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Know YOUR SURF

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON D.C.

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J. W. Johnson & R. L. Wiegel

INSTITUTE OF ENGINEERING RESEARCH,
UNIVERSITY OF CALIFORNIA,
BERKELEY

in cooperation with

THE UNITED STATES MARINE CORPS

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DEPARTMENT OF THE NAVY
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INTRODUCTION

The waves which one encounters at sea and which form the breakers along beaches are almost always caused by winds. There are other types of waves in the ocean such as the waves that are formed by a ship moving in the ocean and the "tidal" waves which occur occasionally and often cause great damage. Tidal waves, technically known as seismic waves, are caused either directly or indirectly by earthquakes on the ocean bottom, and have nothing at all to do with the tides. Those caused by underwater earthquakes are rare, and the ones formed by ships are of little significance. The types that affect amphibious operations are the waves generated by wind blowing over the ocean surface. At first these waves are very small, like the ones formed on a pond; then they grow larger. In general, the greater the area over which the wind blows, the longer it blows and the stronger the wind, the heavier is the "sea" (the higher and longer the waves).

The ocean surface is very confused in the area where these waves are being formed. There are waves of many heights and lengths. They are steep and there are many "combers" and "whitecaps". After the waves have left the storm area they become long, smooth "swells". Eventually they approach shore. When the waves reach a depth that is less than one-half the length of the wave they begin to be affected by the bottom. They are now in "shallow water".

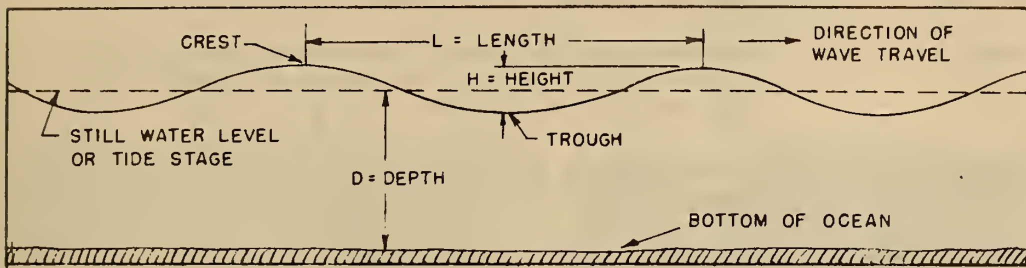
At first the effect is very small. The wave slows down somewhat and the wave length becomes shorter. A little further on, the wave height begins to increase while at the same time the length continues to decrease. The wave is becoming steeper (steepness is the ratio of the wave height to its length). This change occurs at a faster and faster rate as it travels into even more "shallow water". Suddenly, in a distance of a few wave lengths, it peaks up and breaks. It is this surf, the origin of which is usually many miles away, that is your concern when landing a craft on a beach.

A trained aerologist, with adequate weather maps at his disposal, can forecast the wind blowing over the ocean and then forecast the waves caused by these winds. Combining his knowledge of waves with the information obtained from hydrographic (ocean) charts, he can then forecast the surf along beaches even though they may be many miles from the storm area. He can indicate to the planning staff the best places and best times for landing operations but he cannot get you through the surf.

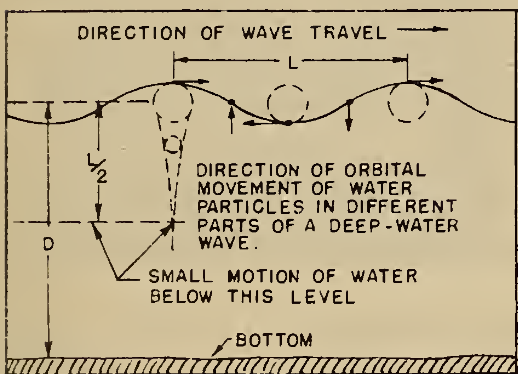
However, there are many items which engineers and amphibious craft operators with long years of experience have found useful in helping you to operate in the surf. These useful suggestions, together with a pictorial description of the surf and beaches are covered in this manual. Proper use of them will result in safer landings.

DEFINITIONS

THE FOLLOWING VERTICAL SECTION SKETCHES ILLUSTRATE THE TERMS COMMONLY EMPLOYED IN DISCUSSIONS OF WAVES, SURF, AND BEACHES

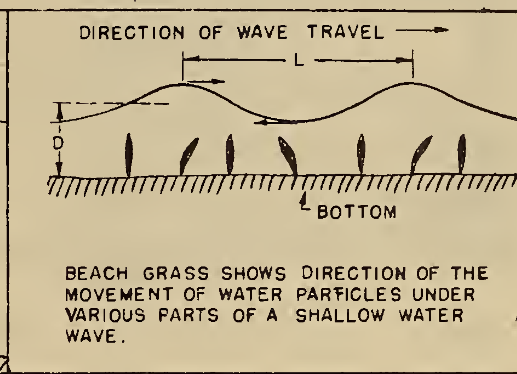


DEFINITIONS OF WAVE CHARACTERISTICS



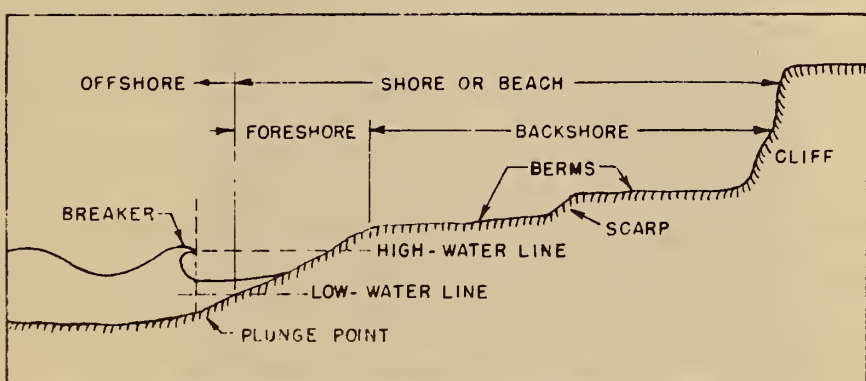
DEEP WATER WAVES

WHEN THE WATER DEPTH IS GREAT, THE BOTTOM HAS NO EFFECT ON THE MOTION OF WAVES; HENCE, SUCH WAVES ARE CALLED DEEP WATER WAVES



SHALLOW WATER WAVES

WHEN THE WATER DEPTH IS SMALL, WAVES CAUSE THE WATER TO MOVE AT THE BOTTOM.



DEFINITIONS OF BEACH CHARACTERISTICS

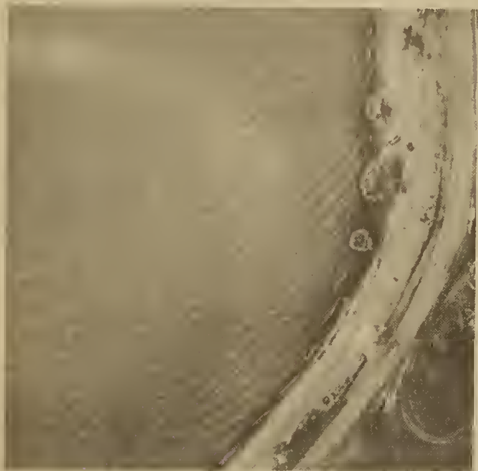
DEFINITIONS

1.	Bar	An offshore bank of sand or gravel.
2.	Beach face	The section of the beach between the berm and the limit of backrush of a wave.
3.	Berm	The horizontal or nearly horizontal section of a beach which is present landward of the beach face when there is an adequate supply of sand.
4.	Breaker	A wave when it spills, plunges or surges into the foaming, swirling mass of water as is seen on a beach.
5.	Breaker angle	The angle a breaker crest makes with the beach.
6.	Crest	The highest part of a wave.
7.	Cusp	A nearly semi-circular alternate ridge and hollow formation often occuring in the beach face which tends to be at right angles to the water's edge with the ridges tapering to a point seaward. (See photograph in Section IV (i)).
8.	Deep water	Water deeper than half the length of the wave.
9.	Height	The vertical distance between the crest and the preceding trough.
10.	Length	The horizontal distance between two successive crests.
11.	Littoral current	The current, parallel to the shore, that is created by a wave breaking at an angle to a beach.
12.	Period	The time it takes two successive crests to pass a fixed point such as a buoy, a rock or a pile.
13.	Scarp	A vertical rise often present in the beach at the juncture of the beach face and the berm. This is the result of waves eroding the beach during a storm.
14.	Sea	The short, high and often broken waves in the storm area.
15.	Shallow water	Water less deep than half the wave length.
16.	Surf zone	The section between the line of breakers and the beach face.
17.	Swell	The long rolling waves at sea.
18.	Trough	The lowest part of a wave.
19.	Wave steepness	The ratio of the wave height to its length.

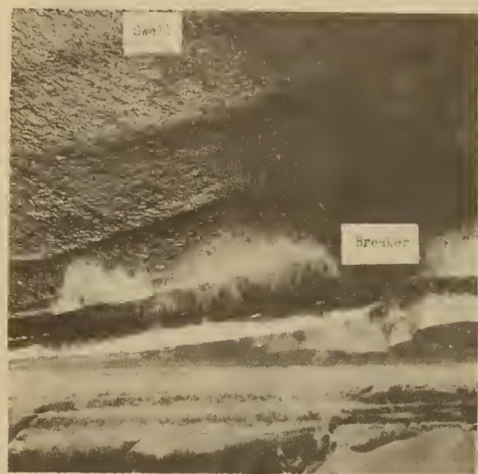
II

GENERATION OF WAVES

Waves which affect amphibious operations are generated by wind blowing over the ocean surface. At first the waves are very small, as shown on the small lake in the photograph below (left). The greater the length of the area over which the wind blows, the longer it blows, and the higher its speed, the larger are the waves. After the waves leave a storm area, as in the open ocean, they tend to become long and smooth "swells" like those shown in the photograph below (right). Eventually the swell reaches shore peaks up and then breaks. It is the larger waves, or swell, breaking on a beach which make the surf dangerous. An aerologist, with the aid of weather charts and hydrographic charts, can forecast the wind blowing over the ocean and then forecast the waves generated by these winds.



Typical wind waves in a generating area. Note the variability of the wave height, wave length, and the length along the crest.



Swell in the vicinity of Oceanside, California resulting from storms thousands of miles to the south. Note the regularity of the swell compared to the waves in a generating area, as shown in the photograph to the left.

Aerial Photograph Showing Two Wave Trains.

The small waves coming from the upper right are being generated by the local wind. The long low swell from the upper left was generated several thousands of miles away. Note that the swell is almost invisible in deep water but peaks up near shore to form the predominant breakers.

III

REFRACTION OF WAVES

(a) Shoaling Bottom

As waves move into shallow water and approach the shore at an angle to the bottom contours, the waves are bent. This is known as refraction. The bending of waves may cause a converging or diverging of the crests (depending upon the hydrography with a subsequent increase or decrease in wave or breaker height. Another effect of waves approaching a beach at an angle is to induce a longshore current inside the breaker zone. This current is effective in transporting sand along the shore and is also a hazard to landing craft operating through the surf zone.

Pt. Pinos, California

Waves moving over a submarine ridge concentrate to give large wave heights on a point.

Arena Cove, California

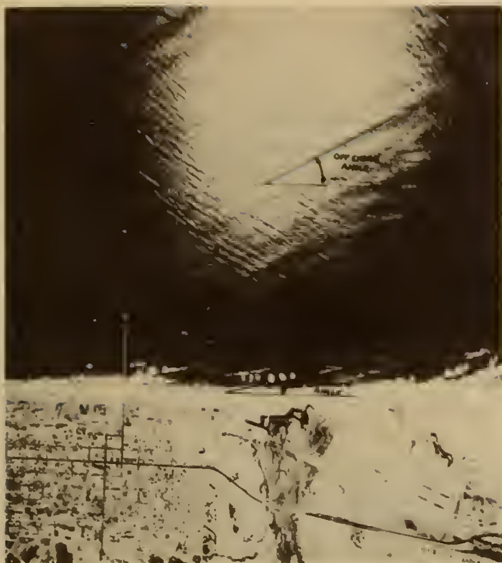
Spreading of waves by refraction produces low wave heights at the pier.

Halfmoon Bay, California

Note the increasing width of the surf zone with increasing degree of exposure to the south.

Purisima Pt., California

Refraction of waves around a headland produces low waves and a narrow surf zone where bending is greatest.



Oceanside, California

Waves tend to become parallel to the beach.

III

REFRACTION OF WAVES

(a) Shoaling Bottom
(Continued)

Waves in shoaling water refract in such a manner that they tend to become parallel to the underwater contours and, eventually, the shore. However, they usually break before becoming quite parallel to the beach.

III

REFRACTION OF WAVES

(b) Currents

When the waves buck a current, as when they run against an ebb current at a harbor entrance, they shorten up and grow higher, producing a choppy sea and, frequently, breakers. When waves run with [illegible] current, as in flood current at a harbor entrance, they become longer and lower.

Humboldt Bay, California

FLOOD TIDE

Humboldt Bay, California

EBB TIDE

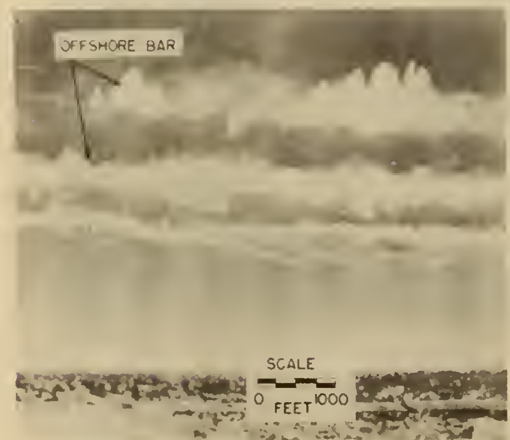
IV

SURF ZONE

(a) General Features

The character of the motion of the water shoreward from the point of breaking is the most critical from the standpoint of sea to shore operations. Two principal types of motion exist: one is the oscillating motion during the passage of each wave, and the second is the longshore or littoral current. In the oscillatory motion, the seaward and shoreward velocities differ considerably. Thus, at a fixed point just shoreward of the breaker point, the motion of the water is a slow seaward flow and then a quick shoreward motion as the breaker passes. The effect of these relatively high shoreward velocities in the operation of amphibious craft is to impose high stresses and to make it extremely difficult to maintain control of the craft.

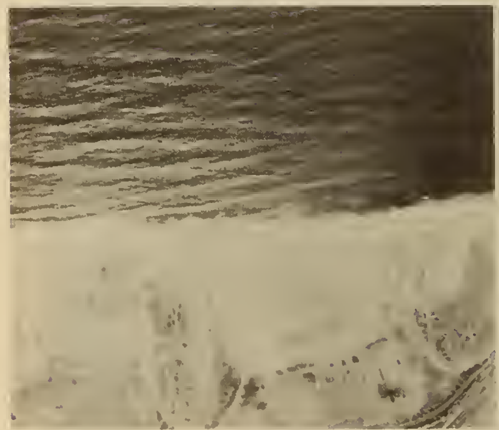
The following radio-synchronized photographs show surf conditions on both flat and steep beaches when viewed from the air and from the shore. The photographs show the same waves. Breakers seldom appear dangerous when viewed from the sea.



Aerial View of the Surf

The Surf as Viewed from Shore

FLAT BEACH
Clatsop Spit, Oregon



Aerial View of the Surf

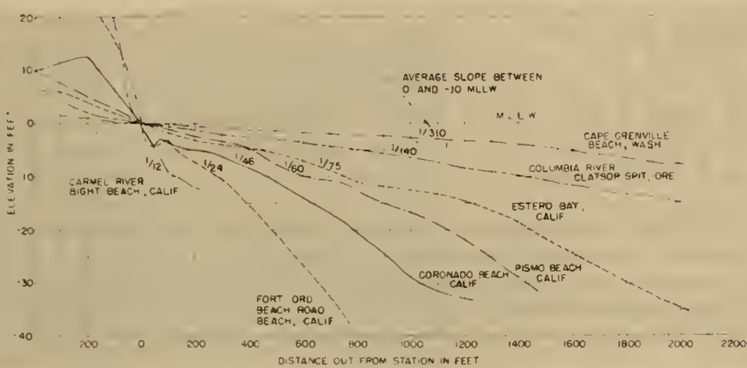
The Surf as Viewed from Shore

STEEP BEACH
Monterey Bay, California

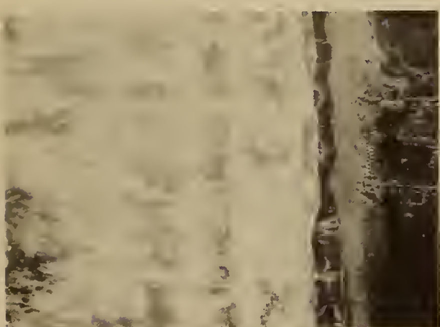
SURF ZONE

(b) Typicel Surf Conditione

A plan form of a heach and its profile perpendicular to the shoraline are the long term reeults of the waves which act upon it, and of the supply and type of eand availahle. The beach elope ie one of the predominating factore in determining the oharacter of the surf. Beachee generally are classified as to slope, that ie, flat, moderate, or eteep. The following aketch shows the range of heach slopee that are found on the Pacific Coast of the United Statee. Aerial photographs ehowing typical beaches under heavy and light surf oonditions indicate the wide variety of surf conditions that may exiet on a particular beach depending upon the height of the offehore swell.



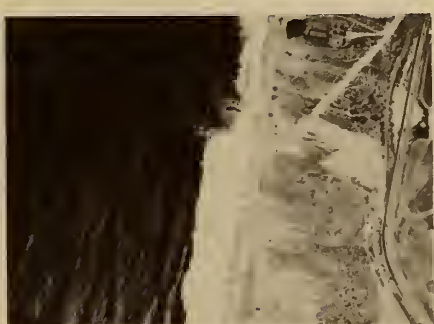
Typical Pacific Coaet heachee ehowing the wide range of heech elopee that oommonly are found



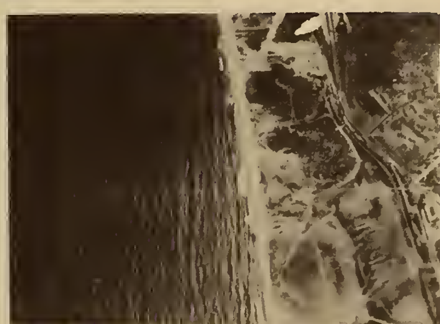
Heavy eurf on a flat beach on the Washington Coast. Paseing through thie eurf zone requiree coneiderable time; hence it would be exhausting to the operator.

Light eurf at the same locality as ehown at the left. Compare widths of the surf zone.

SURF ON A FLAT BEACH



Heavy surf on a eteep beach at Fort Ord, California.



Light surf at the same locality as ahown at the left.

SURF ON A STEEP BEACH

IV

SURF ZONE

(c) Breaker Types

When a wave reaches water that is between one and a half times as deep as the wave is high, it becomes unstable and breaks. The different ways in which waves break, and their effects on landing craft are as follows. These three modes are spilling, plunging and surging. The primary factors that determine the breaker type are the steepness of the wave in deep water (that is the ratio of its height to its length) and the slope of the beach. The steeper the wave and the flatter the beach, the more likely the wave will spill. On the other hand the flatter the wave and the steeper the beach the more likely the wave will plunge. If the beach is very steep (1:5) and the wave is flat it will surge up the beach face. Other factors such as a sea breeze, bars, other trains of waves, currents, etc., tend to cause a wave to spill which would otherwise plunge or surge.

The reason for the different effects on landing craft of the various types of breakers is the method in which the energy is unleashed upon the craft. A plunging breaker releases its energy almost instantaneously. A spilling breaker releases it gradually over a relatively long distance, and this energy is continuously being dissipated by turbulence as it rolls shoreward. In a surging breaker all the energy is transformed into translatory energy right at the beach face.

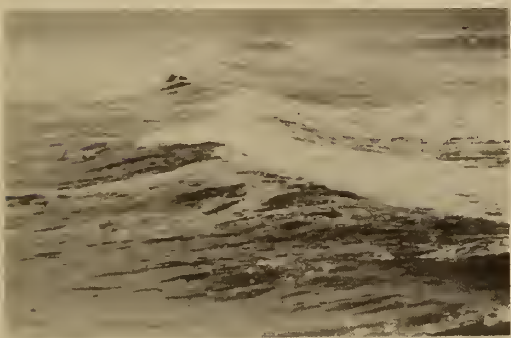
It has been found that the spilling breakers are safest for landing craft to operate in. It has been found that a Dukw can operate in a twelve foot spilling surf with the same ease as in an eight foot plunging type surf. In addition, for the same deep water height, a spilling breaker will be less high than a plunging breaker. The plunging type surf is the most dangerous for all types of landing craft. If high (eight feet) or greater it can pitch an amphibious tractor over if caught right. If it breaks on a non-covered craft it can hit the coxswain or troops with considerable force. Observations of landing craft in surging breakers up to ten feet in height indicate that this type of surf is not dangerous for amphibious tractors or Dukws as they continue up the beach face. However, it is very hazardous to LCM and LCVP as they have to remain at the beach face. Large breakers of this type throw them up on the beach face, broaching and hard-grounding them. Small surging breakers (two and three feet high) caused many LCM and LCVP to broach.

IV

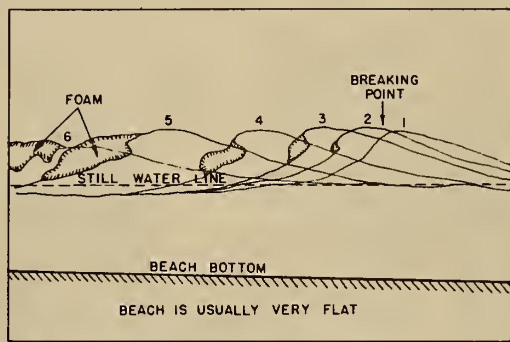
SURF ZONE

(c) Breaker Types

Both photographs and diagrams of the three types of breakers are presented below. The sketches consist of a series of profiles of the wave form as it appears before breaking, during the breaking, and after breaking. The numbers opposite the profile lines indicate the relative times of the occurrences.

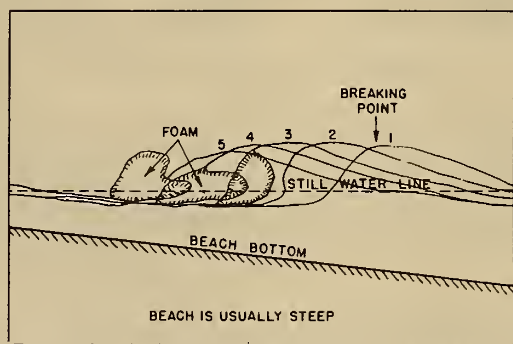


SPILLING BREAKER



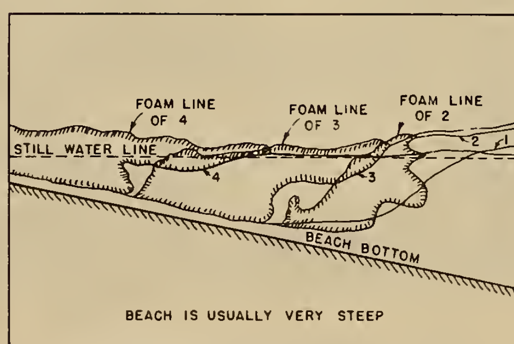
SKETCH SHOWING THE GENERAL CHARACTER OF SPILLING BREAKERS

PLUNGING BREAKER



SKETCH SHOWING THE GENERAL CHARACTER OF PLUNGING BREAKERS

SURGING BREAKER



SKETCH SHOWING THE GENERAL CHARACTER OF SURGING BREAKERS

IV
SURF ZONE
(c) Breaker Type--Effect on Craft

A. Surging Breaker at Blue Beach, Operation Miki. Oahu. T. H.

B. Surging Breaker at Yellow Beach, Operation Miki. Oahu. T. H.

C. Surging breaker at Blue Beach, Operation Miki, Oahu. T. H.

D. Seven Foot Plunging Breaker, Monterey. California

IV

SURF ZONE

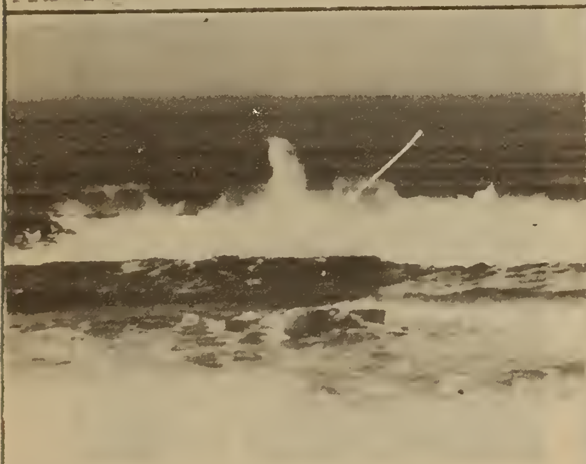
(c) Breaker Type--Effect on Craft

Plunging Breaker. LCM in 14 Foot Breaker

Spilling Breaker. LVT(3)(C) in 6 Foot Breaker.

Plunging Breaker. Dukw in 15 Foot Breaker

Spilling Breaker. LVT(3)([illegible]) in [illegible] Foot Breaker.



Plunging Breaker. [illegible]

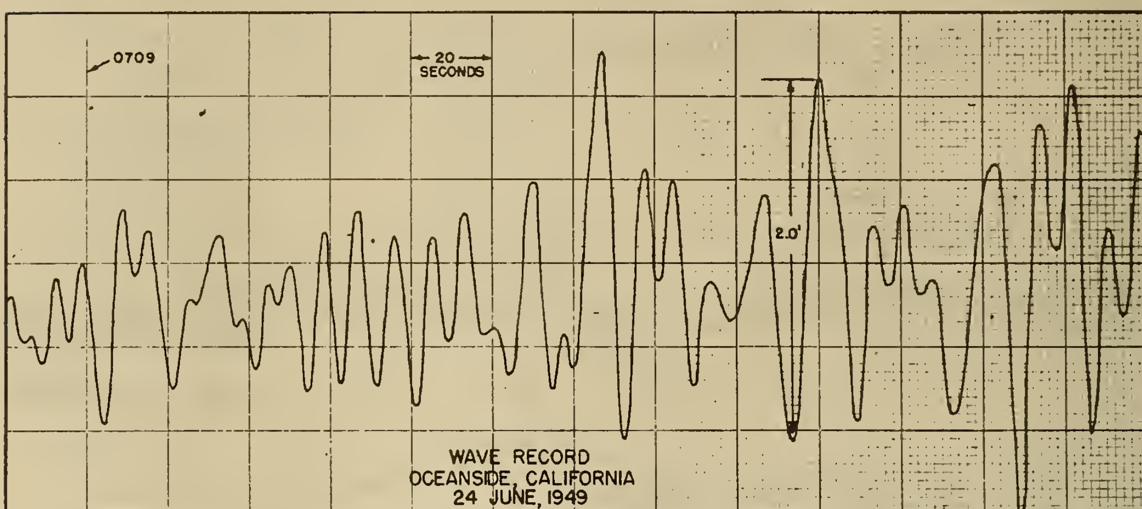
Spilling Breaker. LVT([illegible]) [illegible]
[illegible] by 10 [illegible] Breaker Vertical [illegible]

IV

SURF ZONE

(d) Variability of Surf

Surf is extremely variable both with position along the shore and with time. Refraction effects due to changes in the alignment of a coast, as well as variable bottom conditions along a beach, may cause marked variation in the character of the surf from point to point along a shoreline. Of equal importance is the fact that the height of waves varies considerably from wave to wave. As illustrated by the following chart from a wave recorder, wave trains are usually characterized by groups of high waves separated by periods of relative calm. Waves vary appreciably both as to height and period. If it is desired to traverse the surf in either direction, observe the sequences of the highest waves, then start immediately <u>after</u> the occurrence of a set of high waves because a series of low waves usually occurs in the succeeding minutes.



<u>Typical Wave Record</u>

This record demonstrates the fallacy of the old statement that every seventh wave is a high wave. Passage through the surf should be timed to follow immediately after the occurrence of the higher waves.

<u>Point Loma, California</u>

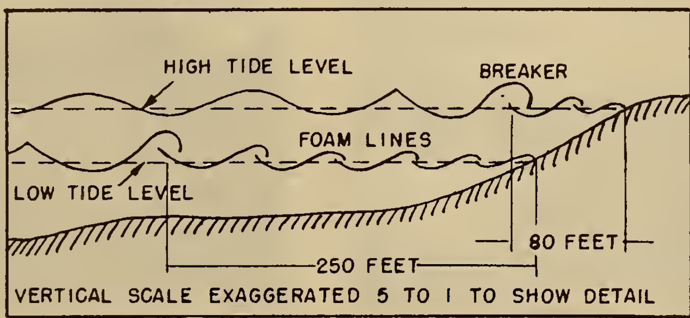
<u>Moss Landing, California</u>

<u>VARIATION OF SURF ALONG A BEACH</u>

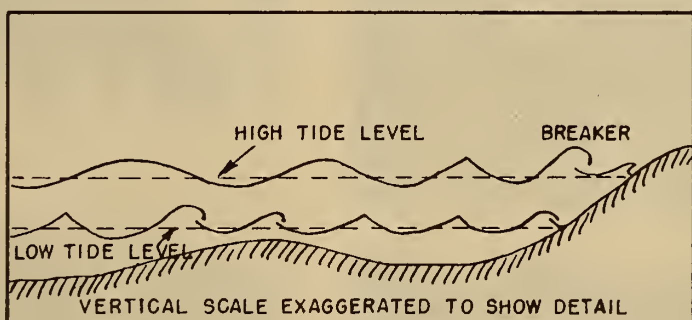
An appreciation of the principles of wave refraction permits the selection of a locality where the surf is relatively low.

(e) Surf Changes With Tide Stage

Changes in the character of the surf may occur in a few hours because of the effect of the tide. Thus, for the beach profile illustrated in one of the following sketches, at high tide the beach has the character of a steep beach with a narrow surf zone; whereas at low tide it appears as a flat beach with a wide surf zone. For a beach with an offshore bar the effect of the tide on the character of the surf zone is illustrated in the other sketch below. Thus, at high tide there is a single line of breakers on the beach; whereas, at low tide there are two lines, one on the bar and one on the beach. On some beaches, particularly the wide flat beaches of the Washington coast, several offshore bars sometimes are present in which case several lines of breakers will exist. On such beaches, the waves reform and break again on each successive bar. The areas of unbroken water between the bars thus provide a place of rest and reorientation for a landing craft. In case of dangerously high surf, the craft might be directed through each breaker zone by an observer at a high point and in radio contact with the craft.



Effect of tide on width of surf zone. At high tide the beach has the character of a steep beach with a narrow surf zone, whereas at low tide it appears as a flat beach with a wide surf zone.



Effect of tide on character of surf zone in the presence of a bar. At high tide there is a single line of breakers on the beach, at low tide there are two lines, one on the bar and one on the beach.

IV

SURF ZONE

(a) Surf Changes with Tide Stages
(Continued)

Vertical aerial photographs of a steep beach and a flat beach at high and low tide stages.

HIGH TIDE

LOW TIDE

FLAT BEACH Clatsop Spit, Oregon

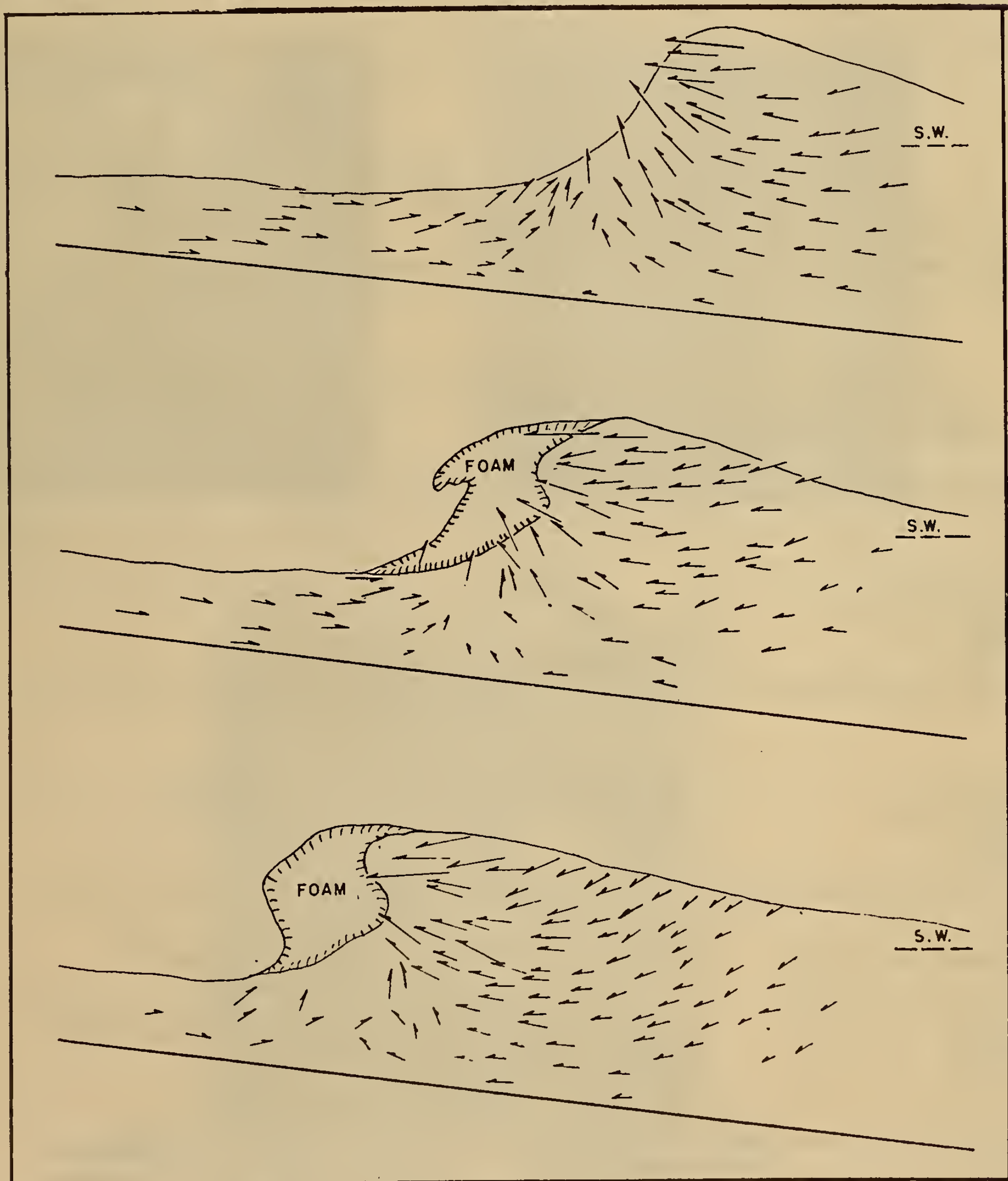
HIGH TIDE

LOW TIDE

STEEP BEACH Soldiers' Club Beach, Fort Ord, Monterey, Calif.

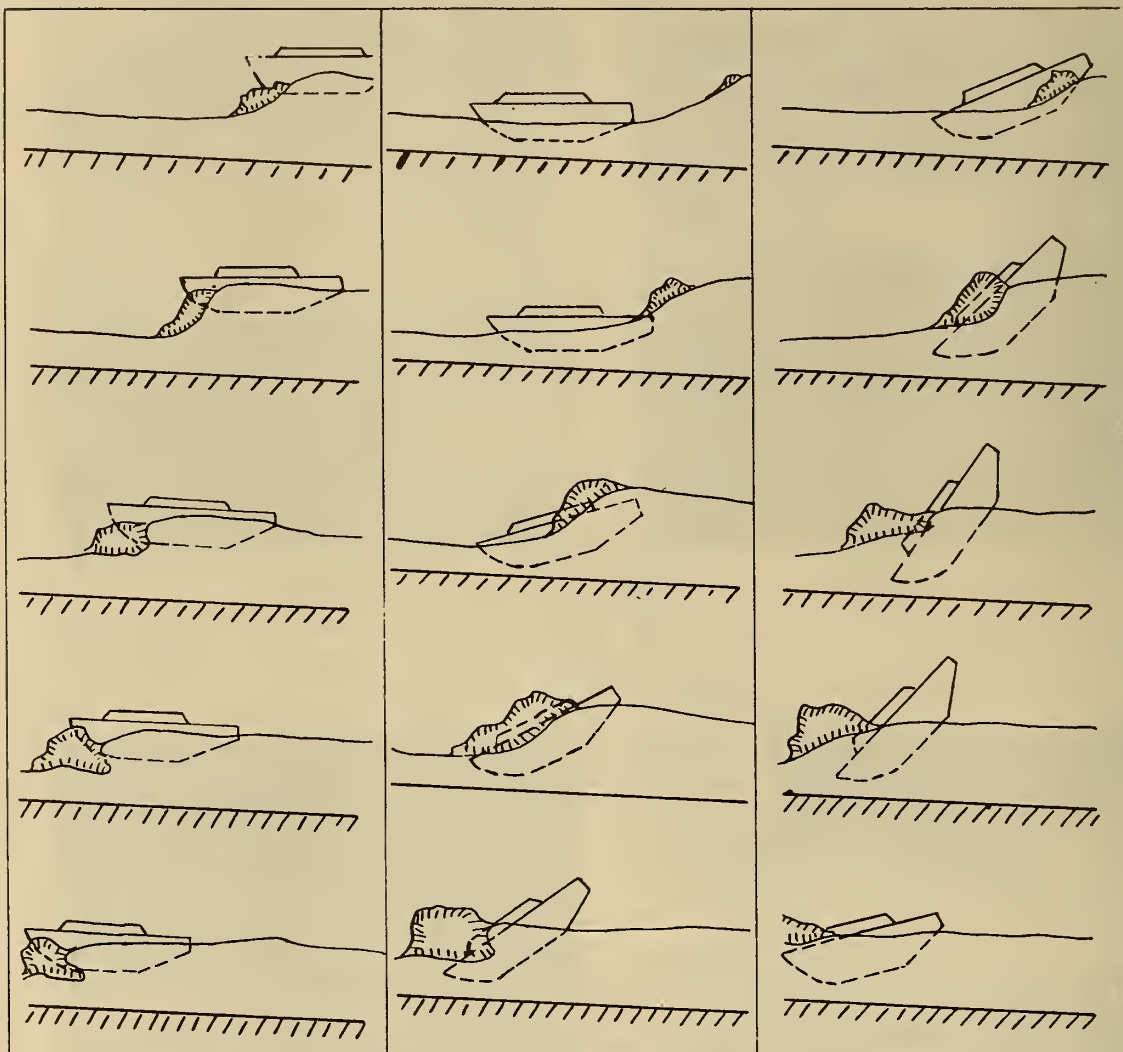
SURF ZONE
(f) Oscillatory Currents

The following sketches (vertical sections) show the general character of oscillatory currents immediately before a wave breaks, at the point of breaking, and immediately after breaking. These sketches were prepared from motion pictures of waves in a glass wall channel. A landing craft in the surf and advancing shoreward has its stern lifted by the forward rush of the crest. As the stern is lifted, the bow sinks deeper in the preceding trough. In this position the stern is being forced toward the beach by the crest, while the bow is being forced seaward by the backwash. These two forces acting in opposite directions tend to turn the craft over or, if the craft is at an angle to the breaker, broach it.



(f) Oscillatory Currents - Effect on Craft

The position of the center of gravity of the craft relative to the wave crest at the time it breaks is very important. The sketches shown below (drawn from motion pictures taken of a LVT(A)(5) model in a wave channel) illustrate the great variation in pitching for three conditions. It has been found that craft is in the most dangerous position when the center of gravity of the craft is just in front of the wave at the time it breaks.



Surfboards (negligible pitch) CG of craft just behind wave crest at time of breaking	Maximum pitch, 30° CG of craft one craft length in front of wave crest at time of breaking	Maximum pitch, 52° CG of craft just in front of wave crest at time of breaking

Prototype conditions: Breaker height, 8.0 feet, wave period, 14½ second; beach slope, 1/15.

IV

SURF ZONE

(g) Longshore Currents

A longshore current is set up within the surf zone when waves break at an angle with the shoreline. The currents flow parallel to the shoreline inside the breaker zone and are found most commonly along straight beaches. Their velocity increases with increasing breaker height, decreasing wave period, increasing angle of breaker-line with the beach, and increasing beach slope. The longshore current is much less than the velocity of the oscillating currents but it is relatively constant in direction with sustained velocities as high as three knots having been measured. Normally, velocities of from 1/4 to one knot can be expected. Strong longshore currents are effective in causing landing craft to broach.

Aerial photograph of swell breaking at an angle to the shoreline, thus causing a longshore current in the direction shown.

Photograph of landing craft broached as a result of the longshore current.

Some difficulty was encountered while attempting to drive jeeps from LCVPs which were careened by the surf, sometimes violently, endangering personnel. An attempt was made to steady and straighten out the craft by hawsers held by men on the beach. (Notice men standing between the jeep and side of LCVP.) November 25, 1946

IV

SURF ZONE

(g) Longshore Currents--Salvage of Broached Craft by Shore Crews

Shore crews can be somewhat effective preventing broaching of an LCVP on a beach (use should be made of a Dukw or tractor for greater pulling power, however). Prompt action is necessary before craft broaches too much. Once the craft has swung around and is laying broadside to the beach, salvage by sea is best. The forces acting on a craft grounded foreward are shown on the accompanying diagrams. The typical situations existent on steep beaches are shown in 1A and 2A. On flat beaches where the craft alternately grounds foreward and aft as it pitches in the uprushes, the resultant movement is as shown in 2A and 2B. There is evidence that these craft rarely ground on the skeg with the bow free. In fact this can occur only on certain profiles at specific tide stages. Such a case is a condition where the bow clears a bar and the stern grounds, leaving the bow afloat. Broaching is not often a hazard under these circumstances. The diagrams portray the conditions that are most frequently encountered. It can be seen that placing a line on the bow is of doubtful effectiveness but that a line astern produces a comparatively great turning movement tending to bring the craft at right angles to the surf.

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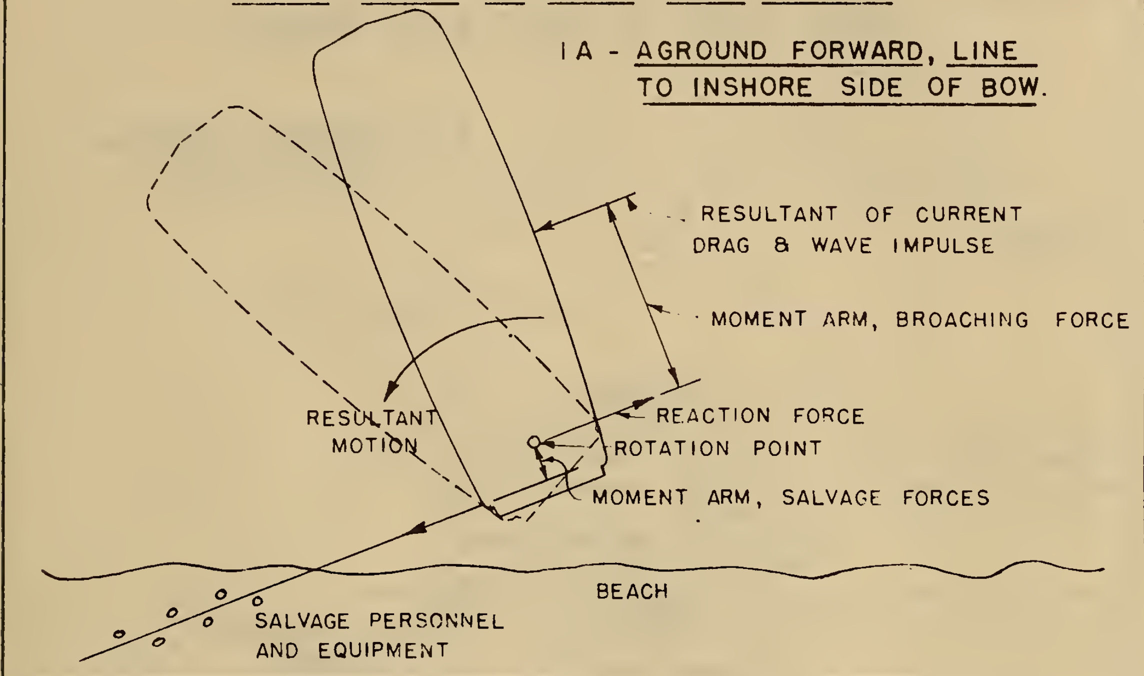
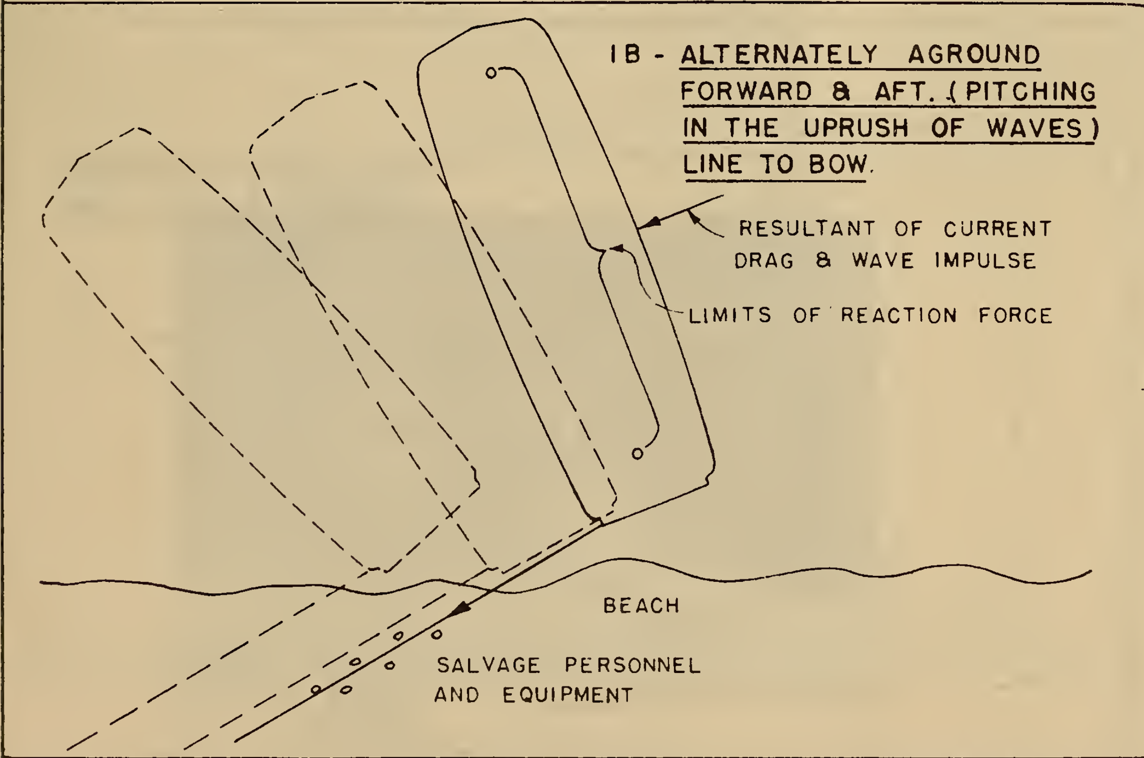
(g) LONGSHORE CURRENTS - SALVAGE OF BROACHED CRAFT BY SHORE CREWS

FORCES ACTING ON L C V P WHEN AGROUND





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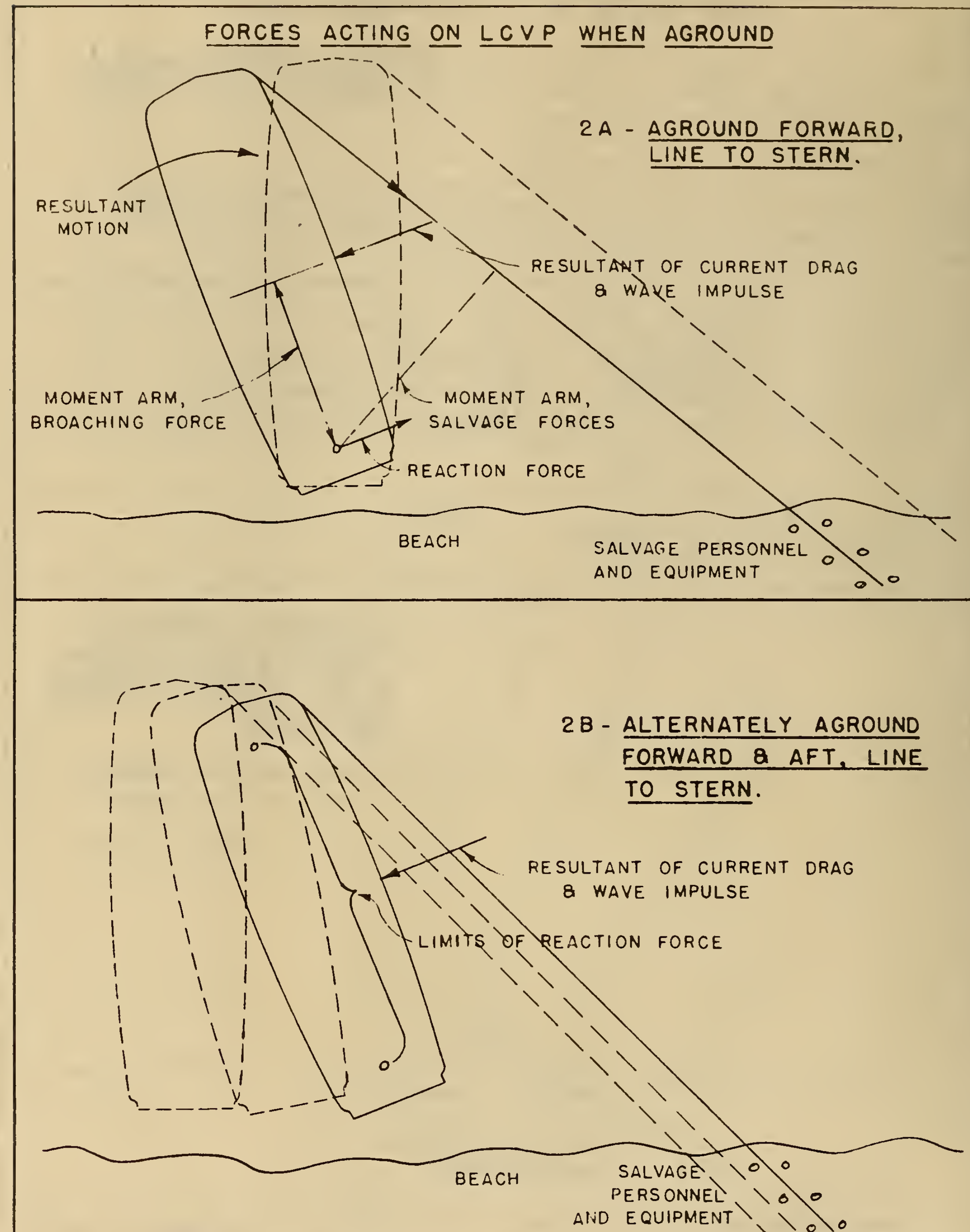
SURF ZONE

(g) LONGSHORE CURRENTS - SALVAGE OF BROACHED CRAFT BY SHORE CREWS



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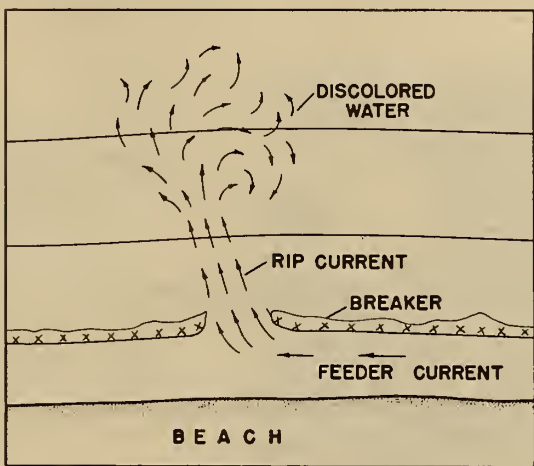
IV

SURF ZONE

(h) Rip Currents

A type of current in the surf zone that may be of importance in certain areas is the rip current. Rip currents flow out from shore through the breaker line in narrow rips and occur on almost all open coasts. They are caused by the waves piling water against the coast. This water flows along shore until bottom irregularities are such that it can escape seaward. As indicated by the following photograph, a rip current consists of three main parts: the feeder current, which flows parallel to the shore inside the breakers; the rip current proper, which flows through the breakers in a narrow band; and the seaward portion, where the current widens and slackens. Rip currents are easy to detect from the air but more difficult to detect from the ground. A ground observer usually can distinguish a rip by a stretch of unbroken water in the breaker line and patches of foam and discolored water offshore. Once rip currents have formed, they cut troughs in the sand and remain fairly constant in position until the wave conditions change. It has been found that, as rip currents cut channels through bars, it is usually best to operate LCM's and LCVP's in these rips during low tides as then there is less chance of the craft becoming stuck. On the other hand, experience has also shown that it is best not to operate LVT's and Dukws in rip currents.



Idealized Rip Current

The Feeder Current may, and often does, approach from both sides.

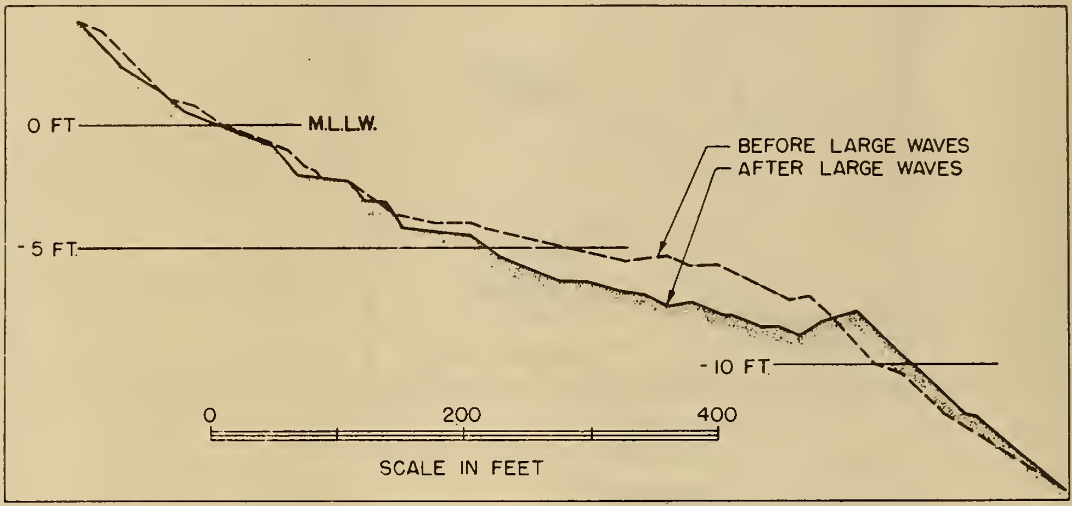
Aerial Photograph showing Rip Current

IV

SURF ZONE

(i) Profile Changes by Wave Action

A sandy shoreline changes in profile and plan as the waves change, and waves are as variable daily, seasonally, and annually as other aspects of the weather. Conversely, changes in its beach cause a change in the character of the surf. During periods of low long waves, the beaches may build up their berms on the foreshore. The beach slope in the shore area tends to steepen and the bars tend to become less pronounced, often nearly disappearing. On the other hand, during periods of high steep waves, the slope in the shore area tends to flatten while the offshore bars tend to increase in size. With a given wave action, the steeper beaches change faster than the flatter beaches. Bars, cusps, gravel deposits and minor forms appear and disappear rapidly and frequently. Recent sand deposits are usually soft but become harder under compaction by wave action and tidal variations. Any beach which is undergoing, or has recently undergone, a distinct change may be a difficult beach upon which to operate.



Profile Changes due to Wave Action

Changes such as this take place more rapidly on a steep beach than on a flat beach

Typical Beach Cusps

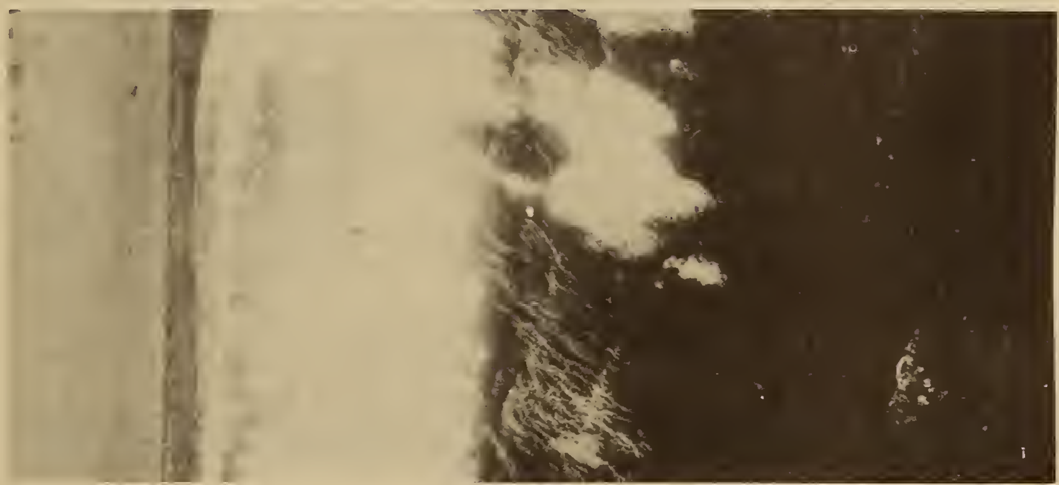
Beach cusps may appear and disappear overnight with an abrupt change of wave action. Erosion of cusps may leave a series of steps where the crest of each cusp has been cut away, and soft sand is newly deposited in the troughs of the old cusps. Water rushing off the ridges into the hollows of the cusps and out to the sea make it advisable to bring LVT's and Dukws in on the ridges but LCVP's and LCM's in on the hollows.

IV

SURF ZONE

(1) Profile Changes by Wave Action
Cause and Effect of Scarps

During the period when steep "storm" breakers cut back the beach face, scarps are formed. When these scarps are high, their adverse effect is quite apparent. In addition, small scarps only a few feet high may offer considerable hazards to an amphibious operation. A small scarp, only two feet high, caused an LVT(3)(C) to throw a track during an attempt to climb it at an angle. It was successfully negotiated when the LVT hit it head-on (which has proved to be the best way) but only after three attempts. However, during each of these attempts, the relatively unprotected underside of the vehicle would have been exposed to enemy fire had this been an enemy-held beach.

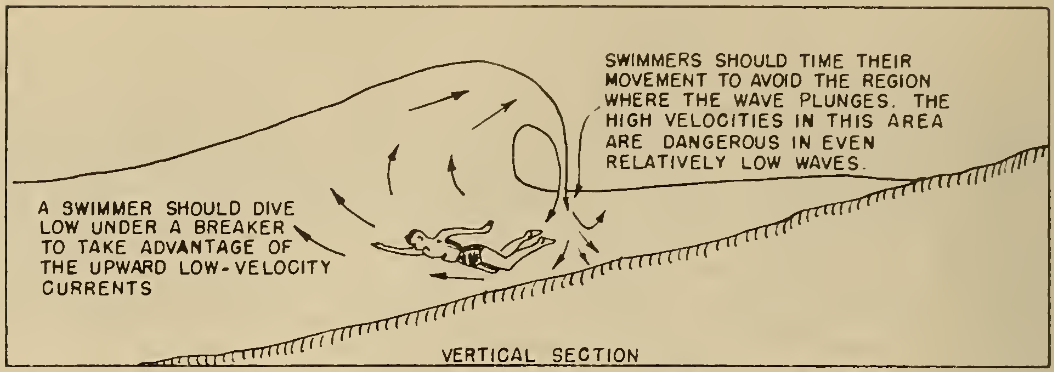


Vertical aerial photo
Steep storm waves of this type cut scarps in a beach face.

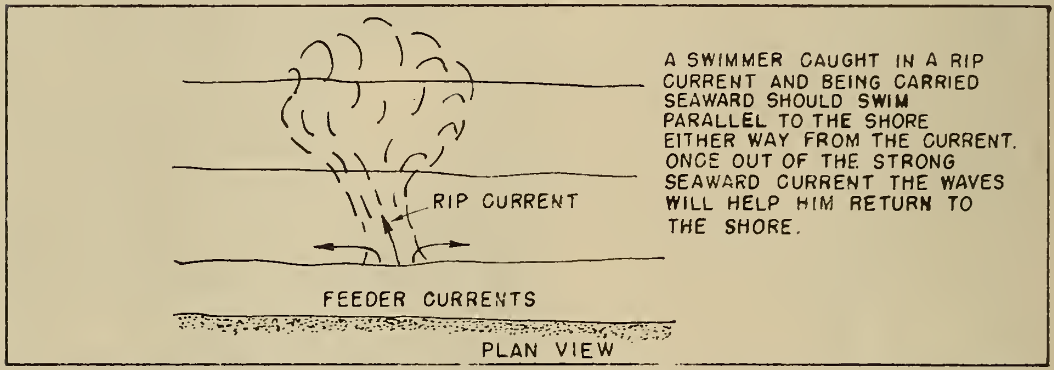
LVT(3)(C) throws track going up a two-foot scarp at an angle.

LVT(3)(C) ascends same scarp at right angle to it on third try.

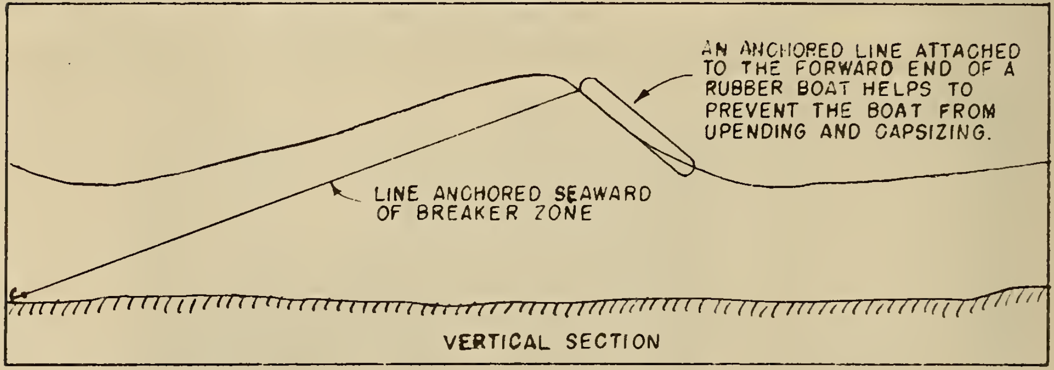
(a) ADVICE TO SWIMMERS AND RUBBER BOAT CREWS IN TRAVERSING THE SURF ZONE



Proper timing in passing a plunging breaker is the key to survival.



A swimmer never should expend energy in fighting a rip current, but instead should take advantage of the other currents which help him return to shore.



A line through the surf zone to an anchor beyond the breaker permits the operators to pull themselves seaward hand-over-hand as well as to assist in preventing overturning.

V

(b) Advice for Craft and Vehicle Operators

1. One of the main causes of casualties in the surf is engine failure (especially Dukws). Be sure and have all hatches dogged down. Don't allow the water to get into your engine compartment and cause an electrical or fuel failure.

2. Make use of variability of breaker height with time. Approach and retract through the lower breakers. Watch them and start just as the big ones break.

3. Make use of the variability of breaker height along the beach. If tactically possible, approach and retract at sections of low surf.

4. When approaching the beach, watch the breakers and try to jockey just on the crest and surfboard in. Don't be just in front of the wave crest as it breaks. This is the most dangerous position. If you are at least one craft length in front of the wave when it breaks you will pitch, but be safe.

5. Keep at right angles to the breakers at all times while either approaching or retracting. If the breakers are at an angle to the beach, traverse the breaker zone at the same angle to the beach.

6. Rip currents run seaward through the breakers from the hollows of cusps. These currents cut channels through longshore bars. Take advantage of this fact and operate LCM and LCVP through the channels. Don't get grounded on a bar. The currents are often high, so operate the relatively slow LVT and Dukw in between the hollows.

7. If a ramp sticks while down, make use of a bulldozer. Get it up quickly and retract before you broach. Do not retract unless the ramp dogged down.

8. LCVP and LCM coxswains should use power to keep the bow hard against the beach. On steep beaches with very small surging breaking there have been casualties because the boat (without power) surged a few feet seaward with the ramp down and immediately filled with water and sank.

9. If a craft broaches, make use of a stern line, not a bow line. Use a Dukw or a tractor to pull on it. Men can do little. Get a salvage line to a broaching craft immediately. Don't wait for it to broach; if stern broaching lines are used as soon as a craft lands, the casualties due to broaching will be reduced greatly. Concentrate on the craft just starting to broach; to work on a fully broached craft that is aground is just wasting time if others can be righted in a short time.

10. When handling the lines during salvage operations be sure and keep them clear of the screws.

11. Launch LCVP and LCM from jeheemies with the stern of the craft to sea. In this manner the section of the craft with the greatest draft will be in the deepest water. The craft is less liable to wash ashore again (perhaps damaging the screw while doing so). Further, the craft is in position to back through the surf.

V

(b) ADVICE FOR AMPHIBIOUS CRAFT AND VEHICLE OPERATORS

12. The longer a boat is at the beach discharging men and equipment, the longer it is in danger of broaching or hard grounding. Get the ramp down, the cargo discharged, the ramp up and retract as fast as possible.

Broached craft — the result of men being slow in disembarking and slow in raising ramps.

13. When retracting, LCMs and LCVPs should back through the surf and not attempt to turn about, retracting bow first. The craft does not tend to breach as much and thus avoids being hit broadside by an approaching breaker when backing through the surf. This applies to a steep or moderate beach. No field information is available for a very flat (1:100) beach.

Backing through the surf
Wet but safe

Turning about in the surf
Soon the craft will be broadside to the surf and in danger.

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