understand the steps of this section because the following sections till the end of this work will use this same method of analysis applied totheir own particular case.

Indicated in the next diagram are the ranges within which we may stress the material in order to satisfy the requirement of not exceeding DSC or DST.



Let's consider now that we will try to determine the best position for the neutral axis by first gaining some insight into



the geometry of the stress distributions and the stress limits already defined.

From the previous diagram we may easily understand that if we decide to stress the material to its maximum in tension and compression when under the effect of a sagging bending moment (SBS - STS) we end up with a neutral axis closer to the bottom due to the fact that DST < DSC and we see that when considering the hogging moment the only possible alternative left is to limit the stress caused by this moment in tension on top STH=DST; in this case the compressive stress on the bottom SBH would automatically fall inside the acceptable range.

If for the hogging moment we choose to allow the stress in compression on the bottom to attain its maximum value SBH=DSC we see from thediagram that we are forcing the STH to fall outside of the acceptable range. We are left in this situation with an acceptable solution so far and we must investigate it further.



At this stage we have



We may see from the diagram that we are asking for SBS=STH= =DST to have the same value and at the same time to have the neutral axis located closer to the bottom DITOP> DIBOT.

We note that the equations that give STH and SBS are

STH = HM*DITOP/I SBS = SM*DIBOT/I

and

and since I is the same STH can never be of the same magnitude as SBS because

STH = HM*DITOP/I > SBS = SM*DIBOT/I

both because DITOP is being set larger than DIBOT and also because we are considering HM > SM to begin with. Thus we are left with the alternative of making DIBOT larger than DITOP to make it possible to satisfy

STH = HM*DITOP/I = SBS= SM*DIBOT/I



Thesituation would then be



Besides this is only natural because what we are doing here is to make the material to be stressed to its allowable limit while resisting the larger of the two moments; hogging in this case. This situation will be worked out here as an example and it seems to be quite clear that similarly, cases where SM>HM or DST>DSC or other situation like DST>DSC with HM>SM or DST<DSC with SM>HM could be solved applying a similar reasoning. So, having HM>SM and DSC>DST we should consider the smaller design stress, in this case DST, and have the material stressed to this upper limit. Why?, because if the larger is considered, DSC in this case, there is no way we can have the material stressed to this higher limit in both hogging and sagging while considering the smaller we may attempt to do so. This can be better understood from the two next diagrams.





So, considering the lower design stress, in this case DST, we will stress the material to this maximum in both hogging and sagging thus giving

STH = HM*DITOP/I = DST SBS = SM*DIBOT/I = DST Note here that we already know that the neutral axis will.

be closer to the top DITOP < DIBOT which means that we must obtain a thickness for the plating at the top larger than at the bottom and so TS=TOP which means that we will be using the following formulas

$$DITOP = \frac{D^{*}(B^{*}BOT + D^{*}TOP)}{P}$$

$$DIBOT = \frac{D^{*}TOP^{*}(B+D)}{P}$$

$$I = \frac{4^{*}D^{2}*TOP^{*}((3^{*}B^{2}+2^{*}B^{*}D)^{*}BOT + (D^{2}+2^{*}B^{*}D)^{*}TOP)}{P}$$

where
$$P = (2*D+B)*TOP+B*BOT$$

we have also

STH = DST = HM*DITOP/I

SBS = DST = SM*DIBOT/I

SBH = DSC = HM*DIBOT/I

From these three equations we may combine the two first to obtain HM*DITOP = SM*DIBOT

and combining the second and third we obtain

DST*HM = DSC*SM

After combining these two equations we obtain

DST*DIBOT = DSC*DITOP

This equation could have been obtained more easily just by looking at the diagram we are considering and notice the similar triangles





Note also that what we obtain from this equation is to determine the N.A. location by making DITOP and DIBOT proportional to DST And DSC.

Proceeding with this equation we obtain:

DST*(D*TOP*(B+D))/P + DSC*(D*B*BOT+D²*TOP)/P TOP*(DST*B+DST*D-DSC*D) = DSC*B*BOT and making AC = DST/DSC+D*(DST-DSC)/(DSC*B) we obtain BOT = AC*TOP

We need now an equation to stress the material to its design limit and this can be done by either using

STH = DST = HM*DITOP/I

or SBH = DSC = HM*DIBOT/I

From these two equations I prefer to use the second **es**pecially because it will simplify the calculations that follow as can be understood from the simpler expression that gives DIBOT as



compared with the one that gives DITOP.

We will then consider here

SBH = DSC = HM*DIBOT/I

which gives

$$DSC = \frac{HM*D*TOP*(B+D)}{4*D^2*TOP((3*B^2+2*B*D)*BOT+(D^2+2*B*D)*TOP)}$$

Simplifying we obtain

$$TOP = \frac{HM^{*}(B+D)}{DSC^{*}4^{*}D^{*}(D^{2}+2^{*}B^{*}D)} - \frac{3^{*}B^{2}+2^{*}B^{*}D}{D^{2}+2^{*}B^{*}D} *BOT$$

or making

$$A = HM*(B+D)/(DSC*4*D*(D2+2*B*D))$$
$$AB = (3*B2+2*B*D)/(D2+2*B*D)$$

we have

TOP = A-AB*BOT

replacing here

BOT = AC*TOP

we obtain

$$TOP = \frac{A}{1 + AB^*AC}$$

Having already found TOP and BOT we may use Bryan's formula to determine S; since the thickness of plating is for this case smaller at the bottom we must consider this thickness and along with it DSC because this will be the larger compressive stress the bottom will be subjected to.
From DSC =
$$\frac{E}{0.30396*(1-POI*POI)} * \frac{BOT^2}{S^2}$$

We obtain

$$S = \frac{1}{\sqrt{0.30396*\frac{1-\text{POI*POI}}{\text{E}}}} *\text{BOT}$$

or making

5

$$Z = \frac{1}{\sqrt{0.30396 * \frac{1 - \text{POI} * \text{POI}}{\text{E}} * \text{DSC}}}$$

we have

S = Z*BOT

A computer program was written and applied to two particular sets of dimensions and two different materials namely steel and aluminum. The results are presented next in the computer printouts.



2254

2-84

1080

1-12

1118

3-24

1-37

130

139

1-78

1233

1765

1-2C

1.54

1-54

150

150

-74

~74 ~8.2

240

-07

170

152

+RĈ

180

1RC

+ 8.4

:27

100

1:5

222 215

210

544 550

223

287

544

202

:00:

SUC

227

```
*AL* IS THE LENGHT
C
      AL=500.
      p = AL/8.
      *DRA* IS THE NRAFT
C
      nR4=8/3.
      n=AL/9.
      *POI* IS THE DOISSON'S PATIO OF THE MATERIAL
C
      FOR STEFL
1
      p01=V • 3
      *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
С
      FOR STEEL
C
      F=30 . *16 . *+6
      *DST* IS THE PESIGN STRESS IN TENSION
С
      DST=25900+
      +DSC+ IS THE RESIGN STRESS IN COMPRESSION
C
      DSC=300004.
      *HN* IS THE HOGGING BENDING MOVENT
C
      HM=1.37143+8+DRA+41 +41
      *SM* IS THE SAGEING RENDING MOVENT
0
      SM=B*DRA*AL*AL
      N=0.30394*(1.=POI*POI;*DSC/E
      H=SQRT(M)
      7=1.70
      A=HM*(R+D)/(DCC*4**n*(D*D+2**R*D))
      VB=(3·*B+B+S·*B*D)/(D*D+S·*3*D)
       S=DST/PSC+D*(DST=DSC)/(DSC*B)
      *TOP* IS THE THICKNESS OF THE TOP DEATING
BOT* IS THE THICKNESS OF THE BOTTOM PLATING
С
С
      TOP = A / (1 + AB + AC)
      BOT=AC*TOP
      WRITE(5,10)TOD
   10 CORMAT( 11, 22V, 100=1010.4)
      WRITE(5,20)BOT
   20 EORMAT(1 1,274, 1807=1610.4)
      *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
C
      S=Z*BOT
      WFITE (5,30)S
   30 FORMAT( 1,224, 15=1F14+4)
      P=2 + * P + TOP + B + (TOP + ROT)
      *DITOF* IS THE FISTANCE OF THE TOP FROM THE NEITRAL AXIS
C
      DITOP=D*(B*BOT+D*TOP) /P
      WRITE(5,40)DITOP
```

40 FORMAT(' ',18%, 'DITOPE'510.4) C +DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AVIS DIBOT=D*(B*TOE+D*TOP)/P WRITE(5,50)DIGOT

10		FORMAT(1, 1) 189, IDTROT = IF10.4)
38	С	GMI + IS THE MOMENT OF INERTIA OF THE X SECTION AROUT NOAN
38		GMI=4.*F*C*((3.*9*P+2.*8*D)*TOE*FOT+(D*D+2.*8*F)*TOE*TCP)/P
4.8	C	STH* IS THE CTRESS CH TOP DUE TO HOGGING
1.2	Ċ	*STS # IS THE CTOPESS IN TOP DUE TO PAGGING
18	Ċ	*SRH* IS THE STRESS ON BOT DUE TO LOGGING

PAGE





S	TREN	эйт (DE SHIF	PS-ON THE	NEHTP	VI VAIC L	nr at I	[r N		(0 A G E	2
	c		"SPS*	TS THE OT	FESC	N. BOT DI	r TO	CARGIN				
143	Ċ		*STOR	ים באין דו הני אדו אדו	CRIT	ICAL STRE	SE Ch		* . 1			
AR	c			IT+ IS THE	CRIT	IFAL STRE	So Ch	N ROT				
148	5		STHEH	*PITOF/SM	1 1							
5.9			STS=St	1+DITOP/AN	٠Ţ							
68			_ <u></u> SВН=Н™	1+DIBOT/ON	17							
08			SBS=51	1+"\TRATZGM	1 T							
ER			STCRI		F/(M.	30346*5*5	*(1	EUT*PL				
58			CBCRI	「= 201 * 80 <u>*</u> *	F/(?.	34396*5*5	* 1	•!.UI*56	:I))			
4.2			- UKITE I	(5) AV) STU (() - 200	LOTU.	1-15 01						
84		60	- FURMA - URITED	(' ') EMY)		111(03)						
95		70		[]] 1.27V.	ISTO	1-12.31						
HA DÅ			URITE	5,90,5760		1.1						
50		80	CORMAT	$f(1 - 1 + 17 \vee 4)$	19100	TT= 1F1(+3	1					
20			WRITE	(5,90) 59นี้								
29		90	FORMAT	r(1 1,2714,	10BH=	1-10.31						
42			WRITE	(5,100)525	;							
55		100	FORMAT	F(1 1,27x,	ICRG_	1212.3)						
79			WRITE	(5,119)380	⊐IT ⊂	_						
94		110	EUDAV1	「(' ',17~,	1 CHCB	IT='F1(*3	۶ y					
а Л			END				0.5					
[5]	+11 D = 7		0794 [1		05PC	(v) B	(* H	564 LV1	DET	15CCLVI	n n n n n	
	-*' <u>n </u>		- 6 2 L C		0400		07		1151	20000000000000000000000000000000000000	C DET	
JUV J	7		- 7584LV	(J 5)" (J 4	06/09 06/09				10	achervi	100	
∦.∨J 1/√1	BOT			3 10	- 0000		0.2		20	3650 rV.	C	
11	30		a654 ()	() P	0650	IVI DITOP) (C)		4 C*	1650 EV1	DISOT	
121	57		0660 CN	1 GMT	2640	(V) STH	\$ F	STAEVI	STS	76741V.	e a a	
113	SRS		067CEN	J STORIT	7680	(V) CALSI	T CL	+ = 4 [[]	60	A4BALLI	7	
(1)	8,2		0528 (1	3 90	1055F	611 100	65	504[]	110	2-20 (S*	• V	
13		ι	-									
170		"FLS: Tut	2004	- N	2084	- Joyn	2000	11.00	2000	ə T	DEFA	
.82		±nj∓ ⊇oo	2850	• V \$ 6	2731		200E	MEG	2850	~ <u>1</u>	20F4	- F
1FA	ATN	T	27F6	SART	2022	• DARG	2 7F	.5	2054	ф.Х.	20.26	• F
1.86	• 0	•	2050	•11	3EB4			• 2				
	11		-020									
} - Y - 5	POTN'	rs:										
»F4	• ₽		2734	• Δ	27E6	SORT	3000	ALAG	SOLT	EXP	PAEA	ΔΙ
15C	• 14		SBEV	•COMP	SHEE	÷ 6	5 55	.PARG	2054	* <u>8</u>	PC7E	• 5
585	•7EF	90	5026	+FRCNT	5088	• •	SCDE	. ME'S	51.62	• 1.	203E	• V
(98	67											
LIGN												
- VIU	-0[00	-K5:										

1

FINER SUBROUTINES:



TOP=	3.3464
80T=	7.2374
S=	14.2732
DTTOP=	25.2525
DTBOT=	31.3030
STH=	25014.003
STS≖	18227.152
STCPIT=	63974.609
SBH=	300 10.012
SPS≈	21874.092
SPCRIT=	29999.961

OB	HANDLING CHARGE	* • २5	/ JAR	• 1 -
18	LINES PRINTED PRI	\$ 1.25	/ K LN	• 1
80	CAPDS SEAD	\$ 1.50	1 4 65	• 1
99	PLOTTER VECTORS	\$ •25	1 1022	• 18 P
19	MODEL 70 SECONDS	\$25.00	/ FINIS	• 1 **
AP	MONEL AN GERONDS	\$12.50	/ FnUE	• (1 *
		TOTAL	CHADGE &	• 7 -

EIR 490 14731 LOGGED OUT 24/21/74 20:22. \$ 9.05 LEFT AFTER 34 LOGING.

STREND T OF SHIPSHEN THE NEUT AL AXIS LOCATION

```
C
             *AL* 1= THE LEGAT
. 4
             AL=5. . .
1.4
             B=AL/: .
:. 0
             +LRAM IN T E DRAFT
      C
116
             DRA=X/Se
112
             D=AL/: .
26.4
             *-OIX IN THE PRISON IS FATIO OF THE MATERIAL
             FOR AL STA "
      0
2 -1
            2:1= - 35
             *R* I. THE YOUNG'S COLLUS OF THE MATERIAL
             FUR PLANTS H
123
      0
             c=1 ...1 ...
1.3 -
                        '2
             .LST. 18 THE DEST & STRESS IN TENSION
* 4 C
      C
UST= · · ·
:)4
             WUSCH IS THE DESIGN STRESS IN COMPRESSION
      Ċ
            :SC=3. . . .
5. 1.
             * AN A IN THIS FORGE O READING MOMENT
150
      5
1.6 0
             HY=1. 11.3. 3+DAAMAL - AL
74
      C
             *SHA IN THE PARET & BENNING MOMENT
74
             SE = T + SE + AC + AC
             -= +2 -= ( / / 1 + = FOI = = 1 ) * > SC/F
            U=Sumi(+)
1.4
            2=1./0
             A=H(*((+))/((SC*4.* *()+0+2**8*0))
            . (
            太し=US1/USC+J/(DST+DSC)/(DSC*E)
             *ICH & IS THE THICK FSS OF THE TOP PLATING
<(
      C
            *DOLT IS THE THICK TESS OF THE BOTTOM FLATING
15
      С
. 0
             TOP=A, (1 + 13+AC)
14
            BUT=AL +TOP
             FITE(PF1 ) T(P
10
         10 FORMAT( 1, 1.2. X, 1T(P=1F12+4)
             48ITE(5+2+)-CT
2.6
         20 FOFMAT( ! !. C. X, ! H( T= ! F1 + 4)
:0
      С
             *S* IS THE SPACING OF EGNCITUDINAL STIFFENING MEMBERS
10
             S=Z*PCT
6.2
             WRITTE (S) SI 15
44
         32 FORFAT( 1,22X, 15=1111.4)
5. C
             P=2.*(*TCP+5*(TOP+5*T))
84
             WOITCE & IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
      С
             DITCRED4 (U RCT+DATCR)/P
14
             PRITE(S,4.) LITCP
         40 FCRMAT(! ',1,X, 'DITCP='F10+4)
LC
             *LIECT+ IS THE LISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
      С
10
             DIBCT=0×(F+TCP+D+TCF)/P
             NRITE(S,S/)LTEOT
110
         50 FORMET(! !, 1xX, !DJB, T=!#10+4)
             *GHI* IS THE MOMENT OF INERTIA OF THE X SECTION ABOUT N+A+
      С
35
             G*I=4+xi+0.((3+xPx0+2+2+xPx0)*T0P*B0T+(Dx0+2+*B*D)*T0P*T0P/P
167
      C
             *STH* 15 THE STRESS ON TOP DUE TO HUGGING
14
             *STS# IS THE STHERS MA TOP DUE TO SAGGI G
      C
152
             *SEF # IS THE STRESS ON BOT DUE TO HOGGING
      6
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PAGE



PAGE 2

	c		665	1 L T (Three		OT DI	IF TO	C: CGT					
302			-жарат Экотбү	17 - 1-21 11 - 11 - 71	CHIENN F CHITT	100	STRIA SATA	SAR D	N TAP	ν G				
26.8	Ē			, т. н. 175 Г. Т.	F C T	TCAL	STRE	125 0	N 601					
24 10			S71-= 11	ALT HZO	St I									
12			515=51	witt +/0	o" T							,		
2.			SILLER	- AC 12 1/0	5* I									
1.5			9 S=5	AULO 1/6	511									
15 2			STCHI		P*E/1 .	Ri J'	16×5×5	5*(1•	* FUT*21	(I))				
ie n			Orchai	(프린지 1 - 러운지 	~E/(•	38.30	56×5×5	5*(1•	*PCI*2((I))				
57		66	- 4 5 1 5 1 5 1 - 7 - 5 7 - 5 1	() / 約 -) つ ! ? [/ ! ! : : : : : :	1 (የርጥ	.tr 1								
• F		0.14	NETT:	15.7 ISTS	9 - 15 - 17 - 6	• · r 1	• 5 /							
+ A		70	FLHENT	(1 1, 2)	(, +STS=	+11								
14			VITT ((··· · · · · · · · · · · · · · · · · ·	FIT									
P t		87	FOFMER	1 1 + 170	GISTO	I T =	· F 1 * • 3	3)						
1 c			NETTO	(225)) pro-	4									
1 -		ο,	POPTAT	ر د را ای	(1870=	+F 1:	•31							
42			+ FIT+ ((* * 1) S (4 și									
ŝ. F		16.	r Cit /		(* 1 85 8=	+ = 1	•31							
12			V F E I L I	• •] []] [st	.CRI™ / Artion									
7 8. 1		ί.	F S IS	1	() * 8 · ()	<u>[</u>]]=	• • 12 • :	-)						
i., "c"	• 11		1011 15-24 F	3 . (1720	r. 1	p	0	Fr4rV1	I F A		(SCCIVE	D	
	FOT		TEDOT	ì F	f i f	[0]	• Fr		SERENT.	DS1		CRE-IVI	0.50	
NT.	11		5.1 31	3 50	(6) 3		ţv	1.	615 201	U		0001051	SCRI	
263	ć.		261551		1430	EV3	AF		641 (V)	ΔC		1644[V]	TCP	
640	SCT		210CE	7 1×	1. A	[5]	(? I	C	SUSIF1	28		864C[V]	S	
d.	37		こちもくい	1 F	7244	EV 3	DITOF) (ř	201111	4 V.		265 - [V]	DIRCT	
Se ?	5 V		1.25511	J CHI	1 2464	[V]	STH	٧.	66C[V]	STS		767 [V]	SH-	
143	S R S		. 67 C	1 SI SI	1.671	ΓVJ.	SPCRI	LT Q	484 [L]	62		43A[L]	-7 V	
-60	~ ~	1	12551	~ ~	1.725		1	₽.	594 (L]	114		027 151	• V	
		Ļ	•											
1,1 -	Li	ELS	}											
+ 7	* M4, 1	[*	eDin	• V	Shirk	•CC'	P	2308	ALCG		2094	φI	26FØ	• 🛱
17:	• ZEr	Σ.	2860	ΕĠ	27:27	• A		2004	•MES		2858	• h	29E8	Ext
111	AIN	T	2762	SGET	2015	• F. A.	≂ G	2C7A	• 5		2050	3.2	2032	• EF
- 5 5	• 0		2048	• 1_	BEH									
= y	CTL.	5.												
1.50	• 8		2734	• **	27:2	SPR	т	2808	ALME		29ER	EXP	2456	AIT
55F	• W		2555	· ((-	2BDC	€.E.		2C1E	.RAFG		2050	9.8	2074	• 5
275	•ZE:	· 1.1	2012	. EFC 1	SC>1	• C.		2CDA	.MES		2064	• U	2D8A	• V
104	(• I													

/

STRENGHT OF SHIFTHEN THE FEUTRAL WYIS LECATION

HIG HELDOKS:

.

TIFI ED SIFROUTINES:

· ·

150

T(P=	• 2464
Fi T =	.7371
S. <u>-</u>	A • 2275
[]]](≻=	Pho2575
[.] k (T =	3 • 373
5 T 64 =	6 8.00
57.5	1 61.7.15
STCHIT=	1 9. 1. 722
Sec. 5	2 1 2 1 1 2
t 1 . =	61274.54
SECHITE	0 1 · 3+

1	TENDER I	MG Criti	35	7 3 8	• 35
1	INES.	FRINTEL HAR	1.65	1 1 LI	•15
1.	18DPP	READ	1.5	/ × CE	• 12
× .	LOTI	- VECTORS	• C*	1 1. "	• Q V
J. 44	COPL	71 5801 1	1. 1. 1.	1 HOUR	• 1 6
1 e,	CDEL	SI SECCERT	10.5	/ 40LH	. 9.6
			TAT	6-4-2-3F #	•72

E1 490 14731 LC 21 UT 47,1774 20:20. \$ 5.80 LEFT AFTER 33 LOGINS.

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STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

```
+AL* IS THE LENGHT
159.4
       С
              AL=1000.
2-194
              p=AL/5.75
378C
       С
              * DRA+ IS THE DRAFT
1718
              DFA=8/3.3
1018
              ~=AL/14 .
1224
1-30
       C
              FOIX IS THE POISSON'S RATIO D. THE MATERIAL
       0
              FOR STEEL
1730
              001=0.3
1230
              *E* IS THE YOHNR'S MONULUS OF THE MATERIAL
       C
1-38
              FOR STEFL
1228
       C
138
              E=30.*10.**6
              +DST* IS THE RESTAN STRESS IN TENSION
       C
·40
              NST=25010+
-40
              * SC* IS THE DESIGN STRESS IN COMPRESSION
-54
       С
              n90=30000.
~54
              HMY IS THE HOGGING BENDING MO ENT
150
       С
              HM=1.37143+8+0RA+A1+41
~~C
              *SM* IS THE SAGGING PENCING MOMENT
-74
       C
              CM=R*DRA-AL*AL
.74
              W=0.30396*(1._POI*FOI;*PSC/E
-88
              H=SORT(W)
~ A R
-24
              7=1./U
              A=HM*(P+D)/(DcC+4++D*(D+D+2+*D+D))
^CP
· 2C
              kB=(3**E×E+2**b*b)/(0*D+5**b*b)
. 5.8
              AC=DST/DSC+D*(DST+DC)/(DSC*B)
              *TOP* IS THE THICKNESS OF THE -OP FLATING
180
       С
              "BOT* IS THE THICKNESS OF THE BOTTOM PLATING
180
       C
              TOP = A / (1 + AB * AC)
:80
. 14
              DT=AC*TOP
·RP
              WRITE(5,10)TOB
          10 FORMAT(111,20x, TOD=1=10.4)
.00
              WRITE (5,20)BOT
1EA
          20 FORMAT( 1,20x, 1801=1-1-4)
:22
              "S* IS THE SPACING OF LONGITUPINAL STIFFENING REMBERS
21C
       C
-1C
              S=Z*POT
228
             WRITE(5,30)S
          30 - - ORMAT(1 1, 22x, 19=1-10+4)
244
5C
              P=2.*D*TOP+B*(TOP+POT
282
              "DITOP* IS THE DISTANCE OF THE TOP FROM THE NEUTPAL AXIS
       С
280
              rITOP=n*(P*E0++r*TOP)/P
044
              "RITE(5+40)DITOP
          40 FORMAT(1 1,188, INTTOP: F10.4)
:CP
DOC
              *DIPOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AVIS
       С
FDC
              DIROT=D*(B*TOp+D*TOP)/P
:22
              WRITE (5,50) DIAOT
          RA FORMAT( ' ', 18x, 'DIROTE'F10.4)
510
              *GMI* IS THE MOMENT OF INFETIA OF THE X SECTION ABOUT 1.4.
238
       C
238
              GMI=4•*F*D*((3•****+2•**))*TOP*PO++(D*P+2•*P*F)*TOP*T(P)/P
PAR.
              *STH* IS THE STRESS ON TOP DUE TO LOGGING
       C
148
              *STS* IS THE STRESS ON TOP DUE TO SAGGING
       Ç
248
              *SBH* IS THE STRESS ON BOT DUE TO HOGGING
```

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STRENGHT OF SHIPS ON THE NEUTRAL AXIS LOCATION

1248	C		*SBS*	IS THE ST	RF 99	OKE BOT	DUF TC	CAGGIN	NG .				
1248	C		*STCPI	T* IS THE	CRIT	TAL ST	RESS UN	TOP					
-18	Ĉ		-SBCRI	T+ IS THE	CRIT	IFAL ST	RESE ON	BOT					
10.4.9			o TH=HM	*PTTOP/OM	1								
			TC-CM	-DITOP/ON	T								
SHX				+ D T P D T / AN	1 • T								
308			- COH= 40	+ 'j Fill TZGM	-								
208			085=5M	* DIBDIZGM	'i				- - . .				
SER			CLCB11	= ! 0 P * ! 0 D *	F/(^.	30306*5	*5*(1.**	-EÚI*EI	([])				
158			SBCFIT	=01*601*	E/(0.	34304*0	*5*(1••	⇒cÚľ*b()))				
168			UPITE(5,60)STu									
1.84		60	FORMAT	(1 1,20V)	19TH=	1610.3)							
49E			WRITE(5,70)STG									
1.8A		72	FORMAT	(1 1,20V.	ISTS2	1712.31							
1.04			WRITE	5.3015768	тт —								
FA		82	EOPMAT	(1, 17Y.	ISTOP	17='F10	• 3 i						
- 20			URTT"(5. 201584			- ,						
- 20		0.2	LOPMAT	11 1.201	ICRU	1-17.21							
		-0		5. 1001 Sug	- <u></u>	C1 · • 31							
-42		- 0.0		01 100 005									
=51		100	PERMAL	(' ') CVY)	1080=	'E1(-3)							
= 7 <u>R</u>			"HKTLFT	5/110/500	- []	• • • • • • •	<u> </u>						
=94		110	FURMAT	(' ',1/X)	ISHEP	14=1510	• 3 }						
= P Ø			END		-	J							
n [S]	• []		2584 (V] AL	65RC	[V] B	0.0	504[1]	Dev		MECC (V)	12	
2 (V)	Pri		ASDC (V) F	C (1 7 A	(c) .R	00	FCC(V)	DST		ASE4 (Va	080	
-(V)	Нм		-604 (V	42 [2600	ENJ W	Q 4	514 [V]	U		erae [S]	SUDI	
~ (V)	Z		-61CTV) A	C64A	(V) AR	\$ A	542 (V)	۸C		R64CEVE	TOD	
r(V)	BOT		MICCEL	3 10	raan	เว้า ดโ	53	Sus (F)	20		2654 CV-	C,	
111	32		0658EV) P	MART	IN DIT	00 90	203(1)	40		2660 (V1	NTANT	
- []]	52		2664 IV	I GMT	2670	INT STH	6	674 EV1	STO	:	76785V.	CRM	
Erva	599		2680 (V	1 CTORTT	3691	IVI SBC	FTT C	4 e 4 E 1 1	60		MARATL.	70	
	8.		-5204	1 00	255-	C 1 400		Sch (L)	110	,	121 151	. V	
LE J	014		MUTAL	3 19	AL LOP	1 - 10	* :		111		07 ()]	• •	
12.13		(
CRAN		Pál o											
270	≕ <u>Γ</u> Δ	T to the	2005	- \/	2025	- <u> </u>	00E0	11.00		2000	at	2458	. 3
1.16	- ··· Δ	INK De	202E	• •		• <u>(</u>) , <u>P</u>				20.0	1 (1) (1)	2050	
LX6	• 7 \	40	254	ΨF	2/3×	* ^ > > > > >	2052	• "FS		2051	• 12 • 0	20150 2028	- F K
AFF	ATN	1	EILA	5681	CCCh	• nArd	20.52	• 🗅		CUD2	(5 tř.	20.00	• =
-CRA	• ∩		2060	• t [*]	SEBS								
IPY-	POIN	TS:											
26F8	• 🗢		2738	• Δ	PTEA	SORT	2 Fr	LIG		SOLE	FXP	SVEE	ΔT
1996	• (J		2BBE	• COMP	PRE4	¢ 6	2226	.RARG		5025	*8 [°]	5085	• 5
1086	• 7 5	RO	2684	• EPCNT	2080	• 0	20E2	, MES		504C	• t1	súas	• V
209C	ØT												
MON	-BLC	CKS											
Ε													
EFI	NED	SUPP	DUTINES	3:									

PAGE 2

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TOP=	5 4293
BOT=	5.3545
S=	139.8065
DITOP=	32.4675
DIPOT=	38.9610
STH=	25000.000
STS=	18220.152
STCPIT=	51278.250
SBH≖	29999.996
SBS=	21874.084
SPORTE	29999.961

 OB HANDLING CHARGE \$.35 / JOB
 .35

 118 LINES PRINTED PR1 \$ 1.25 / K LN
 .15

 80 CAPDS PFAD
 \$ 1.50 / Y CD

 70 PLOTTER VECTORS
 \$.25 / 1020

 14 MODEL 70 SECONDS
 \$ 12.50 / HOUD

 14 MODEL 80 SECONDS
 \$ 12.50 / HOUD

 70 PLOTTER VECTORS
 \$.25 / ADD

 14 MODEL 70 SECONDS
 \$ 12.50 / HOUD

 70 MODEL 80 SECONDS
 \$ 12.50 / HOUD

 70 TOTAL CHAPGE \$.72

EIR 400 14731 LOGGED OUT 04/21/7% 20:27. 8 7.58 LEFT AFTER 26 LOGING.

E SHIPSFON THE MENTRAL AXIS LOCATION	۲۰ ۲۰
AL IS THE LENGHT	
AL=1000. REAL/5.75	
+DRA+ IS THE DRAFT DRA=BZ3+3	

n=AL/14. 1224

С

C

1204

1294

1000

1-18

118

180

180

280

280

244

- *POI* IS THE POISSON'S RATIO OF THE MATERIAL C 1236 FOR ALUMINUM С 12311 -F. N=10a 1-361
- *E* IS THE YOUNG'S MODULUS OF THE MATERIAL C 1238 FOR ALUNTNUM C 238
- F=10.*10.**6 -38 +CST* IS THE DESIGN SPEESS IN TENSION С -4C
- nST=25000. 240 *DSC* IS THE REGION STRESS IN COMPRESSION 254 C
- DSC=30070. 254
- *HM* IS THE HOGGING PENDING MOVENT ^5C 1 1M=1.37143+8+DRA+41+41 °5C
- *SM* IS THE SAGGING BENDING MONENT C 274
- SM=R*DRA*AL*AL 274
- N=0.30396*(1.=PCI*POI)*0SC/F 288
- H=SGRT(V) 240 "B4 7=1./1
- A=HM*(B+0)/(D<C+4 *D*(D*D+2 * a*D)) 206
- $AB = (3 \cdot *B *B + 2 \cdot *B *D) / (D *D + 2 \cdot *B *D)$.90
- 158 AC=DST/PSC+D*(DST=Der)/(DSC*B) 180
 - . TOP* IS THE THICKNESS OF THE SOP PLATING С
 - *BOT* IS THE THICKNESS OF THE POTTOM PLATING C
 - $TOP = \Delta / (1 + \Delta B + \Delta C)$ BOT=AC*TOP
- 1 4 4 WRITE(5,10) TOD · 80
- 10 FUPMAT(111,20%, TOP=1-10.4) 100
- ·E6 WPITE(5,20)POT
- 20 FORMAT(1,277, 1801-1-14.4) 192
- *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS 210 C -10
 - S=Z*BOT
- 328 WRITE (5,30)S 30 FORMAT(1 1,228,15=1510.4) 246
- P=2+*D+TOP+B*(TOP+BOT) 25C
 - "DITOP" IS THE DISTANCE OF THE TOP FROM THE NELTRAL AXIS С DITCP=D*(B*BOT+D*TOD)/P
 - WRITE (5,40) DITOP
- 40 FORMAT(1, 188, DITOP = 1510.4) 200 :DC
- "DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEHTRAL AVIS С 200 nIBOT=a+(R*TOp+P*TOp)/P
- :02 WRITE (5,50) DIROT 50 FORMAT(1,18x, IDTANT = 1810.4) 210 :38 *GMI* IS THE MOMENT OF INEPTIA OF THE X SECTION ABOUT N.A. С
- GMI=4+*0+D*((3.*3*P+2.*3*D)*TOP*B0++(D*D+2.*8+D)*TOP*TOP)/P 238 248 *STH* IS THE STRESS ON TOP DUE TO COGGING C *STS* IS THE GIRESS ON TOP DUE TO GARGING
- 248 C +SBH* IS THE STRESS ON BOT DUE TO HOGGING 248 C

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STRENGHT OF SHIPS-ON THE NEUTBAL AXIS LOCATION

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- T	ノノ	

PAGE 2

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AA		C.		AUDITORAL	4 T. 1. 1. 1. 1. 4 T		e rot	ייר.ר	4 2.17 1					
24×				MURITOR/AN	ግ ፈዋ									
SHX			_ຊະວະວະ		r] 4 7									
19CM					· ·									
1°D8			<pre></pre>		* [
ABE			SICHI		5710.	37439 	5***	*(1•	*F1[*F() ())				
458			RECRI	T≖⊖OT*80Ť*	kF/(n.	3435	6*5*0	5 * (l • ·	⇒rΩT*r(DI))				
168			WPITE	(5,60)STU		_								
1,84		60	FORMA.	T(1 1,274,	, татн₌	1=1 1	•3)							
LAE			WRITE	(5,70)STa										
-AA		70	FORMA	(VES. 1) T	+STS=	1616	•3)							
-04			GRITE	(5, 20) STAR	TI									
LFA		80	EORMA"	Τ(1 1,17γ,	ISTOD	I T = '	F10+3	3 3						
1:20			WRITE	(5,90)544										
=28		90	EORMA"	T(' ',2*Y,	I SRH_	1210	•3)							
1:42			WRITE	(5,100)=00	3									
SF		100	FORMA.	T(1 1.27Y.	1985-	1210	.3)							
. 78		1.5.6	RITE	(5+110)300	TIG									
-94		110	FORMA	T(1 1.17v)	ISACE	$T\bar{T}=1$	F10.3	3)						
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+ LLJ	30		- 7604L		162		01 FUE			40		- 1655 LV -	C LR LL	
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LVJ	59	5	7571 L	VI SICKIT		1.17.3	~H("]		4841 <u>[</u>] 	-517	-	TABALLI		
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2C×2	• 7	FM0	28E0	54 000T	2734	• 4	~	20UF	• <u>"ES</u>		2450	• 6/	2054	+ *
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•C×6	• •		205C	• U	7594									
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=6F4	• P		2734	• 1	27FS	SORT		ົວະຍຸດ	ALOG		29F4	FYP .	PAEA	ΔT
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P098	PT													
MON	-81	OCKS												
1 E	-													
EFT	NED	SUBR	DHITTNE	S:										
-		-0. //						1						



TOP=	3.0209
BOT=	P. 3252
S=	81.5487
DJTOP=	32.4475
DIBOT=	32.9610
STV=	25874.203
STS=	18225.152
STCRIT=	51270.323
SRH∞	50999.096
SBS=	21874.984
SBCRIT=	32800.035

OF HANDLING PHARGE \$.35 / JOP • नद 18 LINES PRINTED PP1 \$ 1.25 / K LN •15 20 CAPOS READ \$ 1.50 / V Ch •12 OP PLOTTER VECTORS \$.25 / 1020 • 11 • 1 -19 MORFL 70 SECONDS \$25.00 / HOUD \$12.50 / HOLD RA MOREL RA SECONDS · 19.00 TOTAL CHARGE # . 7.

FIR 490 14731 LOGGED OUT 24/21/74 20:24. 8 8.30 LEFT AFTER 35 LOGING.

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HOGGING MOMENT AND SAGGING MOMENT OF EQUAL MAGNITUDE DESIGN STRESS IN TENSION AND DESIGN STRESS IN COMPRESSION OF

EQUAL VALUE; LATERAL LOAD ALSO CONSIDERED

The lateral load being here considered will be a "head" of salt water of eight feet on the top plating (HTOP=8 ft) and a "head" of salt water equal to the draft on the bottom plating (HBOT=DRA).

We will use here the simplified approach as suggested in the following note; this simplified approach is at least conservative.

Note: Bleich, from his experiments and theoretical studies on the effect of normal pressure in the buckling strength of thin panels, concluded that the buckling strength is increased when combined with a sufficiently large normal load, and that the increase is greater for thesimply supported edges situation than with fixed edges. For heavier plating , where thedeflection does not exceed half of the plating thickness, the increase in buckling strength resulting from normal load is negligible. It was therefore suggested, for simplicity, that the critical stress be computed for in plane loading only.

The tertiary stresses we are interested in considering here are those exerted at points B directed longitudinally; these will combine with the longitudinal bending stresses or primary stresses as described in a previous section.

Since now we have DST=DSC and HM=SM=BM we may think of



a diagram for the stress distributions as indicated next figure:

From this diagram we may understand that the neutral axis should be located closer to the bottom which means that the thickness at the bottom will be larger than at the top BOT > TOP. So, we may already write the following formulas where TS was replaced by BOT

where

P = 2*D*BOT+B*(TOP+BOT)



We may now think of the following relationships to determine TOP and BOT.



or knowing that

STR3T = $0.152222*HTOP*(\frac{S}{TOP})^2$ STR3B = $0.152222*HBOT*(\frac{S}{BOT})^2$

and anticipating

$$S = Z*TOP$$

where

$$Z = 1/(\sqrt{0.30396*\frac{1-POI*POI}{E}*DST})$$

we have

$$z^2 = (\frac{S}{TOP})^2$$

If we now make $(\frac{S}{BOT})^2 = Z^2$

in order to simplify the equations, we see that when we do this, since



$$\left(\frac{S}{BOT}\right)^2 < \left(\frac{S}{TOP}\right)^2$$

we are increasing the value of STR3B and this means that since

DST = SBH+STR3B we are decreasing"slightly" the value of SBH that could be allowed to reach a larger value; so , the substitution

$$\left(\frac{S}{BOT}\right)^2 = Z^2$$

is on the safe side and has the advantage of simplifying the equations considerably.

So we may write STH = DST-STR3T SBH = DST-STR3B $STR3T = 0.152222*HTOP*Z^2$ $STR3B = 0.152222*HBOT*Z^2$ A = DST-STR3TAB = DST-STR3B

so

A*DIBOT = AB*DITOP

and we obtain replacing DITOP and DIBOT by their equations, and simplifying

$$TOP = \frac{AB*(B+D) - A*D}{A*B} *BOT$$

or making



$$AC = (AB*(B+D)-A*D)/(A*B)$$

we finally obtain

TOP = AC*BOT

Now in order to stress the material to its design stress we may either consider STH, STS, SBH, SBS.

Due to ease of calculation we may either choose STS or STH; the expressions will be exactly the same. I will consider here

STH = BM*DITOP/I

and

STH = DST - STR 3T = A

Substituting for DITOP and I we obtain

$$A = \frac{BM*D*(B+D)*BOT}{4*D^{2}*BOT*((3*B^{2}+2*B*D)*TOP+(D^{2}+2*B*D)*BOT)}$$

and after simplifying we arrive at

BOT =
$$\frac{BM^*(B+D)}{A^{*}4^*D^*(D^2+2^*B^*D)} - \frac{3^*B^2+2^*B^*D}{D^2+2^*B^*D} *TOP$$

Making

$$AD = BM*(B+D)/(A*4*D*(D^{2}+2*B*D))$$
$$AE = (3*B^{2}+2*B*D)/(D^{2}+2*B*D)$$

we obtain

BOT = AD - AE * TOP


substituting

TOP = AC*BOT

we obtain

$$BOT = \frac{AD}{1 + AC^*AE}$$

Considering now the instability formula (BRYAN) we notice that since the top will have the thinner plating we will consider TOP stressed to the maximum allowed DST.

So we start with

$$Z = 1/(\sqrt{0.30396*\frac{1-POI*POI}{E}})$$

S = Z*TOP

The total stresses will then be given by TSTH = BM*DITOP/I+STR3T TSTS = BM*DITOP/I+STR3T TSBH = BM*DIBOT/I+0.152222*HBOT*S²/BOT² TSBS = BM*DIBOT/I+0.152222*HBOT*S²/BOT²

The computer printouts for the same cases analysed in theprevious section are presented next.



STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

3

33

·Ø4	С	*AL* IS THE LENGHT
164		
100	-	
15	C	NRAT IS THE DRAFT
18		
24	-	UTAL/94 VOATA IS THE ACCORDANCE BATTO OF THE MATERIAL
30	C	TOP OTEL:
30	L	
30	•	POI#0+3
3×	C	ACE IS THE TOUNG'S MUDULUS OF THE MATERIAL
38	C	
38	-	ET30+F17+FF0
14L	C	ADDIA 10 THE DEDIAN DIRESS
46	6	- PMA IS THE DENDING MEMENT
54	C	$\mathbf{x} = \mathbf{x} = \mathbf{x} = \mathbf{x} = \mathbf{x} = \mathbf{x} = \mathbf{x} = \mathbf{x}$
54		8 " = 1 • 3 / 1 4 3 * 0 * 0 R A * A [] * A [] U = 0 - 20 0 R (+ / 1
50		W=0+30336=(1+=001+=01)+951/2
130		
90		*HTOP# IS THE HEAD OF WATER ON DECK
A A		UTOPER.
		+HRAT* IS THE HEAD OF WATER ON BOTTOM
AC		UBOT=DRA
RL I		STR3T#0+15222a#HT0P#77
108		cTR3R=0+152220+480T+7+7
00		A#DST=STR3T
FR		AB=DST=STR3B
F4		AC = (AB * (B+D) = A * D) / (A * D)
20		$\Delta D = PM * (B+D) / (A = 4 + D * (D * D + 2 + B * D))$
78		$\Delta E = (3 * B * B + 2 * B * D) / (D * D + 2 * B * D)$
C4	C	*TOP* IS THE THICKNESS OF THE TOP PLATING
C4	č	*BOT* IS THE THICKNESS OF THE BUTTOM PLATING
C4	_	BOT = AD/(1 + AC + AE)
DC		TOP#AC*BOT
.E8		WRITE(5,10)TOP
284		10 FORMAT('1', 20x, 'TOP='F10.4)
1E		WRITE(5,20)BOT
34		20 FORMAT(' ',20x,'BOT='F10.4)
254	С	*S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
254		S#Z*TOP
269		WRITE(5,30)5
27C		30 FORMAT(' ',22x,'S='F10.4)
94		P=2.*D*B0T+B*(T0P+B0T)
88	С	*DITOP* IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
893		DITOP=D*(B+BOT+D+BOT)/P
DC		WRITE(5,40)DITOP
1-8		40 FORMAT(' ', 18x, 'DITOP='F10.4)
14	С	*DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
14		DIBUT#D*(B*TOP+D*POT)/P
38		WRITE(5)50)01g0T
24		50 FURMAI(' ',18X,'DIBOI='+10+4)
:70	С	COMIN IS THE MOMENT OF INERTIA OF THE X SECTION ABOUT NOAD

PAGE

	STRE	NGHT	OF SHIPS-	ON THE NE	UTRAL	AXIS L	OCATI	0N		F	AGE	2
1070			GM1=4 • *D	*D*((3.*B	*R+2.*	B∗D)∗T	00+80)T+(D+D)+2.*B*D)	*BOT*BNT	1.70	
1250		^	+TSTH+TS	THE ATRE	SC ON	TOP DI	C TO	AT SOUL			100	
ISED			21+0701+	THE STOP		TOP DU	- TO	CAGGIN	10			
13EV		C	*1919+10	THE SINE		107 DU		HOCOIN				
13EK			*1284*15	THE SIFE	55 UN	001 00 007 DU		HUGGIN				
IBEN		C	*1282*12	THE STRE	SS UN		E 10	SAUGIN	NG .			
DEG		С	*51CR1T*	IS THE C	RITICA	L STRE	SS UN	I TOP				
1350		С	*SBCRIT*	IS THE C	FITICA	L STRE	55 ON	BOT				
0EC			TSTH=BM*	DITOP/GMI	+STR3T							
3F4			TSTS=BM*	DITOP/GMI	+STR3T							
4 2 8			STCPIT=T	OP*TOP*E/	10.303	96*S*S	*(1•-	POI*PC)]))			
448			WRITE(5)	60)TSTH								
464		60	FORMAT(1,19X, IT	STH=+F	10.3)						
47E			WRITE(5)	70) TSTS								
494		70	FORMAT (1.19X.1T	STS=+F	10.3)						
484		- 1	WRITE (5)	SOISTORIT	- 1 12							
400		80	EORMAT (1.170.19	TOPTE	1510.3	1					
LEC		Ογ	TSBHEBMR	DTBOT/cHT	+0.102	525*HB	, 07*5*	c/(801	*BOTI			
528			TSBSERMA	DIBOTICMI	+0.1-2	222*HB	07*5*	c/(201	#BOTI			
544			CBCBIT-B	07+80++52	10.202	924048			1711			
SAL			URTELEN	OGATC-U	14.983	207072	*(r UI +r C	,,,,			
500		0.0	WOLLENDA CONAT/1	1.10. IT	Court E	10.01						
500		26	UPTTE/E.	100\Top5	SHHHIL	16.31						
DUA			WATERSE	100/1585	000-5							
516		100	FURMALLY	1173X111	SHSmith	10.31						
1610			WRITE(5)	110)SACRI	T							
52C		110	FORMAT('	',17x,'S	BCRITE	'F10+3)					
648			END		_			_	_			
PIS] •L	J	064C[V]	AL Ø	654 (V)	8	06	SKC[V]	DRA	Ø664[V]	D	
CCV	J PC	I	0674[V]	E 0	000[S]	• R	Ø6	84[V]	DST	Ø68C(V)	BM	
4 [V	JW		06 A 0 [V]	U Ø	000(S)	SQRT	06	A4[V]	Z	0648[V:	HTOP	
CLA	J Hg	30T	0680(V)	STR3T 2	688[V]	STR3B	Ø6	BC[V]	Δ	06C0[V]	ΔB	
4 (V	J AC	2	@6D8[V]	AD Ø	6EC[V]	ΔE	26	FOIVI	BOT	06F4[V]	TOP	
4TL] 10	1	0000(S]	ai z	534 (1 J	20	Ø6	F8[V]	S	0270 (L]	30	
CCV] P		0700 (V)	DITOP Ø	528 (j)	40	Ø7	04 EV J	DIBOT	0354(L)	52	
REV	J GM	1 1	0714 (V]	TSTH Ø	718[v]	TSTS	07	1C(V)	STCRIT	0464 (L-	67	
ATL	3 70		04D0 (L)	80 0	720[V]	TSEH	Ø7	24 [V]	TSPS	0728 EV1	SBCRIT	ļ
PIL	3 92	*	05F6(L)	100 0	620(1)	110	00	IND (S)	• V		• • •	
YEQ	/		1									
E			-									
HAGE	ΔΜ 1	ARCIE	. •									
1207	0 ±	ADELS Atua	2502 V	20		Mo	2084	AL 0G	2500	at ·	2790	
2DA			2008 64	20		U F	2707	MEG	2001	- W	2480	5
204	2			DT 20			CLUD	• 165	2104		CAOU	C
201	C A		2888 50	R1 20	4A • RA	n G	2046	• 0	EASU	AEAP	EDAE	•
207	C \$2	3	2DAE .0	SE	84 •U		3FDC					
Innu	0.0											
DRY	- 201	N'S:				*				1 EVE	0.00	-
279	C • F	2	270C • A	28	SE SOR	1	2984	ALUG	2880	AEXP	2795	C
201	2 A 1	INT	2C84 • W	50	F5 +C0	MP	5008	#6	2044	•RARG	50/0	
SDV	6 • 5	5	2044 · Z	ERO 2D	AE • FR	CNT	subb	• 0	SEQE	• MES	SE20	•
SEB	6 • \	1	SEC0 MI									

164

F

F

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TOP=	0.1671
BOT=	0.8383
S=	11.0049
DITOP=	35.3820
DIBOT=	20.1736
TSTH=	25020.012
TSTS≃	25000.012
STCRIT=	25220.200
TSBH=	11728.668
TSBS=	11729-668
SBCRIT=7	P6635.250

END

F VIO OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 04/27/74

•

JOB	HANDLING CHARGE	\$ •35	/ J08	• 35
125	LINES PRINTED PR1	\$ 1.25	/ K LN	•16
84	CARDS READ	\$ 1.57	/ K Ch	•13
66	PLOTTER VECTORS	\$ •25	1 1000	• P P
15	MODEL 70 SECONDS	\$25.00	/ HOUR	•10
00	MODEL AN SECONDS	\$12.50	/ HOUR	• ମମ
		TOTAL	CHARGE	\$ •74

PEIR 490 14731 LOGGED OUT 04/29/74 18:35. \$ 33.19 LEFT AFTER 42 LOGINS.



Note here that because we have in this run BOT>> TOP the approximation made to simplify the formulas, namely

$$S = \frac{S}{BOT}$$

becomes very inaccurate compared to what the actual value should be

$$Z = \frac{S}{TOP}$$

this is the cause for obtaining such low stresses at the bottom. We might refine the result for this case as is done for the "1000 ft steel case" also included in this section which presented still another difficulty. Since all steps to have the bottom stressed to DST are explained in detail for such case they will be omited here.

STEFTCHT OF SEIPSHON THE LEUTINE AKIS LOCATION PAGE *ALX IS THE LENGAT 0 494 \cap AL=5111. 2.34 2=11/> · 1 . AC +DEAN IS THE DRIFT $\widehat{}$ 3.12 J-1=5/3+ 3.18 1724 U=11/7. *FCI* 15 THE DUISSON IS MATIO OF THE NATERIAL 1738 C For ALUS TELL 2 30 201=1+3 1 37 + IS THE YDING'S MUDULUS OF THE VALEPIAL 1 38 0 , 39 FOR ALLO TALT. 1 35 戸戸16・ビネー・メッセ . 40 SUST . TO THE DESTING STRESS ::5T=24(1) 1.40 . ADDA IS THE RENTING CONSULT . 54 R=1+37143-ExpPA+41 +AL 2 54 1'60 W= 1. BHG PAR(1. _ POTRONL) SH ST/E ()=S(□)(□) 1.80 35. 7=1.70 WHICH IN THE WEAD OF VATED ON DECR A1. 24 H [C P = 옷 + WHENT* IS THE HEAD OF ATER AN HOPTOM AC HPCT= PY 40 154 ST-31=1+152220x T00*2+2 1 CR 31-30=1-152620+ - 0T+2+2 30 A=DST-STPRT BH=UST- THRE FR - = 4 $\Delta \Gamma = (\Delta^{II} * (\Gamma +_{\Gamma}) *_{\Delta} * \uparrow) / (\Delta * \alpha)$ 120 10=-1x(+1))/(4*4++11+(D*++2+*R*D)) 178 Aに=(ヨ・* い>3+2・+ P+い)/(!*P+つ・*3*D) +TOP+ IN THE THICKNESS OF THE FUE FLATING * C 4 0 1C4 ABOTA IN THE THIOKLESS OF THE ROTTOM PLATING 1C4 BUF=AD/(1·+AC+AU) 100 TUP=AC+HET LER 1-11E(5+10) 10e 274 1 ~ EORMAT(11) 2009 + TUP= = = 10.4) 21E WMITE(5・20)とり+ 1234 20 FORMAT(! ! , c ? x , ! ..) t = ! # 1 ... 4) 1254 *S* IS THE SPART G OF LENGITUDINAL STIFFENING MEMBERS C, 254 S=7 + 10P SED WHITE (5+29)5 270 30 FORMAT(1 1,228, 13=1=1 1.4) 294 P=2 + *D + MOT+6 + (* () + 9 + 1) 26.8 *DITOP* IS THE DISTARCE OF THE TOP FROM THE NEUTRAL AXIS C PER. DITOP=D*(3*E0T+~*30T)/E 21 C WPITE(5:40)UTTOP 27.8 40 FORMAT(! !, 18x, ""ITOP="F10.4) 214 *DIPOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS 314 DINCTED*(B*TOD+1*30T)/P 38 WHITE (F+ST) DIAOT 50 FORMAT(! !,13V,! :IPOT=!#10+4) 35.4 :78 .GMI. IS THE HOMENT OF UNERTIA OF THE X SECTION ABOUT N.A. С

167

STRENGHT OF SHIPSHON THE EUTRAL AVIS LOCATION

1:71			13™I=4•*0*((7. *****+2. * 3*D	*T1>*F0++(D+)	D+2.*B*C1) *BOT *BOT	1/2
13FU		$\hat{}$	+ISTH*IS THE	ST 1. SR UN INP	DUE TO LOGGI	N G		
ing pt		C	*TSTS+IS THE	STHER IN FOR	DUF TC FAGGI	۷G		
3788		<u>`</u>	* ISPH * T - THE	STRUBE OU BOT	DUF TO DGGI	NG		
17EN		0	VISES+JE THE	strad CV gut	DUE TO MAGGI	NG		
1781		<i>c</i>	+SICPIT IS I	HE CRITICAL ST	IRESS CN TOP			
TEC		(*24021T+ IS T	OF CRITICAL ST	REAC CH ROT			
1-27			TSIF=+++DITOP	13 J+ST-51				
1284			1210=3.4×1105	10' I+STEDT				
612			STOPILELSER	D+1/(1+3+3+6+4	3*S*(1•=+0]*P	01))		
648			WMITE(S+KC)TE	T i≓ t				
- 64		- F	FURNATE 1,13	Y, ITSTU=IF103+:	3)			
L7F			ARITE (5+70) 13	* C				
191		**	FOR AT(1 1,1)	~, 17 STG=(F1).	2)			
-64			, "10E(\$1")ST	criti.				
-D\$		•	FD5"AT(1 1,17	V, TOTOLIT= F10	•31			
LEC			IS HER COTROL	19 1+1.152022	HBUL*C*C/(30	T*RCT)		
-23			TS=+=++ +I; er	1041+5+745455	HPOT*S*1/(RO	$T * F \cap T$)		
c f 14			SPECITE OT YO	14=11.3-396*1	*S*(1•+F0I*P	OI))		
A 4			CHITE(S+D)IS	·1 -1				
ι C.e.		2.2	FOR ATT 1,10	7,118 (H=+F1J+)	5)			
= 1) 4			WR115(2+1))T	0.3 ²				
FA		1 - C	FIRMAT(1,19	<. 17339=1840.	고)			
15			WillE(S+11))S	20-11				
150		110	FUR AT(1 1,17	<pre>v, 'CPC=It='F10</pre>	•3)			
645			E. ()					
[8]	•	I	64C[V] 0L	1 - 7 4 [7] B	KD'C[V]	DRA	3664 [V]	D
r [v]	+2 ~	, Î	,674[V] =	s , inning	\$69+[V]	DST	3635[V	pra Lotter D
.[^]	•		1690[V] ''	, 117 (S) (9)	1 66 (M)	Z	1644 [V]	HENM
(V)	6.0	γT	SEVEENT STREET	674 (V) ST	-36 (6-2[V]	۵	26BC [V*	AB
. [V]	î. ~		4144 [V] 4C	SERIVI AE	66: C (V)	BOT	26F2(V1	TOP
-[[]	1		40 C [S] I	531 (1) 53	(664EV]	S	327C[L]	3%
[V]	F		PERCEVI FILDP	REDUJ 44	27 [V]	DIPUT	1354 [L]	時間
a LVI		T	(7].[V] [STH	/14LVJ TS	TS (7+RLV)	SICRIT	1464 LL1	614 ODCHIT
المالية (MADINEL RI			1515	2724LV1	SBCKIL
(L)	9		"br6[L] 19(620 (J. 11)	FR (ES)	• V		
NE 1		L	-					
-024	M .	a filmet and						
1 70		THELS	· · · · · · · · · · · · · · · · · · ·		0000 100	2505	0.7	2298
2040	**		2001 C		2426 1600	2C SC	(1) <u>1</u>	2/20 •
TORE	• 7	· · · · · ·	DODA CLIT	27.08 • N	2107 · 123	2400		2000 0
CVIE.	4	. F 1		12 1 14 Fe • 12 Fe (N)		CARE	ALAF	2044 .
316-	3		2114 .	2082 · P	3En8			
- 24	20	÷						
2705	PC :	112:	2700	012. 2-1 T	20% 100	2400	AFYD	2138 E
10.15		. T	2000		ande ALUG	2014 2014	RAFG	20/8 \$
TOAD	AI	N. 1	2014 7580			2500	MEC	2580 .
1040	• •		2506 HI	ANA PERCH	e AL el	CLVP	•••••	C2000
5-5	• \		SUCCEST		1			

(I) "=	1. 7217
r () T =	. 42.5
-3 =	12.3632
(ITOP=	25.6132
1 IF OT=	25.33.3
TSTHE	DESCAL DAR
TRTRE	26124.223
STCHIT=	25 2
キミロショ	23232.4.1
TSUS=	23232.4.1
SUCRITE	421:0.532

(MD

 0^R HA-1111G CLARCE
 + 25 × Un^R
 • 35

 25 L1 L2 TRINTEL PR*
 1.26 × KL
 • 15

 84 CANDE LETE
 ± 1.55 × KL
 • 13

 84
 CANDS (FR)
 1.6; / 4 Ch
 13

 00
 PL(1)T(S) /F(T)AS
 -05 / 1 Kh
 -041

 15
 MOANE
 350 / 2 Kh
 -11

 30
 MOANE
 350 / 2 Kh
 -11

 31
 MOANE
 350 / 2 Kh
 -11

 32
 MOANE
 312 KH
 -11

 33
 MOANE
 312 KH
 -11

 34
 MOANE
 312 KH
 -11

 35
 MOANE
 312 KH
 -11

 36
 MOANE
 312 KH
 -11

 37
 TUTAL CHARGE
 -74

FIR HO 14731 LUGGED OUT 34/29/74 18:05+ 5 30+17 LEFT AFTER 38 LOGINS+



This case gave a result close to the correct solution with the bottom stressed to almost DST.

Next is presented the "1000 ft steel case" where still another difficulty was encountered and a procedure to have the bottom stressed to DST is exemplified.

STRENGHT OF SHIPS ON THE NEUTRAL AXIS LOCATION

```
104
      С
             *AL* IS THE LENGHT
184
             AL=1000.
18C
             P=AL/5.75
             *DRA* IS THE DRAFT
      С
118
18
             DRA=6/3.3
24
             D = AL/14.
      С
             *POI* IS THE POISSON'S RATIO OF THE MATERIAL
30
30
      С
             FOR STELL
32
             POI=0+3
      С
             *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
38
38
      С
             FOR STEEL
38
             F=30++10+++6
             +EST* IS THE DESIGN STRESS
      С
4 C
4C
             DST=25000.
54
      С
             *EM* IS THE BENDING MOMENT
54
             B1=1.37143+8+DRA+AL+AL
             w=@.30396*(1.-POI*POI)*DST/E
6C
80
             U=SQRT(W)
             Z=1 • / U
98
             *HTOP* IS THE HEAD OF WATER ON DECK
A4
A4
             H10P=8.
AC.
             *HBOT * IS THE HEAD OF WATER ON BOTTOM
AC
             HEOT=DRA
84
             STR3T=0.152222*HT0P*Z*Z
68
             STR38=0 . 152222*HBOT * Z * Z
C
             A=DST-STR3T
18
             AB=DS1-STR3B
24
             AC = (AB + (B + C) - A + D) / (A + B)
20
             \Delta D = BM * (B + D) / (A * 4 • * D * (D * D + 2 • * B * D))
18
             AE = (3 \cdot B + B + 2 \cdot B + D) / (D + D + 2 \cdot B + D)
24
             *IOP* IS THE THICKNESS OF THE TOP PLATING
      С
24
      С
             *BOT* IS THE THICKNESS OF THE BOTTOM PLATING
124
             BOT = AD/(1 + AC + AE)
)C
             TOP=AC*BOT
-8
             WRITE(5,10)TOP
134
          10 FORMAT('1',20X, 'TOP='F10.4)
1E
             WRITE(5,20)BOT
BA
          20 FORMAT(' ',22X, 'BOT='F12.4)
154
      С
             *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
             S=Z*TOP
154
150
             WRITE(5,30)S
          30 FORMAT(' ',22X, 'S='F10+4)
l'C
374
             P=2 \cdot D = BOT + B = (TOP + BOT)
             *DITOP* IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
118
      С
118
             DITOP=D*(B*BOT+D*BOT)/P
3(1
             WRITE(5,40)DITOP
18
          40 FORMAT(' ',18X, 'DITOP='F10.4)
1.4
       C
             *DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
14
              DIBOT=D*(B*TOP+D*BOT)/P
118
             WRITE(5,50)DIBOT
2.4
          50 FORMAT(' ', 18X, 'DIBOT='F10.4)
2'0
       С
              *GMI* IS THE MOMENT OF INERTIA OF THE X SECTION ABOUT N+A+
```

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

70		GMT=4 + + D + D + (13	*8*8+2•*8*0)*T	OP*BOT+(D+C	+2 + + B + D)	*BOT*B01	()/P
EØ	С	*TSTH*IS THE ST	RESS ON TOP DU	E TO HOGGIN	G		
Fa	С	*TSTS*IS THE SI	RESS ON TOP DU	F TO SAGGIN	G		
F Ø.	Ĉ	TSBHATS THE ST	RESS ON BOT DU	F TO HOGGEN	G		
Fa	Ċ	TSES*TS THE ST	RESS ON BOT DU	E TO SAGGIN	G		
Fa	Ċ	STORIT* IS THE	CRITICAL STRE	SS ON TOP			
Fa	Ċ	LSECRITA IS THE	E CRITICAL STRE	SS ON BOT			
- 0	L -	TSTHERM*DITOP/0	MILGIPOT	50 00 001			
- 2		TSTS=AM+DITCR/C	MILCTORT				
7 Q 7		STORIT=TOP+TOP			111		
		WRITE (5. CONTOL			111		
40 64	60	EDPMAT(1 1.1ex)					
7 -	00		- 1914-1110+31				
	70	THE COMPTEND IN 1813	3 . YOTO-+E10. 3)				
	7 V.)	- PURIAL(- 1194)	1212-1110-37 1212-1110-37				
34	00	WRITE(SJ&F)SICF	VLI 1070017-1540 0	,			
56	ດຍ)"S(LHI)+'FJ/(+3 'Mi(a 460000 HD) AT#(+8/(EAT			
			2011+C+124442×00	01+5+5/(001	*DUT)		
28		1989=8040180170	301+9+154442*HB		*0(1)		
04 A 4		SELKII = EUI + EUI +	E/(0+30396*5*5	*(1•=====01====	· 1 /)		
94 C.A.	0.6	WRITE(5)90)150F					
- 121	90	FURNARI - JIGAJ	C (266651610+3)				
	- 0.0	CODMATLE 1 10Y	17000-1510 ON				
	1.6.60	FURNALLY JIGA	- 1555='F10+37 - Ditt				
20		WRITE(SJII)SBU					
	110	FURMAILY 1,1/X)	• .297CkTI≞.F1(•9)			
ro (cl	- 11		RELEVI P	OLEC IVA	DRA	accie (V)	0
EV 1	801		0004101 0	06000 [V]	DST	00004[V]	ц/ Э.М
EV7	,01		ALAGICI CODI		2	DESCEVI	
ivi.	HBOT	2684 (V) STRAT	MARENI STRAR		<u></u> Δ	CACLEVI	AH
ív 1	1001	260C[V] AD	OCTORY) AF	06561V)	POT	CAECIVI	TOD
	10	evenisi ei	2070 [V] AL	0700EV1	S	10000 C C V J	9 .3
(V)	P		NOESTLI LA	270.C (V)		MAGATIN	EV.
	GMT	3710(V) ISTH	2720 (V) TSTS	2724 EV3	STODIT		5 v
	70			072C(V)	TSAC		SRCPIT
	90	2556[1] 100	2420 [L] 110	aacatsi	-V	01201111	JUUNI
10		Staroter 166	NECCICI IIN	00000[0]	•••		
RA	LABELS						
1712	*MATN*	2E34 .V	206A .COMP	298C ALOG	2E48	ωI	2744 .R
132	•ZERO	2090 \$6	27E4 .A	2D8E .MES	2005	• W	2A94 EXF
19A	AINT	2896 SQRT	2CD2 .RARG	202E .5	2084	\$8	2036 .E
36	• 0	2E0C .U	3F64				

Y-POTATC'			·		
44 • R	2754 · A	2896 SGRT	2980 ALOG	2494 EXP	289A AI
3C .W	2064 . COMP	2090 \$6	2CD2 •RAFG	2004 \$8	20.2E +5
32 • ZE=0	2036 • ERCNT	2038 •0	2D8E .MES	2E18 .U	5E3E • V
48 @I					

/



TOP=	6 • 1748
B0T=	-5-5523
S =	406.7124
DITOP=	142.7614
DIBOT=	-72-6328
TSTH=	24999.992
TSTS=	24999.992
STCRIT=	24999.988
TSBH=	33241+840
TSBS=	33241.842
SBCRIT=	2 213.25%

ND

VIO OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 04/30/74

)B	HANDLING CHARGE	\$.35	/ JnB	• 35
25	LINES PRINTED FR2	\$ 1.25	/ K LN	•16
34	CARDS READ	\$ 1.50	/ K CD	•13
*Ø	PLOTTER VECTORS	\$.25	1 1022	• C. Z
21	MODEL 70 SECONDS	\$25.00	/ 4003	•15
:0	MODEL 80 SECONDS	\$12.50	/ HOUR	• C 3
		TOTAL	CHARGE	\$.79

RIR 490 14731 LOGGED OUT 04/30/74 21:26. \$ 27.07 LEFT AFTER 50 LOGIS.

It does not come as a surprise that the program does not work for the "1000 ft steel case" since in this situation we obtain STR3B DST which cannot be accepted and also this program is not prepared to handle.

AL = 1000 B = AL/5.75 = 173.913 DRA = B/3.3 = 52.7 POI = 0.3 E = $30*10^{6}$ DST = 25000 BM = $1.37143*B*DRA*AL^{2} = 12569.45*10^{6}$ W = $0.30396*(1-POI^{2})*DST/E = 230.503*10^{-6}$ U = W = $15.182*10^{-3}$ Z = 1/U = 65.867HBOT = DRA = 52.7STR 3B = $0.152222*HBOT*Z^{2} = 34803.57$ DST

Since we understand that the program should work for DST > STR3B we make the next run with DST = 35000 to prove that in such case a solution is obtained, and after proceed to obtain the actual solution for the case we were considering with DST = 25000.

STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

84	С	*AL* IS THE LENGHT	
24		AL=10000 .	
2 C		B=/L/5.75	
18	С	*DRA* IS THE DRAFT	
18		DR/=8/3·3	
24		D = I L / 14 + I	
30	С	*POI* IS THE POISSON'S RATIO OF THE MATERIAL	
30	С	FOF STEEL	
30		p0j=@•3	
38	С	*F* IS THE YOUNG'S HODULUS OF THE MATERIAL	
38	C	FOR STERL	
38		-= 30 . * 10 . * * 6	
4 C	С	+DST* IS THE DESIGN STRESS	
4 C		DST=35780+	
54	С	*EN* IS THE BE'DING MOMENT	
54		RN=1.37143+8+DRA+AL+AL	
6C		μ=ℓ·3V396*(1·=POI*P ·I)*DST/E	
8 C		U=SOBI(M)	
98		Z=1 • / U	
Å 4		*HTOP* IS THE HEAD OF WATER ON DECK	
Δ4		HT(P=8.	
AC		*HEDT* IS THE HEAD OF WATER ON BOTTOM	
AC		HBOT=DRA	
84		STR3T=V+152222*HT0P*Z*Z	
28		STP38=0+159222*HB0T+Z*Z	
C		A=DST-STR3T	
18		AB=DST=STF3B	
÷4		$\Delta C = (\Delta B + (B + \gamma) - A + D) / (\Delta + B)$	
2°		AD = BM * (P + U) / (A * 4 * A D * (D * D + 2 * 8 * D))	
78		VE=(3**P*F+5**B*F)/ D-D+5**P*D)	
74	С	*TOP* IS THE THICKNESS OF THE TOP PLATING	
24	С	*BOT* IS THE THICKNESS OF THE BOTTOM PLATING	
24		BOT=AD/(1·+AC=AE)	
)С		TOP=AC*BOT	
18		WRITE(5/10)TOP	
14		0 FCRMAT('1',22X,'TOP='F10+4)	
Ξ		WRITE(5,20)BOT	
14		Ø FORMAT(' ',2%X,'POT='F10+4)	
14	С	+S+ IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS	
*4		S=Z*TOP	
.0		WRITE(5,30)S	
C		0 = FORMAT(1, 22X) = 1 = 10 + 4)	
14		P=2·*D*b01+b*(TOP+BCT)	
18	C	*DITOF* IS THE DISTANCE OF THE TOP FRUM THE NEUTPAL AXIS	
-8		DITOP=D*(UAboI+D*FOT)/P	
5		WRITE(5)40)DITCP	
8	-	0 FURMAI(' ',18X,'DITOP='F10.4)	~ * ~
4	C	*DIBUT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AN	XIS
4			
3		WRITE(5,50)DJBCT	
4	-	DEFORMATICE ', 18X, 'DIBOTE'E10.4)	٨
6	C	*OWI* IS THE MUMERT OF INERIIA OF THE X SECTION ABOUT N.	д +

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STRENGHT OF SHIPS NON THE NEUTRAL AXIS LOCATION

Ŭ		Q111		0	and the second					L L
70			GMT=4 + F)*D<(13.	*8*8.2.*	ARD XTOP	* BOT+(D*.	1+2 • *B*D)*80T*801	
Fa	C		*TSTH*IS	S TEF ST	RESS ON T	TOP DUE	TO HOGGT	<6 G	/ «Et (» 50)	
FØ	C		*TSTS*19	THE ST	RESS DN	TOP DUE	TO SAGGT	G		
EQ	C		*TSBH+IS	THE ST	RESS ON E	SOT DUE	TO HOGGT	G		
50	C		*TSBS*IS	S THE ST	RESS ON B	BOT DUE	TO SAGGI	ς Ĝ		
Ea	C		*STCRIT	IS THE	CELTICAL	STRESS	ON TOP			
EØ	C		*SBCRTT*	IS THE	CRITICAL	STRESS	ON BOT			
Eø			TSTH=6M+	DITOP/G	MI+S-RAT					
F4			TSTS=BH*	CITOP/G	MI+STR3T					
28			STCRII=1	OP + TOP +	E/10.3039	96*S*S*(1 POI*P	((IC		
48			WRITE(5)	60) TSTH						
54		60	FORMAT	1 1,19X,	*TSTH=!F:	10.31				
7E			WRITE(5)	70)TSTS						
94		70	FORMATI	1,19X+	'TSTG=!F:	10.3)				
34			WRITE(5)	REISTOP	IT					
70		80	FORMAT	1,17×,	'STCRIT=	F18+31				
EC			TSBH=PM	KDIP01/G	MI+0.1522	555*HBOL	*S*S/(E0)	T*80T)		
28			TSBS=EM*	DICOTZG	MI+0.1522	555*HBOL	*S*S/(bc	T*BGT)		
54			SBCRIT=	ACT + BOT +	E/18+3239	96*5*5*(1 POI*P	((I))		
14			WRILE(5)	90)198H						
150		90	FURMAT (1,1aX,	$TSB_{F} = F$	10.31				
EJA		100	WRITE(5)	1001754	5					
55		160	- FURMAIT.	1111000	- 1888= F.	10.31				
10		110	- WALLEIDJ - EODMAT/ 1	111150U 1111780U	ALL TODODIT-	1540.21				
38		110	END	, 1 / ^ ,	SAUKI1-					
1.51	• 1 1		2000 0640 (V)	Δi	CASE IVI	R	0650 rV1	DRA	8664 EV 1	n
6.V]	POI		0674[V]	F	2000 [S]	• R	0684 [V]	DST	26×01V1	RM
\$1V3	W		0640 EV3	U	· 0232[5]	SORT	06A4[V]	Z	0645[V]	HTOP
8:V3	HB0	Т	2684 [V]	STR3T	2630 [V]	STR 3B	06C0[V]	Δ	66C4 5V3	1.P
CIV3	AC		06001V2	дD	PSF (V)	AE	06F8[V]	BOT	C6FCIV1	TCP
11 <u>1</u> 1	10		0000[S]	ΦI	6537273	50	0700 EVI	S	(12075h)	32
(V)	P		0708 <u>EV</u> 3	DITOP	65Eo[[]	40	972C [V]	TOGIC	2354[L]	57
1.VJ	GMI		271C[V]	TSTH	2720[V]	TSTS	07245V1	STORIT	24645L3	62
3 L J	70		0400 (L)	80	0725[V]	TSRH	072C[V]	TSBS	Ø73~[V]	SBCRIT
013	90		05F6[L]	143	0650[L]	110	0000 (Sj	• V		
3		l	-							
-										
RAI	LA	RELS	0		00	10				

MAIN	2E84	• 🗸	SCEA	•COMP -	2980	ALOG	SEC8	© I	2714	• R
•ZERO	2D10	\$6	27F.4	• A	SEGE	• MES	2080	• W	2494	EXF
AINT	2896	SGRT	2052	• RAPG	SDAE	• 5	2494	VEXE	5D36	• E+
\$8	2086	• C	2E8C	• U	3FE4					
POINTS:										
• R	27E4	• 4	2896	SORT	2980	ALOG	2494	AEXP	2494	EXF
AINT	2080	• 14	2CFA	. COMP	2D10	\$6	2052	•RA⊐G	2084	\$8
• 5	SDBS	·ZERO	2086	• ERCNT	2088	• G	SEQE	• MES	SE 98	• U
• V	SEC8	۹I								
	MAIN •ZERO AINT \$8 POINTS: •R AINT •5 •V	*MAIN* 2EBA •ZERO 2D10 AINT 2896 \$8 2DB6 POINTS: •R 27E4 AINT 2C8C •5 2DB2 •V 2EC8	*MAIN* 2EBA •V •ZERO 2D10 \$6 AINT 2896 SGRT \$8 2DB6 •C POINTS: •R 27E4 •A AINT 2C8C •V •5 2DB2 •ZERO •V 2EC8 @I	*MAIN* 2EBA •V 2CEA •ZERO 2D10 \$6 27F4 AINT 2896 SGRT 2D52 \$8 2DB6 •C 2E8C POINTS: •R 27E4 •A 2896 AINT 2C8C •W 2CFA •5 2DB2 •ZERO 2DB6 •V 2EC8 @I	*MAIN* 2EBA •V 2CEA •COMP •ZERO 2D10 \$6 27E4 •A AINT 2896 SGRT 2D52 •RAPG \$8 2D86 •C 2E8C •U POINTS: •R 27E4 •A 2896 SQRT AINT 2C8C •W 2CEA •COMP •5 2D82 •ZERO 2D86 •ERCNT •V 2EC8 @I	*MAIN* 2EBA ·V 2CEA ·COMP 298C ·ZERO 2D10 \$6 27F4 ·A 2E0E AINT 2896 \$GRT 2D52 ·RAFG 2DAE \$8 2DB6 ·C 2E8C ·U 3FE4 POINTS:	*MAIN* 2EBA ·V 2CEA ·COMP 298C ALOG ·ZERO 2D10 \$6 27F4 ·A 2E0E ·MES AINT 2896 SGRT 2D52 ·RAPG 2DAE ·5 \$8 2DB6 ·C 2E8C ·U 3FE4 POINTS:	*MAIN* 2EBA •V 2CEA •COMP 298C ALOG 2EC8 •ZERO 2D10 \$6 27F4 •A 2E0E •MES 2C8C AINT 2896 SGRT 2D52 •RAPG 2DAE •5 2A94 \$8 2DB6 •C 2E8C •U 3FE4 2A94 POINTS:	*MAIN* 2EBA ·V 2CEA ·COMP 298C ALOG 2EC8 @I ·ZERO 2D10 \$6 27E4 ·A 2E0E ·MES 2C8C ·W AINT 2896 SGRT 2D52 ·RAPG 2DAE ·5 2A94 AEXP *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP *8 2DB6 ·C 2E8C ·U 3FE4 2D52 ·RAPG *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP *8 2DB6 ·C 2B8C ·U 3FE4 2A94 AEXP *8 2DB6 ·C 2B8C ·U 3FE4 2A94 AEXP *0 2DB6 ·C 2B96 SQRT 298C ALOG 2A94 AEXP *0 2DB2 ·ZERO 2DB6 SQRT 298C ALOG 2A94 AEXP *0 2DB2 ·ZERO 2DB6 ·ERCNT 2DB8 ·C 2D52 ·RA*G *V 2EC8 @I 2DB6 ·ERCNT 2DB8 ·C 2E0E ·MES	*MAIN* 2EBA ·V 2CEA ·COMP 298C ALOG 2EC8 @I 27A4 ·ZERO 2D10 \$6 27E4 ·A 2E0E ·MES 2C8C ·W 2A94 AINT 2896 SGRT 2D52 ·RAPG 2DAE ·5 2A94 AEXP 2D86 *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP 2D86 *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP 2D86 *8 2DB6 ·C 2E8C ·U 3FE4 2A94 AEXP 2D86 *8 2DB6 ·C 2E8C ·U 3FE4 2B8C ALOG 2A94 AEXP 2D86 *8 2DB6 ·C 2B8C ·U 3FE4 2B8C ALOG 2A94 AEXP 2D86 *0 2D86 ·C 2B8C ·U 3FE4 2B8C ALOG 2A94 AEXP 2A94 *0 2D86 ·C 2B86 SORT 298C ALOG 2A94 AEXP 2A94 *1NT 2C8C ·W 2CEA ·COMP 2D10 \$6 2D52 ·RA*G 2D84 *5 2D82 ·ZER0 2D86 ·ERCNT 2D88 ·C 2E08 2E98 *V 2EC8 @I 2D86 ·ERCNT 2D88 ·C 2E98 2E98 </td



TCP= 0.4626 BCT≖ 9.7569 S= 25+7529 DITCP= 53+9186 17.50.99 DIBCT= TSTH= 34999.977 TSTS= 34999.977 STCRIT= 350/0.016 TSPH= 1 196.547 TSES= 1 196.547 SBCRIT=++++++++ (too High OUTSTD= FOY2TUAT RANGE) ND VIC OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATEL 04/27/74 DB HANDLING CHARGE \$.35 / JAB •35 25 LINES PRINTED FRF \$ 1.85 / K LN •16 34 CARDS READ \$ 1.50 / K CD •13 10 PLOTTER VECTORS SV. 1 1 35. 3 • 02

.10

.00

•74

15 MODEL 70 SECONDS \$25.20 / HOUR

\$12.5% / HAUR

MIR 490 14731 LOGGED BUT \$4/29/74 20:46. \$

TOTAL CHARGE 9

NO MODEL 80 SECONDS

177

32.45 LEFT AFTER 43 LOGINS.



Now let's consider our situation with DST = 25000. Once the situation is such that due to the approximation made in

 $\frac{S}{BOT} = Z$

we end up with a STR3B>DST we must consider a value Z1 lower than Z to bring STR3B down. This can be also understood since it is acceptable to make here

 $\frac{S}{TOP} = Z$

but because we obtain with the program as is TOP \ll BOT, making the approximation

S ----- = Z

BOT makes Z attain a much larger value than it actually should. We must then consider Z1 < Z = 65.8 and may start by trying Z1 = 35

The computer printout in this case is as follows.

PACE

1

STRENGHT OF SHIPS ON THE MOUTRAL AXIS LOCATION

WALK IS THE LENG IT 14 (AL=167 ... 14 N=41/5.75 6 C. 1% PLACE THE MEART C. 15 [+1=1/3.3 24 1=1L/14. 30 *FUTE IS THE POISSON'S RATIO OF THE MATERIAL $\hat{\mathbf{C}}$ FUR STEEL 3. \mathbf{c} 31. F-[]=(.7 35 NET 15 THE YOUNCES MONULUS OF THE LATERIAL C_{i} FF .. CTFFI 38 0 に三分に、キカビ・米米モ 35 ALSTA IS THE RECIGE STAASS 40 C 45 DST=r Syst 1. 54 + BI + IS THE PENNING COLENT ٢ 54 DI=1.37143+tx-U/ ALULY 50 1.=2+20395*(1+_F)1*C01)*PST/E 1=5 57() FC 98 7=1.70 44 . TOT # IS THE .. D OF VATER ON DECK 10161=5. 1. 1. *FOOT* IS THE HEAD OF MATER OF BOTTOM AC F: CT=DRL AC <THRT=0+152222+4TOF+2x7</pre> R4 0 9 71=35. STREF=: +152222***** 07 +21*21 n.ç F4 A=081-87R31 19 /P=nsT+STREE FC 1(=(1H×(H+D)-V*D)/(V×D) 34 / = = = = + (+ + D) / (/ * 4 * * C * (D * D + 2 * * B × E)) 88 1+=(3+×2+5+2+*+P)/(C+0+2+×H>O) CC , TOP, TS THE THTOKYES& OF THE TOP FLATING C 22 FCIN IS THE THICKNESS OF THE FOTTEM PLATING 0 00 $FCT = ICZ(1 + FC_{MAF})$ 54 TCF=/C*COT 20 1 RITE (5,10)700 KC. 10 F(FM+T(111,20x, 110F=1F10.4) 1713(3512F) FIFT 24 22 FLF147(1 1;20x, 'ROT='F10.4) 42 1 50 SEN IS THE SPACING OF LUNGITUDINAL STIFFENING NEMBERS C 50 5=Z*16P VEITE (SEBE)S 68 24 20 FLATAT(1,228, 15=1F10.4) Inc F=S+*F*POT+E*(TOP+FOT) SITCER IS THE DISTANCE OF THE FOP FROM THE NEUTRAL AXIS CP С CP NITOF=N*(P+BO++D+B(T)/P 54 VEITE(5,40)DITOP Ar FUREAT(1,18x, ""ITCP="F10.4) 27 10 DIFCTH IS THE DISTANCE OF THE BUTTOM FROM THE NEUTRAL AXIS C 10 [IPC1=0*(E+TOP+0+30+)/P 47 WEITE (5,50)DIDOT 50 cd FCRMLT(1 1,18x,10J80T=1F10.4)


STRENGET OF SHIPSHON THE SECTION AROUT STRENGET OF SHIPSHON THE SECTION AROUT STORE 2

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170		(-1=4 · ~ > [* (().		np+E0++(0+0+2.	×EixE)*P)T = 0']	978	
-1 -	r.	FETENTS THE OF	THESE ON THE DI	F TC FOGGING				
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Γ, ¢	r	STOPESTO THE OF	FERE UN BAT DU	E TO DEGING				
; c	~	FLERCETS THE OF		F TF AGGTLG				
	č	STOLT'S TO THE	-RITICAL STRE	SC (1. TOP				
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E C	6	Erres Hr. 1910A	1,125H=1F10+31					
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► C		1 TH (3+ 20) STO						
3 5	5.0	SCRMETC' 1,174	,'ATCRJT='F10+3)				
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2-		- FITE (SIS2) TSA	4					
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1 2		FACTVE IN				CCB TEV-	-TOP	
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:274	あんこう 王 ちょう	ZECA .V	PCEN +C(MP	299C ALAG	SEDS	(B) I	2784	٠
(LCS	•ZERC	7024 BK	27F4 • A	PRIE .MES	5C9C	• VI	2124	Ε
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-094	4.5	2. FOGE	11. D638	SEF4			•	
Esy-;	PCTNTGt							
784	. n.	2751 .1.	28AA SOFT	2090 ALOG	AAAS	AEXP	2004	E
CZA	1 + 1 +	1. 2015	PCFA . CC"P	2-27 -6	21:15	. FASG	2794	4
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L	- V.							

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V	1) UNEFRITE SYSTE	AFBELC 1 REA	15101 -12 3/04/74 GENERAT	ED 4/27/7
63	HAMPLING CHARGE	4 • 25 / JOR	• 3	
25	CINES AND MAD BAT	7 1.25 / / LN	• 1 4	
34	24005 5610	9 1 • # • / • CN	• 1 3	
0.0	PLATTER VECTORS	生 ・アラ / 1010	• (1 ⁴) **	
21	MUDEL 7 SECOLIS	125.45 / 1040	• 1 5	
21	MUREL ST SECTION	#12. = * / HOUR	• *	
		TOTAL CHALSE	* • 7 ^	

10P= 3.4024 E0T= 5.7711 S= 225.4450 FITC= 42.3455 UTCT= 31.2493 TSTUE 24990.033 TSTUE 24990.033

SEIR 490 14731 LOSOFD DUT 04/20/74 20:59+ # 30+08 LEFT /FTER AN LOGING.



This time we obtained a realistic but still unacceptable result; we notice that the bottom is being stressed to 31000 psi when it can only go up to 25000 psi; besides we assumed

1

 $21 = \frac{S}{BOT} = 35$ and end up with $\frac{S}{BOT} = \frac{225.4}{5.07} = 44.46$ This means that the Z1 value should be higher. We may now try Z1 = 40; the computer results for this case are shown next.



STRE GHT OF SHIPSHON THE NEUTRAL AXIS LOCATION

24	0	*/L* IS THE LENGHT
6.4		AL#1CO1+
20		8=AL/5.75
18	<u>_</u>	*DPA* IS THE DRAFT
1 2		$0 \neq y = H \setminus 3 + 3$
24		D=AL/14 ·
36	С	*POI* IS THE POIRSON'S FATIO OF THE MATERIAL
21	<i>c</i>	FOR STEEL
32		P01=2+3
32	1	*E. IS THE YOUND'S MONULUS OF THE MATERIAL
35	1	FUR STELL
38		E=3./+#E ⁻ +*×6
4 C	ſ	*UST * IS THE OFSIGN STHESS
4 (057=253 *
54	C	*BH* IS THE RENTING COMENT
E. 4		2'=1·37143*8*nR**AL*AL
FC		#=C+3/336*(1+_=CI+00I)*D3T/E
85		リギタウや子(x)
<u> </u>		7=1·/U
14		*HICP* IS THE HEAD OF VATER ON DEC.
\$ 4		$P^{\perp}_{1} \cap E = S^{\perp}_{1}$
ΔÇ		*PHOT* IS THE HEAD OF MATER ON BOTTOM
A 🗋		ASU=TOBH
n4		STROT=1.152222*+10P*2+2
ζ 2		71=+ۥ
10		SFF3F=1+15222p+H99T+Z1*Z1
E4		A=UST=STRET
FUt		AB=DST-STR3R
FC		$\nabla C = (\forall B * (B + D) = \forall * L) \setminus (P + B)$
34		AT=B***(ドキロ)/(メ*4・*D+(ウ*り+2・*B*ロ))
R()		AE=(3·*H*E+2·*B*D)/(D*D+2·*P*D)
CC.	C	* TOP* IS THE THICKNESS OF THE TOP SLATING
CC	C	*POT* IS THE THICKNESS OF THE BUTTER PLATING
CC		$\frac{PD}{P} = AD / (1 \cdot + AC \star \Delta F)$
<u><u> </u></u>		
F (*		MRITE (5,10) ICA
i C	1	FCRNAI('1')2/X/'TOP='F12+4)
. 0		WELLEVOICY DOUT LOOT LOOT LOOT LOOT
42	22	FURMATUR JEVY, "RUTE"FIVEH Suite the solation of toothothic strepening rempers
10	ί.	-V=SYICB -Kok 19 imp seVÜIVR AF FONGTIOUTANF SITELERING LEUDEVS
- C C -	• 1	
0.4	र ७१	
62	~	RECONTORN IS THE EXSTANCE OF THE TOP FROM THE NEUTRAL AXIS
10-0	L	DITOR SKENEDTING OF THE TOP THOSE HERE AND TO THE HERE AND TO THE HERE AND THE
F 1		
500	1. (2	F(EMAT(1, 1, 18), 10TTOP-1E(0, 4))
11	6	+DIRCT IS THE FISTANCE OF THE BOITOM FROM THE NEUTRAL AVIS
210	C	DIPOTED*(F*TCo+C*BOT)/P
240		WPIIE(5,56)CLOOT
250	50	FURLAT(1 1.18V. 11 TRCT-1E10.4)
-		

PAGE 1



STREICHT OF SHIFSHON THE LEUTRAL AXIS LOCATION

278	C	*GN1* IS THE	- 	CF INESTI 2.*R+D)+T	A UF	THE Y SI		ABOLT ' +) * ROT + Br 1	A.)/2	
258	Ç	*ICTHAIS THE C	THERE	CN TOP DU	r 10	+ OGGING				
28.30	0	*FETS*IS THE ST	regage.	CH TOP DL	25 I.C.	- AGGING				
35.8	С	*ISBINIS THE C	12130	CH ROT DI	. <u>E</u> 11	+0661N6				
21.8	C	*TEESAID THE A	1-250	CN HOT DL	ETC	CAGGING				
15.8	C.	*STCRIT* 15 TH	CRIT	ICAL STRE	.ee (1	TOP				
228	r <u>*</u>	SACHITA 15 TU:	E CRIT	ICAL STRE	95 (N	U HOT				
28.8		TETHERM+DITORY	: i+c1	۲ کا ۱						
SEC.		TETS== Y Y I ITOF /	3.1+C+	53T						
.11		CICEIT=ICPAlco	*E/(C.	3/396*5*5	·* (1 • -	FOI*PCI))			
1.08		WPTTE(5+40)TST	٩							
45C	€. S	FIRINT(' ')19X	, 1187H	=+F13+3)						
10 cm		WFITE(5,70)1970	2							
- 22	ا هـ	FUEL/T(1 1,194)	11910	=+F19+€)						
- 3C		WHITE (SHED)STOP	· 11							
กร	* . *	FCF1/T(1 1,17v)	, ISTER	37=1516+3	3)					
F 4		I CEREEWS ETFOLV	· · · · + / •	1255555 46	UT + E >	r / (RNT *	-(1)			
-32		TESSERV*DIFUT/	n`+-•	1=28252	107851	Ep/(BOT+	К СТ)			
1 5 L		SECULIED AND	i ⊨ / [f	443244545	• * (⊥••	⇒rut+ru⊺))			
AT AT.	2.5		1750							
- <u>-</u>	(**	THE FLORE (CONTRACTOR)	n e Sternerij⊒							
1 /2 1 / E		2012070111.100	17500	= 1 E 1 (1 - 2)						
518	1 / 1	-5115(5)110)Sor	-5 1 F							
34	1.1.1	- #CRMATCH 1,17V	. Lagro		2)					
50	1 : *			The stress	. ,					
เรา	• 1 .	ES4IVE At			64	ALVI D	P۸	0660 (V)	D	
EV)	H- C T	(670 EV) E	: 17.	[s] .R	÷ é	SCCVI D	ST	2694 [V-	BM	
n c V 3		5:40 - EVJ -	1 125	(S) SGAT	€ €	SICIVI Z		7680 (V-	HTOP	
° (V)	+ oT	C6PC[V] STH3T	1554	CVJ Z1	\$ e	ANCIVI S	TF3B	260 CV-	Δ	
• [V]	4 - 2 % 6	CEDSEVI AC	0650	LVI AD	67	Z ATVI A	E	9738[V]	ROT	
1 [V]	T ~ D	022011 10	1 122	SI OI	62	SESTI S	2	?71₽€V*	S	
EL 3		2714 ENT P	1714	(V) DITOR	° (*)	37 7 CLD 4	2	2710 <u>[V</u>]	DIGUT	
- CF 3	7.1	ALSULAI CUI	672r	CVI TSTH	£ 7	LUILL	STS	2734 (V 1	SICHI	T
CL1	10° - 1	244211 72	= 4 h s=	(L] 80	67	231V1 T	SEH	073C(V)	Teas	
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i≤ <u>Ε</u> Ω		-								
									•	
GRAN	" LAPELS									
24.14	werv I VI +	PECA V	POFA	• COME	5990	ALOG	SEDE	ωI	2784	• •
2002	• 7 5 8 7	2720 \$6	27F4	Δ •	SEIF	• MES	5000	• Inf	2444	E
AS35	ATST	28A6 SURT	2062	• PARG	2085.	• 5	SVVY	AEXP	5006	+ -
294			SEAL	• U	2 C F 4					
rRY-	POINTS:									-
2754	• **	2754	CEAF	SORI	5990	ALOG	2444	AEXP	2004	E)
105C	4 T \ 1			• COOP	SUCK	5 D	2062	• KANG	2004	\$
TECE	• 14	LUCE VIENU	CUCE	H - MI	2042	• J	CEIL	• 12.3	CENC	•
to b. F	- 11									

ENGE 2



	10P= 601=	3.2859 6.5153			
	्र 	199,4754			
	CIPOT=	21.2503			
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	TSTS=	24999.084			
	SICRITE	24990.004			
	TORHE	19514-234			
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VIN OFF	PLATE SASTE	M VERSICE 1 REVIS	IGN -12 (3/	04/74 GENERATED	4/27/74
DR HANDA	T'G CHARGE	1 .75 / JAR	•3=		
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sh CADIS	· · = AD	SI.FAZYUN	• 1 3		
N. PLATI	Fr VECTORS	9 • 35 / 1(1· 0	• 1.4		
15 (100년) 21 (100년)		912.50 / HOUR	• 1 · · · · · · · · · · · · · · · · · ·		
r - t		TUTAL CHAPSE 3	• 7 4		
ETR LOA	44721 LOGGE	D DUT 04/29/74 21	·22. * 58.	69 LEFT AFTER	8 INGINS
CT N	14/21 0.000	0.001 //4/6-//4 01	• 1 5.		
					L
			1		
			/		

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In this case we assumed Z1 = 40 and ended up with

$$\frac{S}{BOT} = \frac{199.5}{6.59} = 15.09$$

and a stress at the bottom of only 19000 psi which is too small. We may now try to use a better Z1 value and can do the following:





STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

174 С *AL* IS THE LENGHT 174 AL=1000. V°C. n=AL/5.75 *DRA* IS THE DRAFT 1.8 С DR4=8/3.3 118 24 D=41/14. *POI* IS THE POISSON'S PATID OF THE MATERIAL C 30 30 С FOR STEEL 37 P01=0.3 C *E* IS THE YOUNG'S MODILUS OF THE MATERIAL 38 POR STEEL 38 -C F=70.x10.*+6 38 DST* IS T E DESIGN STRESS C 4 C. 40 57=25000. C * FM* IS THE BENDING MOMENT 54 54 BM=1.37143+3+DPA+AL +AL FC. N=0+3v396*(1.*POI*POI)*DST/F 80 U=SOFT(W) 92 Z=1 · /U +HTOP* IS THE HEAD OF WATER ON DECK 14 HIDP=2. 14 :0 *HRATH IS THE HEAD OF WATER AN BOTIOM 120 LBOT=DRA R4 STR3T=1+15222+HTCP+Z+Z CR 71=35++5+*4404+/115-7+ 20 SIR38=0 .152222*HBOT + Z1 * 71 50. A=DST-STP31 FC AP=DST+STP39 72 $\Delta C = (\Delta R + (R + n) = \Delta + D) / (\Delta + n)$ 400 1D=PM*(P+D)/(A*4.*D*(O*D+2.*B*D)) 80 AF=(3+#B*B+P,*B*D)/(D*D+2,*B*D) 20 *TOP* IS THE THICKNESS OF THE TOP PLATING С *BOT* IS THE THICKNESS OF THE POTTOM PLATING 28 C 75 POT = AD/(1 + + AC + AE)50% TOP=AC*HOT FC. WRITE(5,10)TOP 18 10 FORMAT(111, 20X, 1TOP=1F10.4) 32 WRITE(5,20)ROT 4E 20 FORMAT(' ', 20X, 'BOT='F10.4) 58 С *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS 38 S=7*TOP . 74 WRITE(5,30)S 90 30 FORMAT(' ', 22X, 'S='F10.4) 48 P=2**D*B0T+B*(T0P+B0T)30. *DITOP* IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS С 20 DITOP=D*(B+BOT+D+POT)/P 50 WRITE(5,40)DITOP 40 FURMAT(' ',18X, 'DITCP='F10+4) 30 28 *DIPOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS С 28 DIBOT=D*(B=TOP+D=ROT)/P 40 WRITE(5,50)DIBOT 58 50 FORMAT(' ',1xX,'DIBGT='F10.4)

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PAGE





STRENGHT OF SHIPS-ON THE NEUTRAL AXIS LOCATION

3844 3875 3875 3875 3875 3875 3875 3875 3875	C C C C C C C C C C C C C C C C C C C	*GMI* IS THE MO GMI=4*D*D*((3* *TSTH*IS THE ST *TSTS*IS THE ST *TSBS*IS THE ST *TSBS*IS THE ST *TSBS*IS THE ST *STCRIT* IS THE *SBCRIT* IS THE TSTH=BM*DITOP/O TSTS=BM*DITOP/O STCRIT=TOP*TOP* WRITE(5;60)TSTH FORMAT('',19X; WSITE(5;80)STCR	MENT OF INERTI *B*B+2.*8*D)*1 RESS ON TOP DU RESS ON TOP DU RESS ON BOT DU RESS ON BOT DU CRITICAL STRE CRITICAL STRE MI+STRBT MI+STRBT FZ/(0.30396+5*S 'TSTS=!F10.3) TTSTS=!F10.3)	A OF THE X SE TOP*BOT+(D*D+2 JE TO HOGGING JE TO SAGGING JE TO HOGGING JE TO SAGGING SS ON TOP SS ON BOT S*(1.=POI*POI	CTION . 2•►8*C)	ABOUT N• *86⊺*80⊺	A •)/P
.E4 00 3C 78 58	88	FCRMAT(' ',17X, TSBH=BM*DIQOT/0 TSBS=BM*DIQOT/0 SPCRIT=BCT*BOT* WRITE(5,90)TSBH	'STCRIT='F10.0 MI+0.152222*HF MI+0.152222*HF E/10.32396*S*S	3) 80T*S*SZ(80T*8 80T*S*SZ(80T*8 8*(1*=P0I*PCI)	30T) 30T)))		
-D4	90	FORMAT(1 , 19X,	1TSBH=!F10.3)				
IEE .	100	WRITE(5,10)) TSH	S				
24	100	WRITE(5,11))SBC	-1:28941610+31. 811				
40	110	FCRMAT(' ',17X,	'SBC%IT='F10+3	3)			
5 C		END					
[S] [V] [V]	•U POI W	2660[V] AL 2688[V] E 2684[V] U 2668(V] SID21	0668[V] B 0000[S] •R 0000[S] SQRT 0000[S] SQRT	0670(V) DF 0698(V) DS 0688(V) Z	A ST IRoc	2678[V] 2681[V] 2680[V]	D BM HIOR
CV3	AB	06F0[V] AC	0704[V] AD	0718(V) AE	- N 3 0 -	272- [V]	ROT
[V]	TOP	0218[L] 10	Vezalsi @I	024E(L) 20	2	2728[V]	5
(1)	30	072C(V] P	0737 (V) DITOR	9 030C(L) 40	2	734 [V]	TOFIC
([]	50	0738[V] GMI	0744 [V] TSTH	0748 [V] TS	STS	2740EV3	STCRIT
CV1	50 SPCDIT	24AELLE 70	04E4[] 80 8484[] 128	0750 <u>r</u> V- TE	म म म	3754[V] 2000[5]	1585
EQ	JOCKI	00114110 90	RENTED INN	0040(L) 11	• ¥	1.4.6.4.6.5.1	• •
GRA	LABELS		204.0 0240	0001 1100	0550	67	2700 D
204	•7EPO	2038 \$6	2012 • COMP	2954 ALUG	2640	(a: 1	PAR EX
242	AINT	288E SQRT	207A RARG	2006 •5	2ABC	AEXP.	2005 +E
DAC	\$8	2DDE •C	2ER4 •U	402C			
1 24-	POINTS:						
100	• R	280C · A	28BE SORT	2984 ALOG	SARC	AEXP	SAFC EX
:42	AINT	2CR4 .W	2012 .COMP	2038 \$6	2074	• R ∧ R G	SUIC #8
106 E6	•5 •V	2DDA •ZERO 2EFØ ØI	200E • ERCNT	2DE0 •0	SE36	• MES	SECV .

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PAGE 2



TOP≂	3+2486
BOT≞	5.7418
S=	213.9701
DITOP=	42.2107
DIBOT=	29+2179
TSTH=	25000.000
TSTS=	25020.000
STCRIT=	24999.992
TSBH=	24788+316
TSBS=	247×8.316
SBCHIT=	7=100-937

END

: VIO OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 04/27/74 1

10B	HANDLING CHARGE	\$.35	/ JOB	•35
26	LINES PRINTED PR2	\$ 1.25	/ K LN	•16
85	CARDS READ	\$ 1.50	/ K CD	•13
20	PLOTTER VECTORS	\$.25	1 1900	• (A 93
15	MODEL 70 SECONDS	\$25.00	/ HOUR	•19
90	MODEL 80 SECONDS	\$12.50	/ HOUR	• @ 7
		TUTAL	CHARGE	\$ •74

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EIR 490 14731 LOGGED OUT :4/29/74 21:30. 5 27.86 LEFT AFTER 49 LOGINS.

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The results show that we have obtained

$$Z1 = \frac{S}{BOT} = \frac{213.9701}{5.7418} = 37.265$$

while it was assumed

$$Z1 = 37.617$$

We could further correct the result until Z1 assumed and Z1 actual would coincide but it seems that there is no need to refine more the solution for the purpose here involved.

Note that this procedure should also be followed for the other cases in order to bring the stress at the bottom to its maximum allowed DST for such cases as well.

STREPLAT OF SHIPSHOP THE NEUTRAL AXIS LOCATION

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3.1		-	
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.34		5]= <u>1</u>]• ×1]]• = -5
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$\gamma \subseteq J_k$	C	-	ANA TRITHE RENDING MOMENT
$\sim 57 ~ \rho_{\rm p}$		·	M=1+87143+8x08AxAL>AL +
40			2=>+3/396*(1.++POI*POI)*DST/E
- 2 -		1,	(マリ) T はつの中
0.4		-	2=4 • / 1
14			HTORK IS THE HEAD OF WATER ON DECK
\$ 4			TOPER.
* ^			HADTY TO THE HEAD OF WATER ON BOTTOM
220			
ير ت		c	T73T=1+150222+HT02+Z*Z
(° P		-	*TRRA= .1FARP2+HRDT+Z+Z
70		5	LEURITHOT DRA
- ° 9			
J 14		,	$C = (A \Omega + (N + 1) + \Delta + \Omega) / (1 \times 3)$
2.2		,	D = 223 + (D + D) / (2 + 4 + 40 + (0 + D + 2 + + B + D))
70		1	1-2(3·*P=7+2.+3+0)/(0+2.*8+0)
~ L	2	•	TOPA IS T S THICKNESS OF THE TOP PLATING
<u>^</u> .	-		POTA IS THE THICKNESS OF THE BOTTOM PLATING
	2		301年60人(1+140×4F)
°1/7		T	$C_{2} = 10 \times 20^{-7}$
2		,	PTTP/S/CATAP
		1.2 -	- DEMAT/1+1 24Y.ITDD_1#12.65
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3 A.		22 5	$\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{i$
52	~	201	ST THE SPACING OF LONGITHDINAL STIFFENING MEMBERS
54	Ç	Ċ	NETRIOP NETRIOP
60			17 TE (5, 26) S
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a /,		32 -	
20	~		TITORY IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AVIS
22	5		NITOPEDK/AUROTINEDAWAU OF THE TOF TROM THE NEDARAU WATO
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= 2		40 -	$\frac{1}{2} \frac{1}{2} \frac{1}$
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70	~	0% -	NEW TRITIE MOMENT OF INFORTA OF THE V OFFICIAN AROUT NEW.
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PAGE 1



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STRENGHT OF CHIRGHON THE NEUTRAL AXIS LOCATION

PAGE 2

-17M		3,42 = 5 + x (+ 3 + (+ 3 +	•нэ»5+5•наж))	*TOP*BOT+(D*))+2•*9*D))*80T*801	[]/P
7-7.0	C	ALCINE STRESS	REAS ON TOP	DUE TO HOGGI	∖G		
257	С	*Idio*10 T I S1	RESS ON TOP	DUE TO SAGGT'	NG -		
1.50	0	*_035*16 _12 6.	REER ON BOT	DUE TO HOGGI	VG		
	r			DUE TO SAGG -	ve		
7-1.0	~		rater and et	RESS ON TOP			
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47 8			* C / () * 3 / 5 9 9 8 3	*2*(1+***********	5171		
144			· · · · · · · · · · · · · · · · · · ·				
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1 - 24		ITTIA PRINSTC					
<i>ي</i> ، ر	80	- 12YATI * 17X,	,'STCRIT='F1V	+31			
. ` ົ			SMT4 4.152222*	HPOT*S*S/(PO)	тжвот)		
1.25		- * - RSHEMMADI - 3エアク	MT-1.152222.	HADT*S*S/(R)	T#80T)		
= 54		DROPITEBOTADI.	E/12,37395+S	*S*(1.=P01*P	OI))		
= <u>1</u> 1		45TTP (5, 07) TOAL			-		
=00	97			}			
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= 4	182		17000±1547 3)			
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11.7	147		이 가지는 것을 만든 것이 있어?	• ,*)			
				THE FULL			0
	• []	A STALL ALL	ACC. 1. [11] A	2650 [V]	DRA DOF	0664[V]	D
	FÜT	x 74 [V] 2	4/7(0) •R	2687[V]	051	2628[V]	HM
	fr	TEALENI U	ISL - S%R	T 364/EVJ	Z	2644 (V)	нтор
10171	HADT	SERVICE ALABA	ARENI STR	38 268CIVI	Δ	2609 (V)	ΔB
	AC .	AD AD	MARCIVI AR	26F4IV5	POT	26F8(V)	TOP
411	1 1	27 TST 41	103A 113 - 23	26FC(V)	<u>S</u>	2270 IL1	32
11.12	P	077411 DITOP	7289 ILI 42	7778IV1	DIBOT	2354 141	52
n 11 1	GMI	271FIVI TSTH	7710IVI TST	S 272%1/1	STORIT	7454 LI	67
A IRD	7 2	2457 TE: 48	772VIVI TSB	H 2728:V-	TSBS	072CIVI	SBCRIT
11E2	97	SEGIEI 10	3620101 117	7127 1St	• V		
N 7 7	L	_					
5							
DEPAR	1 ADELS						
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50 A E				2700 AC(10	25.64	2 I.I.	2/AD 10
20.0	* とこいい			2544 • 165	21.00	• W • E V D	2490 EA
	AINI	2202 D	2 00	5040 .2	2490	AEXH	2982 •E
1158	¢ R	50 × 50 × 0	2 T > P + 년	3FE0			
13Y -1	POINTS:						
=7 AB	• ₽	9773 · A	BRAR SORT	2988 ALOG	2490	AEXP	2490 EX
2715	AINT	FCRR	ROTA . TOMP	2000 \$6	2D4E	•RARG	2080 \$8
ANC	• 5	EDAF .ZERM	2012 .FRONT	2084 .0	PENA	.MES	2E94 .L
-==.4	• V	2=C4 01			6 54		

TOP= 2**15 (
507# 6+21 2		
S= 02+03×5		
1177 日二 45+5月4 ,		
01 C 74 2 2 4 2 5		
TST (= 250 0++1)		
TOTO= 25/ 2+215		
今日の「日間井」 アニア・ア・アイル		
TS+4# 16945+707		
TSpS# 1 945+707		
5001 17#16-148+255		

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- VIC OPERATING RMOTEM VERSION & REVISION 312 03/04/74 GENERATED 04/27/74

1" "	-AND_ING CHATGE	5 .35 / JOB	• 35
54	LINES PRIVICE PRR	5 1.25 / K LV	• 1 4
$(i_{k})_{k}^{i}$	CARDA READ	1.5% / : ()	•13
, প	PLOTIER VENTORS	.25 / 1223	• 7 A
1 ର	MADEL 78 3100005	하수토니트에 V 4784명	•12
1.14	NUDEL SY RECOVICE	· 2.54 / 10112	• 2·2
		TOTAL CLARGE 4	,76

```
FTR 497 14731 LOSSED AUT 14723/74 18128+ 6 34+67 LEFT AFTER 40 LOGINS+
```

This 1000 ft aluminum case shows again a stress at the bottom much lower than DST. It should be corrected as done for "1000 ft steel" in the previous situation.

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HOGGING MOMENT LARGER THAN SAGGING MOMENT DESIGN STRESS IN COMPRESSION LARGER THAN DESIGN STRESS IN TENSION

LATERAL LOAD ALSO CONSIDERED

With the help of what was understood for the similar situation without the lateral load being included, we may here proceed at once to look at what the diagram of stress distributions might look like. Actually, the diagram that will be considered first is basically the same with only a small change due to the addition of the tertiary stresses; since these will probably be of the same magnitude on both top or bottom and assuming that their actual value does not differ considerably, what we may start looking into is a diagram as follows:



We would consider here the same basic distribution of longitudinal bending stresses thus obtaining



We will then expect to obtain TOP> BOT and DITOF< DIBOT and we may already consider the respective expressions for DITOP, DIBOT and I with TS replaced by TOP

From the diagram we may consider thefollowing equations: STH*DIBOT=SBH*DITOP

and notice here that if we want to stress the material to the allowable design stresses we have

STH = DST - STR 3T

SBH = DSC-STR3B

we may combine these equations to obtain

(DST-STR3T)*DIBOT = (DSC-STR3B)*DITOP

STR3T and STR3B are given by

STR3T =
$$0.152222*HTOP*(\frac{S}{TOP})^2$$

STR3B = $0.152222*HBOT*(\frac{S}{BOT})^2$



anticipating here that S = Z*BOT because BOT is the thinner plating we have

$$\left(\frac{S}{BOT}\right)^2 = Z^2$$

and thus may write

 $STR3B = 0.152222*HBOT*Z^2$

Since

$$\left(\frac{S}{TOP}\right)^2 < \left(\frac{S}{BOT}\right)^2$$

because TOP > BOT, if we make

$$\left(\frac{S}{TOP}\right)^2 = Z^2$$

to simplify the equations that will follow we will understand that in doing so we are only increasing the value of STR3T. This as we see fron

STH = DST - STR 3T

will make us have STH with a slightly lower value than the one that is allowed, so we are on the safe side when we consider

$$\left(\frac{S}{TOP}\right)^2 = Z^2$$

Now if we end up too much on the safe side and we have a TSTH too low we may bring it to a value closer to DST by considering a Z1 value as done and exemplified in the previous section and done again in this section for the case 1000 ft steel where for this particular exemple it is TSBH that needs correction as explained in detail .
We may then write

$$Z = \frac{1}{\sqrt{0.30396*\frac{1-P0I*P0I}{E}*DSC}}$$

STR3T = 0.152222*HT0P*Z²
STR3B = 0.152222*HB0T*Z²

and from

(DST-STR3T)*DIBOT = (DSC-STR3B)*DITOP

we have if we make

A = DST - STR 3T

AB = DSC-STR3B

P = (2*D+B)*TOP+B*BOT

$$A^* \xrightarrow{P} = AB^* \xrightarrow{P} P$$

which gives after simplification

A*((B+D)-AB*D)*TOP = AB*B*BOT

and making

AC = (A*(B+D)-AB*D)/(AB*B)

we have

BOT = AC*TOP

Following the suggestions of a previous section we will also use the equation that will make the bottom to be stressed the most in compression under the larger of the moments being considered (HM in this case).

We obtain

SBH = HM*DIBOT/I = AB Replacing DIBOT and I by their expressions we obtain



TSBS = SM*DIBOT/I+STR3B

TSBH = HM*DIBOT/I+STR3B

Considering here again the bottom as the location of the thinner plating (in this particular situation we are looking at), and knowing that it will be subject to a compressive stress of magnitude as large as DSC we may again write S = Z*BOTWe finally obtain the total stress on top and bottom in both tension and compression by adding the longitudinal bending stresses to the tertiary stresses.

 $TSTH = HM*DITOP/I+0.152222*HTOP*S^2/TOP^2$

TSTS = $SM*DITOP/I+0.152222*HTOP*S^2/TOP^2$

 $TOP = \frac{AD}{1 + AC * AE}$

BOT = AC*TOP

substituting here

TOP = AD - AE * BOT

we obtain finally

we have

 $AE = (3*B^2+2*B*D)/(D^2+2*B*D)$

now making $AD = HM*(B+D)/(AB*4*D*(D^2+2*B*D))$

 $TOP = \frac{HM^{*}(B+D)}{AB^{*}4^{*}D^{*}(D^{2}+2^{*}B^{*}D)} - \frac{3^{*}B^{2}+2^{*}B^{*}D}{D^{2}+2^{*}B^{*}D}$

simplifying we end up with

 $AB = \frac{HM*D*TOP*(B+D)}{4*D^2*TOP*((3*B^2+2*B*D)*BOT+(D^2+2*B*D)*TOP)}$



NOTE: since usually the secondary stresses are assigned a constant value like 2000 psi or 3000 psi they can be accounted for when giving a value to the design stresses.



```
0 2 0.4
               *AL* IS THE LENCHT
        С
8704
               11=502.
378C
               2=21/8.
218
               +DRAW IS THE DRIFT
        С
               NHA=8/3+
218
2.24
               E=AL/9.
1. 312
        С
               *POI* IN THE DOISSON'S RATIO OF THE MATERIAL
2:30
               FÜR ALH TMIM
        С
              201=, +33
2:30
               AFT IS THE YOUNCES MODUL IS OF THE ATERIAL
2:38
        С
1 38
        C
              FUR ALU'INIM
3:38
               F=12++1 ++>6
224C
        С
               . UST . IN THE REATON STRESS IN TENSION
2*4C
               5T=250 0.
1854
        С
               *DSC* IS THE DESTON SARESS IN CUMPLESSION
               090=3000 N.
3 54
               *H. * IS THE HUSELNE RENDING NO FLI
315C
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              HA=1-37143×1 5001 AL King
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3 74
        С
3 74
              Q~=P×DR2×AL×AL
1288
              -=0.41396*(1._Phij*Phij*Phij*USC/E
              11=5667()
1248
1564
              2=1.70
17CM
               HATCHE IS THE HEAD OF WATER ON DECK
1200
               HIG0=8.
0108
               WHENTY IS THEN WEAD DE WATER OF FOITOM
8011
              HOOT=DRA
1206
               STABT=0+152225*AT00+Z4Z
12E4
               STR38=V+152220+-40T+Z-Z
288
               A=DST=SIR3T
124
               AR=DSC-STRRB
:10
               AC=(A+(++D)=A2+T)/(×PUR)
148
               AD=HM*( +D)/(AR+4++D*(1*D+P+*R+0))
:94
               AL=(2・* #F+2・+F+1)/11 +1+2・+B*5)
               FIDE* IT THE THICK FASS OF THE TOP CLATING
1EØ
       С
               *HOT* IS THE THICKNERS OF THE ROLL 4 PLATING
:EØ
        С
              TUP = AD / (1 + AC < AL)
HE0
11F8
               HOT=AC+TOP
224
               WEITE(5,12)T00
220
           10 FORMAT( 11, 227, 1708=1=10.4)
234
              WRITE(5,22)HOF
256
           20 FURMAT( ! !, 272, ! ()T=!#1 (.4)
278
              *3* IS THE SPACE IS OF LONGITUDINAL STIFFENING FEMBERS
       Ç
078
              S=Z=BOT
97C
              "HITE (5,30)S
298
           30 FORMAT(1 1,202,1%=1=1=1+++)
280
              H=2.*D+10P+0*(TJ0+201)
204
               *DITOP* IS THE DESTAINE OF THE TUP FROM THE NELTRAL AKTS
        C
2D4
              nITOP=D*(C+ROT+D-Tho) /P
2F.8
              ↓RITE(5+42)01+0P
           40 FURMAT( ! 1,18x, ! (ITOF= + F12.4)
314
130
               CIBOT* IS THE ISTALLE OF THE BUTTOM FROM THE NEUT AL AXIS
        С
```



STRENGHT OF SHIPSHON THE FUTURE VELS LOCATION

0330 03370 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 03570 0000000000	с СССССС СССССС СССССС ССССССС ССССССС СССС	01+01=0*(F*T)9+ 9+1TE(5,57)+100 FORMAT(1,1,140, 46*T* Is THE 90 501=4.*1+F*(10) *TSTH*19 THE 97 *TSTH*19 THE 97 *TSTH*15 THE 97 *SHORIT* IS THE 97 *SHORIT* IS THE 97 *SHORIT* IS THE 97 STOFIT* IS THE 97 FORMAT(1,1,100,00 FORMAT(1,1,100,00 TS STOFIT* IS THE 70 TS STOFIT* 10 TS STOFIT* 10		<pre>A OF THE Y SECTI DP*F0*+(')*D+2.«B F TC FOGGING E TC FOGGING E TC FOGGING E TC FOGGING SS ('S TOP SS ('S TOP SS ('S DOT nP*E*S/(TOP*TCP) *(1.*FOI*FOI))</pre>	(Η 480 Γ +/+ *Γ)*ΤΩëà Ρ)/ο
2587 2500 2500 2576 2412 2448 2448	0 - 1 9 1 1 1	SCCFITE CT*80** *KITE(5:90)1886 FORMAT(''; 98, *TITE(5:100)T93 FDFTAT(''; 197, FTTE(5:110)8:0 FDFMAT(''; 177, C20	<pre>'/('.3~396*8*5 '1930=(F1).0) 'T928=(F1).0) TT 'T928=(F1).0) TT 'T928=(F1).03</pre>) *(1•-POI*PO[))	
2 (S) 3 (V) 4 (V) 5 (V) 5 (V) 5 (V) 14 (V) 14 (V) 22 (V) 4 (V) 4 (V) 4 (S) xEQ 3F	•H POI H Z A TOP S DIROT STCFIT TSBS •V	1068[V] AL 1090[V] E 1090[V] E 1090[V] F 1000[V] HIDP 1000 1	67~(v] 8 21~(c] •R 638(v] ↓ 650(v) HBCT 658(v) AC 220(c] 10 720(v) P 720(v) 6NJ 1574(c] 70 500(c] 36	0670(V) DRA 0600(V) DST 0604(V) DST 0604(V) STF3T 0500(V) AD 0724(V) DITOP 0728(V) TSTH 0500(L) SC 0612(L) 100	948 [V3 p 1644[V1 030 120 [S1 SFP] 960([V] ST 38 271 [V1 76 2266[L] 2 1314[L] 4 1730[V1 T515 1744[V] TSAB 1648[L] 110
13GR AN 2070 204E 2886 2052	1 LABELS: *MAIN* •ZEFO AINT •O	2855 •/ 2010 •5 2852 STRT 2868 •0	2084082 2307 -A 2055 -54RG 3681	24148 / LDG 2E 21 44 - MES 20 21 44 - 5 2D	64 9T 2700
1784-F	•R	2800 .4	2332 Sakt /	2948 VF00 5V	BI EXP 2866 AT

* 1 ive 5

TOP=	1.34 8
60T=	£.2733
3=	13.2791
DITOP=	26.3133
CIrOT=	21.2210
TETHE	24459.7.4
TSTS=	1-1-1-1
TCHII=	454 - 7 . 3.14
TSP ==	29999.976
TSUSH	22931 . 1 M
PORTE	211 24 119

S

5

1 END

OF VID OPERATING SYSTEM VERSTER 1 PRVISION 12 3/34/74 GENERATED 14/34/74

108	HANDLI O CHARGE	5 5	1 103	. 3%
130	LINES FRINIED PRI	· 1.25	/ K LH	• 1 6
88	CARDS SEAN	5 1.5%	1 2 25	•13
00	PLOTTE- VECTORS	· · · · ·	/ 1/ .	• 5 1
15	MONEL 7 SECTIONS	526 . 77	1 april and	• 1 *
66	MODEL & SECONDS	512.002	1 4040	• 1
		TCTAL	CHATGE -	• 14

RREIR 490 14731 LOGGED OUT MY/1/7% 22:19. 5 26.33 LEFT AFTER II LOBING.

As we see the results obtained for the 500 ft aluminum case are acceptable and agree with all our considerations in the derivation of the formulas, namely TOP>BOT.

The following two runs, for 500 ft steel and 1000 ft aluminum show that the results are in disagreement with TOP> BOT used in the formulas. We will see next why this happens and derive the proper set of formulas to be used for such cases.

STRENGHT OF SHIPS-ON THE NEUTPAL AXIS LOCATION

```
2284
        С
               WAL * IS THE LENGHT
2884
               AL=500 .
1288 C
               H=AL/8.
        С
               *DRA* IS THE DRAFT
2718
2018
               URA=8/3+
               D=11/9.
2:24
22301
        С
               *PCI* IS THE POISSON'S RATIO OF THE MATERIAL
        С
1230
               FOR STEEL
1230
               P01=0-3
        С
7733
               *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
.238
        С
               FOR STEEL
1:33
               E=30 + + 10 + + + 6
        С
274C
               *DST* IS THE DESIGN STRESS IN TENSION
34C
               NST=25160.
254
        С
               *DSC* IS THE DESIGN STRESS IN COMPRESSION
1254
               DSC=34000+
P25C
        С
               *HM* IS THE HOGGING BENDING MOMENT
2:5C
               H*=1.37143+8+0RA+AL+AL
274
        С
               *SM* IS THE SAGGING BENDING MOMENT
2274
               SM=B+DRA=AL*AL
2788
               v=0+3:394*(1.*POI*POI)*DSc/E
12A3
               U=SGRT(h)
2284
               7=1 - 10
200
               *HTOP* IS THE HEAD OF WATER ON DECK
2C0
               HT0P=8.
708
               *HBOT . IS THE HEAD OF WATER ON BOTTOM
208
               HBOT=URA
200
               STR3T=0+152222*HT0P+7*Z
124
               STR38=0.152222*HB0T*Z*Z
2F8
               A=DST-STR3T
124
               AB=DSC-STRAB
110
               \Delta C = (A * (B + D) = \Delta B * D) / (AB * B)
148
               \Delta D = HM * (B + D) / (AB * 4 \cdot * D * (D * D + 2 \cdot * B * D))
194
               AE=(3·*B*C+2·*B*D)/(D*D+2·*B*D)
IEQ
        С
               *TOP* IS THE THICKNESS OF THE TOP PLATING
IER
        С
               *BOT# IS THE THICKNESS OF THE BOTTOM PLATING
1E2
               TOP = AD/(1 + AC + AE)
1F8
               BOT=AC+TOP
204
               WRITE(5,10)TOP
226
           10 FORMAT('1',20X, 'TCP='F10+4)
23A
               *RITE(5,28)BOT
           20 FOPMAT(' ',22X, 'BOT='F10+4)
256
278
        С
               *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
279.
               S=Z*BOT
27C
               WRITE (5,30)S
298
           30 FOFMAT(' ',22X, 'S='F10.4)
280
               P=2 \cdot *D * TOP + B * (TOP + B \cap T)
204
               *DITCF* IS THE DIST NCE OF THE TOP FROM THE NEUTRAL AXIS
        С
204
               DITCP=D=(B=BOT+D+TOP)/P
2F8
               WRITE(5,40)DITOP
314
           40 FOPMAT(' ',18X, 'DIT(P='F10.4)
330
        С
               *DIBOT* IS THE DISTINCE OF THE BOTTOM FROM THE NEUTRAL AXIS
```



```
DIFOT=D*(B*TOP+D*TOP)/P
1330
2354
               WRITE(5,50)DIBOT
           50 FOFMAT(' ',18X, 'DIBOT='F10.4)
2370
               *GMI* IS THE MOMENT OF INFRIA OF THE X SECTION ABOUT N.A.
138C
        С
               GMI=4 • *D*D*((3 • *B*B+2 • *B*D)*TOP*BOT+(D*D+2 • *B*D)*TOP*TOP)/P
2380
               *TSTHWIS THE STRESS ON TOP DUE TO HOGGING
23FC
        С
23FC
        С
               *TSTSWIS THE STRESS ON TOP DUE TO SAGGING
               *TSBH*IS THE STRESS ON BOT DUE TO HOGGING
23FC
        C
23F C
        C
               *TSBS#IS THE STRESS ON BOT DUE TO SAGGING
MAFC
        C
               *STORIT* IS THE CRITICAL STRESS ON TOP
               *SBCRIT* IS THE CRITICAL STRESS ON BOT
NEFC
        С
13FC
              TSTH=HM*DITOP/GMI+0.15222*HTOP*S*S/(TOP*TOP)
              TSTS=SM*DITOP/GMI+0.152222*HTOP*S*S/(TOP*TOP)
1138
              STCRIT=TOP+TOP+E/(0.30396+S*S*(1.=P0I*P0I))
6474
              WRITE (5,60) TOTH
.464
2400
           60 FORMAT(' ',19X, 'TSTU= 'F10.3)
               WRITE(5,7%)TSTS
16EA
           70 FORMAT( 1, 10X, 'TSTS= 1F10.3)
15.26
1520
               WRITE(5,80)STCRIT
           80 FORMAT(! !, 17X, 'STCPIT='F10+3)
153C
1358
              TSBH=HM*DIROT/GMI+STR38
               TSES=SM*DIROT/GMI+STR38
156C
               SBCRIT=ECT+BOT+E/(0,30396+S+S+(1.=POI+POI))
500
32:08
               WRITE (5,98) TOBH
150C
           90 FORMAT( ', 19X, 'TSBH= 'F10.3)
25F6
               WRITE(5,100)TSBS
1612
          100 FORMAT(! !, 19X, 'TSBS= (F10.3)
               WRITE(5,11:)SBCRIT
1292C
          110 FORMAT(' ',17X, 'SBCFIT='F10.3)
1648
.664
               ENC
"7 [S]
                                                   0678[V] DRA
                                                                     0689[V] D
               0668[V] AL
                                 867 (V) B
     • U
EV18:
                                                   @6A0(V] DST
                                                                     P6A3[V] DSC
    POI
               0690[V] E
                                 400"[S] .R
·P[V]
               2668[V] SM
                                                   0.6C8[V] U
                                                                     002/IST SGRT
     HM
                                 6680 (V)
                                          W
                                                                              STR3B
10 (V)
     Ζ
               0608 (V)
                       HTOP
                                 06D4[V]
                                          HBOT
                                                   06D8(V)
                                                            STRAT
                                                                     26E (V)
4 EVJ
                                                   0700(V)
                                                            AD
                                                                     0714(V)
                                                                              AE
               06F8[V] AB
                                 REFEVI AC
     A
EV3.8.
                                                   RECOLS] GI
                                                                     0256[L]
                                                                              20
     TOP
               071CEVJ BOT
                                 5552 (T)
                                          10
10 [V]
                                                            DITOP
                                                                     0314[L]
                                                                              40
     S
               02981L1 30
                                 8724 [V]
                                          P
                                                   0728(V)
                                                                     0743(V)
                                                                              TSTS
C(V) DIBOT
                                                   073C(V)
                                                           TSTH
               2370 ELJ 50
                                 0730 (V)
                                          GMI
                                                                              TSBH
41VJ STORIT
               2400 ELD 60
                                 9596(L)
                                          72
                                                   053C(L) 80
                                                                     2743(V)
                                                                     8648(L)
                                                                              112
C(V)
                                                   0612(L) 100
     TSBS
               2752 [V] SBCRIT
                                 0500(L] 90.
2(5)
      • V
IXEQ
F
OGRAM LABELS:
                                                                               27C4 .R
2270 *MAIN*
                215A .V
                                208A .COMP
                                                29AC ALOG
                                                                2E68 @I
                                                                               2AB4 EXH
2052 .ZERO
                                                                5C5C •M
                SCEN $6
                                2884 · A
                                                2DAE .MES
288A AINT
                                                                               2D56 .E
                2886 SGRT
                                2CF2 .RARG
                                                204E •5
                                                                2024 $8
2056 .0
                5F5C .0
                                3FR4
 TRY-POINTS:
                                                                               2BBA AI
 27C4 .R
                28.8:4 · A
                                28P6 SORT
                                                29AC ALOG
                                                                2AB4 EXP
```



	TOP=	0.3923			
	80T=	11 • 4748			
	S =	28.5459			
	DITOP=	29.2419			
	DIBOT=	26.3137			
	TSTH=	27045.305			
	TSTS=	21466.824			
	STCRIT=	2/483.910			
	TSBH=	3/000.012			
	TSBS=	24980.129			
	SBCRIT=	29999.953			
ND					
V	IO OPERATING SYSTEM	T VERSION 1 RE	VISION 012 03/04	/74 GENERATED 04/3	30174 1
ÜB	HANDLING CHARGE	\$.35 / JCB	• 35		
30	LINES PRINTED PR2	\$ 1.25 / K LN	• 16		
88	CARDS READ	5 1.50 / K CD	•13		
20	PLOTTER VECTORS	\$.25 / 1 32	• 6 0		
15	MODEL 70 SECONDS	\$25.82 / H-UR	• 1 Ø		
68	MODEL 80 SECONDS	\$12.52 / HOUR	• 8 2		
		TOTAL CHARGE	₹ •74		
EI	R 492 14731 LOGGER	D OUT 25/21/74	22:23. \$ 25.59	LEFT AFTER Ø2 I	CGINS.
	•				



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202

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14	С		*AL* IS THE LENGHT
14			AL=1000.
'C			8=AL/5+75
8	C.		*DRA* IS THE DRAFT
8			DRA=R/3.3
24			D=AL/14.
361	С		*POJ* IS THE POISSON'S RATIO OF THE MATERIAL
10	Ċ		FOR ALLMINIM
a	2		
8	C		FF THE YOUNGIS FOODLUS OF THE MATERIAL
S	(
	C		
	C		DETE IS THE DESIGN GERERS IN TENSION
	C		POINT TO THE REALCH STRESS IN TENSION
	~		
24	L		*DSC* IS THE DESIGN STRESS IN COMPRESSION
. 4	~		USCESVAVV
	C		*HW* IS INF HUGGING RENDING MOMENT
C			$H^{N} = 1 \cdot 3/143 * d * D \times A * A[* A[$
4	C		*5M* IS THE SAGUING BENCING MOMENT
4			SM=5*UKA*AL*AL
8			W=0+30396*(1+=POI)*DSC/E
8			U=SGRT(W)
· 4			2=1 • / U
.0			*HTOP* IS THE HEAD OF WATER ON DECK
.0			HTOP=8+
-8			*HEOT* IS THE HEAD OF WATER ON BOTIOM
8			HBOTEDRA
10			STP3T=4 • 152222*HT0P*Z*Z
4			STP3B=0+152222*HBOT+Z+Z
8			
14			ABEDSCESTROE
.0			AC = (A * (B + D) * AB * D) / (AB * B)
8			AD = HM * (B + D) / (AB * 4 • * - * (D * D + 2 • * B * D))
14	_		$\Delta c = (3 \cdot * b \times b + 2 \cdot * B * D) / D \times b + 2 \cdot * B \times D)$
Ø	C		*IOP* IS THE THICKN SS OF THE TUP PLATING
0	С		*BOI* IS THE THICKNESS OF THE BOTTOM PLATING
.0			TOP=AD/(1 + AC + AE)
8			
4			WRITE(5/10)TOP
. NJ		10	FURMAI('1')Z(X)'I()P='FI(+4)
A		00	WRITE(5)20)501
0	~	20	FURMAT(' ')20X)'BOT#'F10+4)
2	L		*5* IS THE SPACING OF LUNGITUDINAL STIFFENING FEMBLES
0			
0		20	WKITE(DJJV)5
0		310	PURIAIL: () 227) (SHIPIN-4)
C	~		- DITOR: IS I F DIOXAMOF OF THE IOD FOOD THE HEHTON (1970) - PEZITOR: IS I F DIOXAMOF OF THE IOD FOOD THE HEHTON (1970)
4	L		BUTTORE IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
4			DITUPED=(0+D01+D=10+1/F
:5		1.0	NATIE(5)40)DT100 F0004T(1)1 4-2 107700 1440 4)
17	~	40	FURNALL' 'JISAJ'UITUKE'FIM4) FORMALL' 'JISAJ'UITUKE'FIM4)
- 1.	L		ADTOOLA TO THE DISTURCE OF THE DUITOW FROM THE NEULKAL AXIS

PAGE 1

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SETEEFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF		50 C C C C C C C C C C C C C C C C C C C	DIBOT=D*(B*TOF- wRITE(5,50)DIBO FOPMAT('',18X) *GNI+ IS THE MO GNI=4*D*D+((3) *TSTH*IS THE ST *TSTS*IS THE ST *TSBS*IS THE ST *TSBS*IS THE ST *STCRIT* IS THE SUCPIT* IS THE SUCPIT* IS THE SUCPIT* IS THE SUCPIT* IS THE SUCPIT* IS THE SUCPIT* IS THE FORMAT('',19X) WRITE(5,80)STCF FORMAT('',17X) WRITE(5,80)STCF FORMAT('',17X)	D*TOP)/P)T 'DIB*T='F10.4) MENT OF INFRTI *E*B*2.*B*D)*T (RESS ON TOP DU (RESS ON TOP DU (RESS ON BOT	<pre>A OF THE X SEC OP*BOT+(D*D+2*) E TO HOGGING E TO SAGGING E TO HOGGING E TO SAGGING SS ON TOP SS ON BOT OP*S*S/(TOP*TO OP*S*S/(TOP*TO *(1**POI*POI))</pre>	TION ABOUT N. *B*C)*TCP*TOF P) P)	• A • >) / P
「たえここ」	800800620	90 100	TSBN=HC*DIHOT/C TSBS=SN*DIHOT/C SBCRIT=BGT*BGT WRITE(5,90)TSEF FORMAT('',19X, WRITE(5,100)TSE FORMAT('',19X, WRITE(5,114)SE(HT+STR38 HT+STR38 E/(2+30396*S*S TSBH=!F10+3) S TSBS=!F10+3) CRIT	*(1POI*POI))		
	8 8 8 8 8 8 8 8 8 8 8 8 8 8	ILU POI HM Z A TOP S DIBOT STCRIT TSBS •V	FORMAT(' ',17X, END 0668[V] AL 0684[V] E 0684[V] SM 0600[V] HTOP 0683[V] AB 0720[V] BOT 0298[L] 30 0370[L] 50 0400[L] 60 0754[V] SBCRIT	<pre>% 'SBCRIT='F10+3 %670(v] B @@@@(S] •R @6BR(v] W @6D4(v] HBOT @6EC(v] AC @22*(L] 1@ @72P(v] P @734(v] GMI @50A(L] 7@ @50C(L] 9@ </pre>) 0678(V) DRA 069C(V) DST 06C4(V) U 06D8(V) STR 0700(V) AD 0000(S) @I 072C(V) DIT 0740(V) TST 053C(L) 80 0612(L) 100	0680[V] 0644[V] 0000[S] 3T 26E2[V] 0714[V] 0256[L] 0P 0314[L] H 0744[V] 074C[V] 0648[L]	D DSC SORT STR3B AE 20 40 TSTS TSPH 112
	RAN 70 56 BE 54	<pre>* LABELS *MAIN* •ZER0 AINT •0</pre>	2E5E •V 2C84 \$6 288A SGRT 2E30 •U	2CPE •COMP 2808 •A 2CF6 •RAFG 3F88	2980 ALOG 2082 •MES 2052 •5	2E6C WI 2C30 W 2D28 \$8	2708 •R 2488 EXP 2054 •ERC
	1 Y - F	POINTS: •R	2808 · A	288A SQRT	2980 ALOG	2AB8 EXP	28BE AINT

PAGE 2

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TOP=	3 • 1 1 2 3
BOT=	3+8359
S=	134.5649
DITOP=	38.4762
DIBOT=	32.9524
TSTH=	25792.578
TSTS=	19427.625
STCRIT=	19622+289
TSBH=	29999.980
TSBS=	24548.845
SRCRIT=	30000.031

END

F VID OPERATING SYSTEM VERSION 1 REVISION 312 03/04/74 GENERATED 04/30/74 1

JUB	HANDLING CHARGE	• • 35	/ JOB		• 35
36	LINES PRINTED PR2	\$ 1.25	/ Y LN		•15
88	CARDS READ	\$ 1.50	/ K CD		•13
RØ	PLOTTER VECTORS	\$.25	1 1002		.02
55	MODEL 70 SECONDS	\$25.22	/ HOUR		•15
180	MODEL NØ SECONDS	\$12.50	/ HEUR		. 82
		TOTAL	CHAPGE	\$	•79

EIR 490 14731 LOGGED OUT 25/01/74 22:26. \$ 24.80 LEFT AFTER 03 LOGINS.



STEEL

POI = 0.3 $E = 30*10^6$ AL = 500B = AL/8 = 62.5DRA = B/3 = 20.833D = AL/9 = 55.556 $HM = 1.37143*B*DRA*AL^2 = 44642.187*10^4$ $SM = B*DRA*AL^2 = 32551.562*10^4$ $W = 0.30396*(1-POI^2)*DSC/E = 276.6*10^{-6}$ Z = 60.129HTOP = 8HBOT = 20.833STR3T = $0.152222*HTOP*Z^2 = 4402.865$ note that this value should be corrected for the Z approximation and actually is slightly smaller $STR3B = 0.152222*HBOT*Z^2 = 11465.61$

We see from the tertiary stresses obtained that we end up with the following diagram of stress distributions:





From the diagram we see that theneutral axis will end up closer to the bottom and so we must consider BOT > TOP in the formulas.

The same type of diagram will be obtained for 1000'aluminum case since the tertiary stresses obtained in such case are

STR3T = 1498.73 STR3B = 9873.078

For the 1000' steel case the same type of diagram will occur due to the tertiary stresses being

STR3T = 4402.86

STR3B = 29004.

Besides this situation requiring us also to consider the neutral axis closer to the bottom, still another problem arises since STR3B is larger than DST=25000. This case is solved by properly correcting the inaccuracy that was introduced by the Z approximation as exemplified next.

· ·

Now let's derive the formulas capable of handling the 500' steel case, the 1000' steel case and the 1000' aluminum case. We must consider BOT > TOP and DITOP > DIBOT

DITOP = D*(B+D)*BOT/P

DIBOT = D*(B*TOP+D*BOT)/P

$$I = 4*D^2*BOT*((3*B^2+2*B*D)*TOP+(D^2+2*B*D)*BOT)/P$$

where

P = 2*D*BOT+B*(TOP+BOT)

Starting again with the equation

STH*DIBOT = SBH*DITOP

and making

A = DST - STR 3T

AB = DSC-STR3B

we obtain

```
A*DIBOT = AB*DITOP
```

Knowing that now the top is the thinner plating we anticipate

S = Z*TOP

and may write

```
STR3T = 0.152222*HTOP*Z^2
```

```
STR3B = 0.152222*HBOT*Z^2
```

where the Z value in STR3B should be $\frac{S}{BOT}$ which has a smaller

value than Z.

We then obtain:

A*D*(B*TOP+D*BOT)/P = AB*D*(B+D)*BOT/P



Simplifying and making

AC = (AB*(B+D)-A*D)/(A*B)

we obtain

TOP = AC*BOT

Making now the top to be stressed the most in tension we have.

STH = HM*DITOP/I = A

Replacing DITOP and I by their equations we have

$$A = \frac{HM*D*(B+D)*BOT}{4*D^2*BOT*((3*B^b+2*B*D)*TOP+(D^2+2*B*D)*BOT)}$$

and obtain

$$BOT = \frac{HM*(B+D)}{A*4*D*(D^2+2*B*D)} - \frac{3*B^2+2*B*D}{D^2+2*B*D}*TOF$$

Making

$$AD = HM*(B+D)/(A*4*D*(D^{2}+2*B*D))$$
$$AE = (3*B^{2}+2*B*D)/(D^{2}+2*B*D)$$

the formulas become

BOT = AD - AE * TOP

and substituting

TOP = AC*BOT

we finally have

$$BOT = \frac{AD}{1 + AC^*AE}$$

The results obtained for the examples chosen are presented next:

ę.



```
0 24
               ALA IS THE LENGERT
        C
1774
               AL =520.
1 3 C
               -=AL/8.
               *LPI* IS THE DRAFT
118
        C
218
               0-1=8/3.
1.54
               0=11/9.
               *FUL* IN THE DOISSONING MATTO OF THE MATERIAL
1 36
        C
1:31
               FLH STEFL
        C
34
               ₽(T=2+3)
               SEN IS THE YOUNGES MUNELUS OF THE CATERIAL
1:33
        C
               FLA STELL
· 3×
        C
:138
               1=31 ++1. +++6
               * UST + 15 THE DESIGE STRESS IN TENSION
4 C
        С
~+C
               151=25460.
               * SC* I' THE RESIGN STRESS IN COMPRESSION
54
        ŗ,
               - SC=31717.
 54
SC
        C
               *" IS THE HOGETIG PETUTNE MOMERT
 SC.
               41 = 1 + 37142 + B * OR / = AL + AL
               ABON IS THE BASELAS SERVING MORENT
 74
        C
 74
               S' = i + DE i = AL + AL
32.
               ,= 1+3035 6+ (1++ 05 J*80 J)* 090/E
 AX
               UFS(KT(')
12:4
               7=1./11
. C ¢
               .HICP. IS THE HEAD OF VATER ON DEC-
00
               HI1F=X.
               FROT IS THE HEAD OF MATER ON BOTTOM
 30
28
               HH ITELSA
.)'
               SINGT= +152220++10F+2+7
. = 4
               STR35= +152222+-- JT+Z+Z
158
               A=UST+SIP31
124
               AB=DSC+STR2B
               \Delta C = (AB * (B + C) + A * C) / (A * C)
110
142
               \ \ = + \( * ( - + \) / ( \ * \ * + * \ * ( * ( - * ( + 2 * * B * \ ) )
               AS=(3·*-*P+2·+p*()/(1+L+2·*S*n)
194
               + 10F + 13 THE THICKNESS OF THE TOP FLATING
182
        С
               *MOT + IS THE THICKNESS OF THE ROTTOM PLATING
1-12
        C
1:27
               ROT=AD/(1 + AC + AF)
               TOP = AC + PriT
1F3
>24
               NHITE(5:10)TOB
150
            10 E0WNAT( '1', 20x, 'TOP='E10.4)
23A
               XMITE(5:22)20T
            2- =08MAT(1 1,22X,1901=1610.4)
256
178
               .S. IS THE SPACING OF LUNGITUDINAL STIFFENING NEMBERS
        С
               S=Z*TOP
278
27°
               RRITE(SFEE)S
>38
            32 FOR AT( 1,228, 15=1F1 +++)
:30
               P=2++D++DT+B+(TPP+PD*)
               +UITLE* IS THE CISTANCE OF THE TOP FROM THE NELTRAL AXIS
204
        С
104
               UITCH=N*(P*BOT+"*BOT)/P
2F8
               ARITE(E:47)DITCH
            40 FORMATE! 1,18V, 10 ITOF= 1F10.4)
114
               PINETS IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXTS
130
        С
```
```
11001=" * ( 2 * 100+ " «ROT ) /P
330
1254
              RITE (S, SE) FIANT
          378
              THE IS THE MOLENT OF INFETIA OF THE Y SERTION ABOUT
38C
                                                                         + A +
       C
             RC
              . ICILINTS THE GTORSE I TOP DUE TO HOGGING
SEC
       C
              TETSATS THE GT - I SO TH TOP DUE TO MAGSING
RF C
       C
              TENANIS THE STRUSS OF BOT DUE TO ROGGING
:=C
       С
              VIS-SATE THE GTHESS THEOT DUE TO CAGGING
: = C
       C,
              +STORITE IS THE CRITICAL STRESS ON TOP
SEC
       C
:=0
       C
              ASECRITY IS THE CRITICAL STRESS ON BOT
-FC
             ISTHER + PITUPIC I+STERT
             T TEAS' * ITCPyst THETMAT
-12
             <iCFIT=icP+TDo+L/(...B+3B6*S*S*(1+~PDI*PDI))</pre>
.24
              FIT ( SEC) TSTL
- 54
          N= F PUNT(! 1,194, TSTUE, F13.3)
42.
             VITE (NOT?)ISTS
-94
          7' F -MAT(' ',19V, 'TSTS=++10.3)
- 36
              WITE (NAPP) STOPIT
- ).
          x> r(>MLT(! !,17x, !STCPJ+=!F1++3)
LEC
328
              THEFER ALISELAND 1+0.1:55554 HBUI+2*CV(BUI*BCI)
              10-9=5 % DIRCT/GUI+0.1428222× HBOT*8*8/(ROT*BOT)
-44
             S'CAIT= (T+LOT+//L .3.3#6*9*S*(1.+**0I*POI))
720
· C 6
             · NITE (SIGNITSON
          9r FINDAT(' ',19v, 'TSHA=, F13.3)
·DC
SEA
             , MITE(S, 170) TOPE
12
         12- FCARAT(1 1,19V, 17SPS=, F10.3)
              ** ITE(5+11")SaCHTT
:20
             ac+rAT(1.1,17v,198(RIr=1F10+3)
548
         117
              - 111
- 54
 [S]
              HAREVI AL
                                672[V] A
                                                E678EVI DRA
                                                                  0631 [V] P
     • [ ]
                                                 (6. JUJ DST
                                                                  REAS (V)
                                                                          720
 [V]
     POT
              769. [V] E
                               1069 [e] •R
              · HEREVI SY
                                                                  WE av [S-
                                                 0603[V] U
                                                                          5021
 [V]
     HV
                               1680 (V)
                                        :1
 EVJ Z.
              ADJEVI HTOP
                               SFALVI HEAT
                                                C653(V] STRAT
                                                                  36EV [V- STR3B
 EV3
              FILVI AR
                               : 6Er (1.]
                                                 G7: (V) AD
                                                                  2714EV1
                                                                          \Lambda =
     1
                                        AC
                                                                          21
 (V)
    Ent
              2710[V] TOP
                                                 POPOISI OI
                                                                  8250 [L-
                               125-113
                                       10
                                                                          4 .
ICV3
     S
              298[L] 31
                               :724[1]
                                        P
                                                 M728(V) DITUP
                                                                  7314 [L"
                      32
                                                                  274. EV:
IEV]
    DIBOT
               370 (L)
                               2730 CVI GMI
                                                 173C(V)
                                                         TSTH
                                                                          TATS
                                                                  0748EV:
                                                                          TSAH
              187[L] 6.
IVJ STOFIT
                               2482 E1 3 78
                                                 (14EC(L) 80
                                                                  2643[L- 117
ICV] TSAS
             27-27 VI SACRIT
                               1560 C 1 90
                                                 612(L) 100
[[S]
     • V
:=0
            1
IGRAM LAPELS:
                                                                            2704 .R
 270 + 4 AIX+
              ZEEK . V
                              2014 .COMP
                                             29AC ALOG
                                                            SEES WI
                              2×14 • 1
                                             2F2E .MES
                                                            H. JA35
                                                                            PAB4 Ext
 002 ·7580
               673 $6
 TVIA AES
               2416 SLAT
                              2072 .AKG
                                             3DUS
                                                  • 5
                                                            SAB4 AEXP
                                                                            5000 · E1
                                             4604
               2016 .1.
 JA4 50
                              SEAT .II
RY-POINTS:
                                                                           2AB4 EX.
 764 .2
               EX:4 .1
                              2886 Soft
                                             29AC ALOG
                                                            2AR4 AEXP
```

PAGE

2

102=	. 271 '
E(1)] =	1.4575
S=	25.3 41
01100=	29.2413
0140T=	26.3134
TST :=	2,999. 0
78TS=	19421.010
STCHIT=	29399. 14
イムトーー	26477.141
. 15±5≠	21132.248
SISCETT=	45627.762

1.5.4

- VIO OPERATION SYSTEM VERGIE - 1 MEVISION -12 03/04/74 GENERATED - 5/82/74

 GF
 HANDLING (HUNCH HUS 1.25 / U0)
 .31

 337
 LINUS POTULA HUS 1.25 / KL
 .16

 48
 GARDS FERL
 51.50 / KL
 .16

 48
 GARDS FERL
 51.50 / KL
 .17

 49
 PLOTIEF FULLES
 5.05 / 10 0
 .00

 21
 MODEL 7
 510 5 425.00 / HOUS
 .1

 40
 HOUEL 8
 510 CS
 \$12.50 / HOUS
 .1

 40
 HOUEL 8
 510 CS
 \$12.50 / HOUS
 .1

FEIR 40 14731 LEGGED OUT 29/20/75 22:41. 5 17.92 LEFT AFTER 12 LOGINS.

We could have obtained TSBH = 30000 by correcting the approximation used Z = S/BOT as is done for the 1000' steel case that follows next.

In this case we already anticipate the use of a Z1 value as done in the previous section and according to the output obtained we will then obtain the correct result.

```
084
              *AL* IS THE LENGHT
       С
2:4
              AL=1111 ....
. . C
              8=AL/5.75
              SDRAW IS T & DRAFT
:18
       С
218
              D-A=R/3.3
224
              1=41/14.
       C
              +FOI* IS THE POISSON IS RATIO OF THE MATERIAL
139
              SUP STELL
. 3:1
       С
3.1
              POT=0.3
              "E* IS THE YOUNG'S MODULUS OF THE MATERIAL
:38
       i
133
       C
              FAR STFEL
              #=30 . ×10 . × . 6
              STA IS T E DESIGN STRESS IN TENSION
: 40
       -
40
              057=254.21.
              VISCA IS THE UNSIDE STRESS IN COMPRESSION
154
. 6 6
              050=31227+
- 20
             AHME IS THE HOSSING RENDING 10MENT
              - =: . 77143 - (*) - A * A1. AL
14
              ---- S TH RACGING RENDING MOMENT
14
              BI = P + NAHAI *AL
123
              .=:+3 -**(*(1.+***]****[)*OSC/E
4 3
              ·만부분약자(**)
7 = 2
              2=3 + / 11
0.5
              * TOP A IS THE HEAD OF WATER ON DECK
20
              HTCP=S+
5.8
              * HEAD OF WATER ON BOTTOM
is
              - nT=Dech
              3143T= +1522224HT02*7*Z
12.4
              21=35+
              G1+3P= +152222*H801#Z1*Z1
E. C.
              4= 187-STR3T
1 . . 1
1.0
              A =DRC+STR30
130
              ここ=(ムッカ(マナリ)=A*3)/(A*3)
1 - 1
              12=+1+*(2+0)/(1+4+***(0*0+2+*3+0))
1 -1 -
              1F=(3+****6+8+*****)/(0*0+2+**8*0)
121
              *TUP IS THE THICKN AS OF THE TOP PLATING
       5
              * CUT+ IS T F THICKNESS OF THE BOTTOM PLATING
123
       Ĵ
• 2 2
              307=AC/(1++AC+AE)
2:17
              TERELOND T
E.C.
              V-ITE(5/17)TOP
          10 - - CHTAT(111, P2X, TTOP=1413+4)
222
242
              INTERPERSON
- - 1
          20 FINTAT(' ', P)X, '9CT='417+4)
27%
              13. IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
       Ê
273
              ウェブアエクト
              "44; TEL 136, 5
224
          30 FUTMIT(' ', <24, 'S='F10.4)
21.10
11 -
             P=/+*i.***CT+R*(TOP+RDT)
200
              HOITCRH IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
       C
200
              DITOP=D*(A+ECT+D+ACT)/P
34 6
              SETTERS PARNOITOP
310
          48 FORMATI' ',1-Y, 'DI--P='F1/+4)
```



2070 2052 2052	*MAI* * •ZF#C AINT \$8	2EF2 •V 2D48 ±6 28CE SGRT 20EE •C	5505 5710 5715	• COMP • A • RARG • U	29C4 ALOG 2E46 • MES 2DE6 • 5 401C	2500 2004 2400	ØI •W AEXP	27DC 2ACC 2DEE
	IABLES							
YER	L							
12 [1] 2	110	CLACIST V	7763	LVJ SPCK	LI ESEALEJ	90	NOTYPET	T K KY
C EV:	1514	CZERTA SIGRIT	1483	LJ 61	VARELL)	90	24F4 LLJ	1 910
	4VI	7744(V) 0100T	/37:	LJ 50	0/45 (V)	30	9754 LVJ	00
	60	V/3×[V] S	6578	(L) 30	0730(V)	P	2744 [V]	DITOP
EV3	4 F.	\$730 (V] POT	0734	SVI TOP	055% [L]	10	000~[S]	GI
4 [V]	STRAF	VEFREVI A	ØKEC	CVJ AR	0700 [V]	AC	07145V3	AD
4 CV]	Z	(6051V) HTOP	RAET	IV] HEOT	06E45V1	STRGT	Ø6EC(V)	Z1
8[V]	F1.	(6CM IV J SM	VAC4	EVJ W	06D0(V)	U	000-[S]	SGRT
EV3	FOI	· 698[V] E	6000	15J .R	Ø6A8[V]	DST	068 (V)	DSC
"[5]	• U	RETORVI AL	PATU	CVJ B	2680 [V]	DRA	0683[V]	D
6.6C		10						
450	110	FORMAT(1,17X)	ISUCS	IT='F12'	3)			
434		VELTE(5,11)SR(RIT					
614	184	: GRMAT(1 1, 10X	ITSUL	= F10.3)				
SFF	1.41	26 TTE (5+19) TSE	15	16.51				
SE4	50	FORMAT(1,150	ITCR	= (E10.3)				
5×2 519		SHCRII=BOI-HOT-	• <u>E / (~</u> .	30396*5*	5*(1POI*D	(1)		
546			(N) (+) +	125555×H	30T*S*S/(8h	*BOT)		
m 1 (7		TSHHEHINFLENT/	10 - 1	TRESSAN	**************************************	T¥BUT)		
254	60	FCPMAT(ISTC.	IT= F12.	?) 			
109		AFTERS, SUBTCE	- J T					
-15	7.3	FORMATIC LITY	TRTO	=!F10.31				
- 6.2		R . TE (5,7) TSTS	5					
170	60	FERMATIC 1, 19X1	1797	= + F 10.3)				
1.65		WEITERS, ANDERLY	4					
1.75		CTOPITET PUT/A	-E/(.	3/396+8*3	q+109++1)+8	~I))		
418		TSTSECK+DITCH/	ST T + NT	PAT				
4 14		TSTHERMAPTTIC/	MT+3-	स्वा .				
1:4	-	-SHEPTT- T. THE		TOAL STRA	SS ON BOT	•		
4.1.	-	ASTONT + TO THE		TCAL STR-	ISS ON TOP	× 4		
1. 1. 1.	-		2223	C. SOT D	IF TO SAGGE	NG NG		
4. 4 · · ·	C		HESS.	CA BOT D	15 TO HOGE	· · · ·		
1 5 70	C C		RESS	ON TOP D	TO POGGI	NG ST		
- 10	6	TOTI TO T C OT	45 - E a , i 4	P. ARAN) ×I	NP*301+(D*	n+2 • * B * D)	* ROT*BOT)/P
	C	AND A TS THE AP	Sult of the	OF INFETI	A OF THE K	SECTION	ABOUT N.	Δ.
379	50	FCC"/T(' ',18K)	I D T R	T= 'F1"+4)				
020		HETTELS, SUITES	T.					
334		JPCT=DH(P+TCP+	-00-	178				
333	С	ACTRONA IS THE	DIGT.	NCE OF TH	E BOTTOM F	ROM THE N	FUTRAL A	XIS

TRY-POINTS:

220

PAGE

2

• E .



TOP=	3.5788
BCT=	3.6860
S =	215+1818
DITCP=	36-1863
DIRCT=	35+3423
TSTH=	21628.400
TSTS=	1 421.525
STCR17=	21909.984
▼S⊢H≖	47512.793
TSES=	4-149-322
SECRIT=	31224.254

EI D

OF VIL OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/02/74

5.6	ANCLINE CHAILTE	• 35	/ JC3	• 35
131	LINES FRINTED FRE	+ 1.25	/ K EN	• 1 6
69	CARDE READ	\$ 1.52	1 < 05	• 1 3
V.C.	LOTTER VECTORS	· .25	1 1020	- 650
15	CDEL 7% SECON S	2.5.17	V WOUD	- 1 0
69	CDEL HE SECON S	\$12.57	1 2010	- 1 ·
				• ¥ Z
		TOTAL	CHARGE	« •74

PEIR 497 14731 LOUGED OUT 29/29/75 02:48. \$ 16.44 LEFT AFTER 14 LOGINS



8764	С		ALT IS THE LENGAT
6 4.4			$\nabla r = 1 \otimes \Delta r$
D.V.C	_		BEAL/5./5
0.18	С		*DRA* IS THE DRAFT
0.18			
0024			$D = \ell L / 1 4$.
013K)	C		*POINT'S THE POISSON'S MATIO OF THE MATERIAL
0.35	C		FOR STEFL
0.30			PUI=104
0.38	С		*E* IS THE YOUNG'S HOBULUS OF THE FATERIAL
0°38	С		FOR STRUC
038			E=3(++1, +++6
0°4C	C		*DST TO THE DESTRI STRESS IN TENSION
074C			PST=250 00.
0"54	Ç		* SCA LY THE DESIG STRESS IN COMPRESSION
8:54			05(=30000.
835C	ſ		NO # IS THE HOCST A BENUTNA MODENT
2.2C			$H^{P} = 1 \cdot 3^{2} + 3 \times t < 5 R \cdot (A + A)$
2174	ſ		ADIA THE BAGILIE AND DING MOWENT
0:74	-		Su = Experiment + 2
8816			
2748			
7-124			
3.00			
3200			NUMBER OF THE HEAD DE WATER UN DEUX
1000			
3708			ACTED DE LAER HEND JE HATER DU FOTTOM
1 00			
1 15 1			
1 20			
1 EC			S10007 110222*00JTx41+41
11214			AFPSIMOLOGY
1146			A D = D S C + C T A B B
110			$\Delta U = (\Delta d \star (1 + 1)) + \Lambda \star (1 + 1) / (\Delta + 1)$
1156			$\Delta U = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) \left(\frac{1}{2} + 1$
190			$AE = (3 \cdot * * (+2 \cdot * B \times D)) / () * D + 2 \cdot * B \times D)$
128	C		+ LOP * IN THE THICKNEND OF THE TOP PLATING
1E8	С		* OT & IS THE THICKNESS OF THE ROTTOM PLATING
1E×			BUT = AD/(1 + AC + AE)
580			TOP=AC*ROT .
52C			WRITE(5,1())0p
828		1	FORMAT(111,20v, TOP=1F10.4)
242			WRITE(5,22)FOT
25E		21	FORFAT(' ',2, Y, 100T='F1).4)
278	C		*5* IS THE SPACE G OF LUNGITUDINAL STIFFENING MEMBERS
278			S=Z*TCP
284			WRITE (S. DT)S
SAG		30	FURMAT(' ',22x, 'S='F10.4)
58.8			P=2.*D*HOT+H*(T0P+00T)
⊃DC	С		. UITOPA IS THE DISTANCE OF THE TOP FROM THE NELTON AND
PDC			DITCH=D*(F+POT+D+POT)/F
300			WHITE (5,42) [1+09
31C		40	FORMATEL 1, 12Y, INTOP, IFIC. 41
			1

PLGE

STRENGHT OF SHIPS ON THE FITRAL AXIS LOCATION

0338 0335754 04004004 04004004 04004004 044004 044004 044004 04400 044004 00000 0000 00000 00000 00000 00000 0000		*DIBOT* IS THE DIBOT=P*(~~100+ RITE(5,6))PT*O FOFMAT('',184, *GMJ* JN THE MO GMT=4**5*15 THE MO GMT=4**5*15 THE CT *ISTS*15 THE THE CT *ISTS*15 THE THE CT *ISTS*15 THE THE CT *ISTS*15 THE THE THE CT	DISTARCE OF THE PROTINE I ROTEFFIC.41 PROTEFFIC.41 PROTEFFIC.41 PROTEFFIC.41 PROTEFFIC.41 PROTEFFIC.41 PROTEFFIC.41 PROTEFROT PROTEFFIC.30 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.31 PROTEFFIC.33 PROTEFIC.33 PROTEFIC.33 PROTEFIC.33 PROTEFIC.33 PROTEFFIC.33 PROTEFFIC.	30T+)M FR UF 1HE X *F0T+()*T TC F0GGIN TC F0GGIN TC F0GGIN TC F0GGIN TO GAGGIN TO GAGGIN TO GAGGIN TO GAGGIN TO F0GGIN (*S*CZ(GOT 1.+F0[*P(20M THE SECTION ()+2.************************************	FUTRAL 4 A8Ouf * *PO1×8 1	· A · ()/P
0450 0460 0460 0460 0400 8200 8200 5200 5200 5200 5200 5200 52	11 •U POI H* Z STR33 AF 27 47 TSIS TSOH 113 U MATMA •ZEPO ATMT	<pre>PATE(5, 11, 130) FORMAT(' ', 17%, END %67, EVD AL %692EVD F %602EVD F %602EVD HTCF %673, EVD MTCF %73, EVD MTCF %73%EVD S %744EVD DIRCT %764EVD STCFT %764EVD TSBS %6%EED * 204% %5 28CF S'PT</pre>	<pre>>11 >2022 *COMP 2* 2022 *COMP 2* 2* 2* 2* 2* 2* 2* 2* 2* 2*</pre>	C6 (EV) × 6 (V) × 6 (V) × 6 (V) × 6 (V) (7 (V) (2 (V) (2 (V) V7 (V) V) V V V V V V V V V V V V V	DRA UST U SIF3T AC 12 P GMI 70 90 2CC4 2ACC	1	D SILPT Z1 AD BI DITUP TSTH R1 121 27UC -5 PACC E2 20EE -
2C52 2DBC ITRY-F 27DC	AINI \$8 °UIN⊤S: •R	280E SUPT 20EE -0 2810 -4	2-2- 20RT 22 28C+ •0 42	1C -1C	2400	AEXP	PACC EX

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PAGE

ē



2.26
4.4217
213.62-3
38.9611
32.4574
26.000
14421 - 23
29294.5%
34131 - 55
24427.15P
51270.154

1 END

IJCE VIO OPERATING SYSTEM VERGING 1 PRVISION 012 03/04/74 GENERATED 5/ 2/74

JOB HANDLI'S CHARGE 5 . - 25 / Ja-• २८ 131 LINES POINTER PD1 5 1.05 / K ... • 16 - 1.54 / 4 Cm 89 CARDS FEAD .12 CO PLOTIF VECTOS CON / 14 . 20 MODEL 7 SECTIOS SPENAL / P. A. • 1 . AD MODEL & SECONDS 112.47 / HOUSE • • • FOTAL CONVERS • 7 7

ERREIR 491 14/31 LUGUED (UT 73/ 9/75 2:5 . # 15.66 LEFT AFTER - 15 LOUIS

Now we see that with an assumed value Z1 = 35 we obtain S = 215.1808

BOT = 3.686 so Z1 actual = 58.38

TSBH = 47512.793 (too high)

TSBS also too high

The Z1 actual value obtained suggests that we should have assumed an higher Z1 value and with an assumed value Z1 = 40we then obtain

S = 203.626 BOT = 4.428 so Z1 actual = 45.98 TSBH = 34131.855 (too high) TSBS also too high

This suggests an assumed Z1 value higher than 40 but now we may interpolate with the two results already obtained and determine the Z1 value that will bring TSBH = DSC = 30000 psi and done properly this new Z1 assumed will end up being Z1 actual. From interpolation we obtain

 $\mathbf{Z1} = 40 + \frac{(40-35)*(34131.855-30000)}{(47512.793-34131.855)} = 41.544$

and now assume this value obtaining the following result:

1

.



```
0.04
                *AL* IS THE LEFT T
         C
10 124
                AL=1. " .
NEC
                R=A1 /5.75
0118
                * DEAX T' THE MUMET
         С
0-15
                DFA=5/3+3
V: 24
                D=AL/14+
                *POIN I' THE DOISSON'S PATIO OF THE MATERIAL
V. 31
         C
                FUR STEEL
0.30
         0
0"30
                PUI=(+4
0.30
                * +* IS THE YOURGIS MUNULUS OF THE PATERIAL
         \sim
0030
                LUP CTELL
0032
                L=3( +*1+++E
13 4C
                *UST * I' THE FERIGE STREESS IN TENSION
         2
61-4C
                115T=21
                          . .
6 44
                SC+ I' THE DENIGH SHEESS IN COMPLESSION
         \sim
6 54
                (\gamma^{(1)})_{i=1}^{(1)} \in [\gamma^{(1)}]_{i=1}^{(1)} = [\gamma^{(1)}]_{i=1}^{(1)}
                STILL TO THE HEADTHS TELDING MEMENT
0.50
         0
M 50
                H"=1.37145+F*PE1MAL*1
8.74
                WSH IS THE SUGAL TO PENLING MONENT
         ~
U'74
                SPEEDE PILAN
6 83
                1=1.020306>(1.0P01*P01)*USC/E
6
  2:4
                1.=S( UT( )
12 64
                1=1.11
0 00
                THTOP IS THE HEND OF VATER ON DECV
0 C1
                H10F=2.
0 50
                WHEGEN IS THE FRADILE MATER ON BONTOM
0.CX
                HUR TOKE
 D.C.
W
                S1831=2+152722++105*2.7
6 24
                21=42++5+*4131+*5521968-+928
0 FS
                STP3 =: +152220+1401424+21
0120
                _=0ST+4163T
0.18
                AF=USC+STREE
0124
                \Lambda C = (\Delta P_{2} (F + P) - \Lambda + P) / (A + P_{1})
0150
                AD=トット( +C)/(メキャッキにキ(コメトナち・米B*D))
0 · 1×
                ATCEN TO THE THICKLESS OF THE TOP FLATING
0.F4
         С
611F4
                WELTY IN THE THICK FOR UP THE ROTTOM PLATING
         C
61 + F 4
                PUT=40/(1 + 40*AF)
102%C
                T0P=AC**0T
0218
                4917F(5+14)70P
0234
            10 FORMAT(111,200,170P=101.4)
1774E
                -RITE(5+20)601
            20 FURMAT( 1,2/4, 1397=1=1-4)
VEEA
                .S. IS THE SPACE & OF LEGGITUDINAL STIFFERING NEMBERS
ション4
         C
12284
                S=ZITOP
1290
                WRITE (F, SO)S
            30 FURMAT( 1, 224, 15=1F1/-4)
JUSE
ARC4
                P=2.**) ** OT+E* (TCO+POT)
0258
                PITODE IS THE LISTAL OF THE TOP FROM THE NELTRAL AXIS
         C
JTES
                DITORED (R+HOT+'+HOT)/P
338C
                →RITE(5,4/) DITOO
33528
            40 FORMAT(' ', 189, 'DITOP='F10.4)
```

PAGE



	STREACHT	OF SHIPSON THE	EUTRAL AKI	S LOCATION			PAGE	2
0344	С	DIFATA IS THE !	1STARCE OF	THE BOITCM	ЕРОМ ТЫС	NELLEDAL		
0744		OILOTER* (R*TOD+	WRET JA	Professional Chinese	FICUS EMP	PEUIRAL	ex 13	
026×		- * HITE (* * 5 1) LINDI	·					
0384	50	CELEMATEL 1,188,	TENT- 1F10	• 4)				
NEAD	C	* G. I. I.S. INE NOV	HAT OF INE	PTIA OF THE	X SECTION	ABOUT	• ^ •	
0020		$G^{h} I = 4 \cdot x^{1/2} f = ((-, -)$	***+2.*11+0)+10P*POT+()	*0+2 . *B*r	1+107×13	TIZP	
6110	<u>_</u>	+ISTHATS THE STR	ISE OF TOP	DUE TO LOGG	ING			
8419	<u> </u>	+ ISTS+IS THE OTE	rec (ICP	DUE TO CAGS	TNG			
0410	C.	* SREATS THE OT	ESS (BOT	DUE TH LOGG	ING			
6 14	•	* TENSOIS THE OTE	FUS CH HUI	DUE TO CAGS	ING			
Ve IV	Ç	*PICPIT IS THE	CRITICAL S	TRESS ON TOP				
0411	<u> </u>	*2.CPTI & IS INC	CRITICAL S	TREAS ON BOT				
Viall		TSIL=H PDITUP/G	キャナトゥギ					
V . P.4			THOTHOT					
6174			//(.2.346*	$S = S = (1 \bullet f \cap I \star)$	POI))			
6 64	<i>,</i>							
W. AF	h?	RTTLE 7 TEAN	1514=+F14.	(B.)				
SACA.	7	- VOLITIDIZA) (STS - NORMATA	1010 64					
OLE4	/ '		1.216=+FT%+	2)				
aner	Sr.	- M - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	CTCDTa-Int					
0º 10		TORE HAVE THE THE	399 FUTE1F1	Vezi) Vezi				
VERX			140 1606055	****************	ЭТ*Р(Т) ЭТ:Сеть			
2594		SPERITEROIS FOR WE	110 - 1860 - 6		'E*ECJ)			
8= F.4		ANTIF (CARATA	/ \ \ • \ \ d \ b +	2#2*(T•m, 7T*;	·OT))			
USE.	Ģ	FURNATI 1.19.1	TSCHELFIG.	2)				
0+ 2 h	-	WRITE (CHIPE) TOPS		21				
05.26	1 (56	FURMAT(1 1,14V.1	1 SE 9 = 1 E 1 2 .	21				
31,40	*	WRITE (S, 117) SHC4	Ţ]					
0450	110	FOR+ 4T(1 1,17V,1		(· 3)				
3178		FND						
0. [2]	• EF	DETCEVI AL	1684 [1] R	(6.C(V)	DRA	2594 FV-	D	
Эц [Л]	POI	MGAG [V] E	*1/00 (=) .P	PAR4EV]	051	CAPCEV-	DSC.	
C+ [V]	big Bal	CECCIVI SM	SPORVI W	CELC [V]	Ŭ	MONTO IS-	SOST	
E [V]	Z	WAELIVI STOP	AFREVI HPI	T PARALY	STEBT	RAFETVA	71	
SULV]	ST938	07101VJ 4	714 [V] AB	6718CV]	AC	@72CTV	1	
4. (V] 4. [V]	AF	4745 [V] PG]	740 [V] 10	FS341E3	16	0000CCS-	0I	
	20	ezeriyi s	5VC[1] 35	\$7=4[V]	Р	0758 [V-	DITOP	
Ir LL, J Z. E. D	4 · //	WZECLVI DIROT	38111 59	(767 [V]	GMI	0760 EV-	TSTE	
	Tent	W74[V] STCRIT	494 [1] 62	P4CALLI	70	0540 (L)	2.12	
	1538	CZZETVI TSUS	782[V] SB(RIT PSFOLL	97	0626[L-	170	
N CLI	41.2	Set for (2) • A						
15.12	t							
						•		
PADES	M LAPFLA							
2176	*MVIV*	2F04 • 7 - 21	3A .CUMP	290C ALOG	2F18	@ I	27F4	. 9
SEDS	·ZEPO	21 60 36 73	· 34 • A	2F5F .MES	schu	• 14	PAE4	81
CL6A	AINT	SELE DUBL SI	A2 . pA*G	20FE .6	ZAFL	AEXP	2E.6	• 50
2004	3 R	SEUC •C SE	DC +11	4734				

ETRY-POINTS:

CO PLATTER VELTO-S s .n= / 10.0 €3.02 22 MODEL 70 SECONS 425. 10 / 40.0 • 1 5 18 YONEL 20 SECONS \$12.00 / 10 0 •07 TUINE CHARTER .7.2 WEIR 490 14731 LO WER OUT 09/09/78 MA:01. B. 14.87 LEFT AFTER -6 LEDING.

1

CE VIO OPERATING SYSTEM VERSION 1 PEVISION 012 03/04/74 GENERATED 5/20/74

• 3 =

•10

•16

1-15

TCPF	3.3 35	
1.01 =	4.7414	
S=	193.620	
していらき	400,0312	
DINCTE	31.3967	
TOTHE	24959.9 3	
TSTS=	19481.515	
SICHIJ=	89900.942	
T 19 10 12 =	3.191.648	
TSHGE	25811 4	
SBC41T=	61942.123	

131 LINES PRINTED FUL + 1.25 / 4 L.

89 CARDS READ \$ 1.57 / 4 25



We see that TSBH is just a little too high and the same happens with TSBS; here it might be the case that TSBS should have been the one under consideration for the choice of a Z1 value. Nevertheless for the purpose of this work this example shows the procedure to be used along with the equation derived. The accuracy obtained can be total. Here we assumed Z1 = 41.544 and ended up with Z1 actual = 41.83 which is close enough for our purpose and TSBH and TSBS is very close to what it should be to use the material effectively.

229

```
0884
        С
               *AL* IS THE LENGHT
8724
               AL=1022 .
0720
               8=AL/5+75
8218
               +DRA* IS THE DRAFT
        С
2718
               DRA=8/3.3
2-24
               D=11/14.
2936
               *POI* IS THE POISSON'S RATIO OF THE MATERIAL
        С
2-39
               FOR ALDMIN M
        С
213%
               P01=0.33
1:35
        C
               *E* IS THE YOUNG'S MODULUS OF THE MATERIAL
1738
        C
               FOR ALUMIN M
2732
               E=10++1+++6
3:40
        C
               *29T* IS THE DESIGN STRESS IN TENSION
7.40
               DST=25 . 2+
               *DRC* IS THE DESIGN STRESS IN COMPRESSION
3754
        C
3754
               750=31472+
3750
        0
               +HM+ IS THE HOGGING BENDING MOMENT
31,50
               HM=1+37143+3+084+61+61
3174
        Ç
               * MA IS THE SAGGING BENDING MOMENT
1774
               SM=B+DRA*A *AL
1083
               %=Ø+3+396*(1.+P0]+P I)*TSC/E
17 45.
              U=SCRT(%)
1284
              7=1 . 11
1250
               *HTOPY IS THE HEAD OF WATER ON DECK
900
              HTOP=R.
1905
              *HADT & IS THE HEAD OF WATER ON BOTTOM
203
              HEAT=LASA
500
              STR37=2+152222+HT12+7+Z
054
              STR38=2 . 15: 222 . HROT . Z .Z
955
              A=DST-STP31
124
              A9=PSC+STRRB
110
              △C=(A℃*(B+r)-A*C)/(A*B)
140
              AD=4M*(P+0)/(A*4+*D*(D*D+2+*B*D))
194
              AF=(3.*F*7+2.*3*D)/(D+D+2.*B*D)
EP
       С
              *TOP* IS THE THICKNESS OF THE TOP PLATING
              *POT* IS THE THICKNESS OF THE BOTTOM PLATING
1EA
       C
1EC
              BOT=AD/(1++AC=AE)
1FR
              TOP=AC=BOT
204
              WRITE(5, 1VITOP
220
           10 FORMAT('1', 20X, 'TOP= +F10.4)
23A
              WRITE(5,20)ENT
           20 FORMAT(' ', 20X, 'BOT='F10+4)
256
270
              *S* IS THE SPACING OF LONGITUDINAL STIFFENING MEMBERS
       C
270
              S=Z*TOP
27C
              WRITE(5,30)S
           30 FOPMAT(' ',22X, 'S='=10+4)
298
280
              P=2·*D*BOT+8*(TOP+R*T)
204
              *DITOF + IS THE DISTANCE OF THE TOP FROM THE NEUTRAL AXIS
       C
ED4
              DITOP=D*(B+BOT+D*HOT)/P
PF'8
              WRITE(5,40)DITOP
314
           40 FORMAT( ! ,18X, 'DITOP='F10+4)
330
              *DIBOT* IS THE DISTANCE OF THE BOTTOM FROM THE NEUTRAL AXIS
       C
```

PAGE



00000000000000000000000000000000000000	50 C C C C C C C C C C C C C C C C C C C	DIBOT=D*(E*TOP WRITE(5,52)DIE FORMAT(' ',14X *GMI* JS THE M GMI=4*D*D*C*(3 *TSTS*IS THE S *TSTS*IS THE S *TSTS*IS THE S *TSBH*IS THE S *TSBS*JS THE S *TSBS*	+D*POT)/P OT ,'DIE T='F10+4 OMENT OF INERT *****+2****0)* TRESS ON TOP D TRESS ON BOT D TRESS ON BOT D TRESS ON POT D E CRITICAL STR GMI+3***3T GMI+3***3T SMI+3**3T *E/(2**30396*********************************) IA OF THE X TOP*BOT+(D* UF TO HOGGI UE TO SAGGI UE TO SAGG UE TO SAGG ESS ON TOP ESS ON TOP ESS ON BOT S*(1POI*P S*(1POI*P S*(1POI*P	SECTION +2•*B*D G G G G G (G (G () ()) ()) ())) ())))	ABCUT N)*Bct*Bo	• A • T) / P	
5F6		WRITE(5,107)TS	PS					
412	100	FORMAT(' ',19X	,'TSPG='F10+3)					
620	110	WRITE(5)11)SB	CRIT	_				
464	114	FURPARCE 117X	,'SACRIT='F1Ø+:	3)				
<pre>% [S] 8 [V] 8 [V] 5 [V] 5 [V] 5 [V] 4 [V] 6 [V] 8 [V] 8 [V] 8 [V] 7 [S] x EQ 2</pre>	•U POI HM Z A ROT S DIBCT STCRIT TSBS •V	2668[V] AL 2668[V] F 2684[V] F 2684[V] SM 2600[V] HTPP 2668[V] AB 2720[V] TOP 2298[L] 30 2372[L] 52 2482[L] 62 2754[V] SBCRIT	067:[V] B 0000[S] .R 0688[V] W 0604[V] HBOT 0650[V] AC 022:[L] 12 0723[V] P 0734[V] GMI 0484[L] 70 0500[L] 90	0678[V] 069C[V] 0608[V] 0608[V] 0700[V] 0700[V] 0720[V] 0740[V] 0740[V] 0740[V] 04EC[L]	DRA DST U STRGT AD @I DITOP TSTH 80 100	0680[V] 0644[V] 0000[S] 2684[V] 0714[V] 0256[L] 0256[L] 0254[L] 0744[V] 0746[V] 0648[L]	D DSC SQRT STR3B AE 20 40 TSTS TSBH 110	
DGRAM 2078 2006 2035 2048	<pre>/ LABELS: *MAIN* •ZERD AINT \$8</pre>	2EDE •V 2D34 \$6 288A SORT 2DDA •0	2DME .COMP 2809 .A 2D76 .FARG 2EB0 .U	2980 ALOG 2832 • MES 2002 • 5 4008	2EEC 2CBØ 2AB8	@I •W AEXP	27C8 2488 2DDA	•R EXP •ER
(RY-F 27C8	PDINTS: +P	2808 • 4	28BA SORT	2980 ALOG	2488	AEXP	2488	EXP

PAGE 2



TOP=	5.9995
BOT=	3.7688
S=	105-2122
DITOP=	38.4761
DIBOT=	32+9524
TSTH=	24599.988
TSTS=	18635+231
SICRIT=	3 0100044
TSPH=	24416.247
TS#S=	2 954.855
SHCRIT=	47172-344

END

OF VIC OPERATING SYSTEM VERSION 1 REVISION 012 03/04/74 GENERATED 05/02/74 0

1	JCR	FANDLING CHARGE	4	•35	1	JhB	• 35
	132	LINES PRINTED PR2.	넵.	1.25	1	K LN	•16
	٤8	CARDS READ	2	1.50	1	K CC	• 1 .
	× 2	PLOTTER VECTORS	2	.25	1	1 17	• 6 5
	15	ODEL 77 SECTIONS	4.2	5.00	1	-008	
	10	ODEL S. SECONUS	1 1	2.50	1	HOUR	• 0 .
			Ī	UTAL	CH	HARGE S	.74
							- /

RREIR 492 14731 LOGGED OUT 09/09/75 02:45. \$ 17.18 LEFT AFTER 13 LOGINS.

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This last example shows that TSBH is low and the Z approximation used in the formulas here again should be corrected as already exemplified in order to bring it closer to the DSC value.
CONCLUSION

From this work the author is led to conclude that there is no simplified approach to the neutral axis location in the midship section, capable of handling properly all or only a majority of cases. It is advisable to look into each particular situation by first gaining some insight at what the diagrams of stress distributions may look like as exemplified in several sections. The two last sections exemplify well why this may be of some advantage and specially the last section which shows that while at first it was expected for the examples studied a neutral axis closer to the top, actually the results ended up requiring a neutral axis closer to the bottom and a new set of formulas had to be derived.

As a future development for this work it is here suggested that a more ship like cross section could be analysed as a step forward towards obtaining a method of determination of scantlings as direct as possible. This next step should consider the derivation of proper formulas for DITOP, DIBOT and I involving only the plate thicknesses as unknowns. It should be considered then, in order to simplify the problem., a standard type of frame and its scantlings should be constant throughout the midship section. 234

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