SYRACUSE UNIVERSITY STADIUM

SYRACUSE UNIVERSITY STADIUM

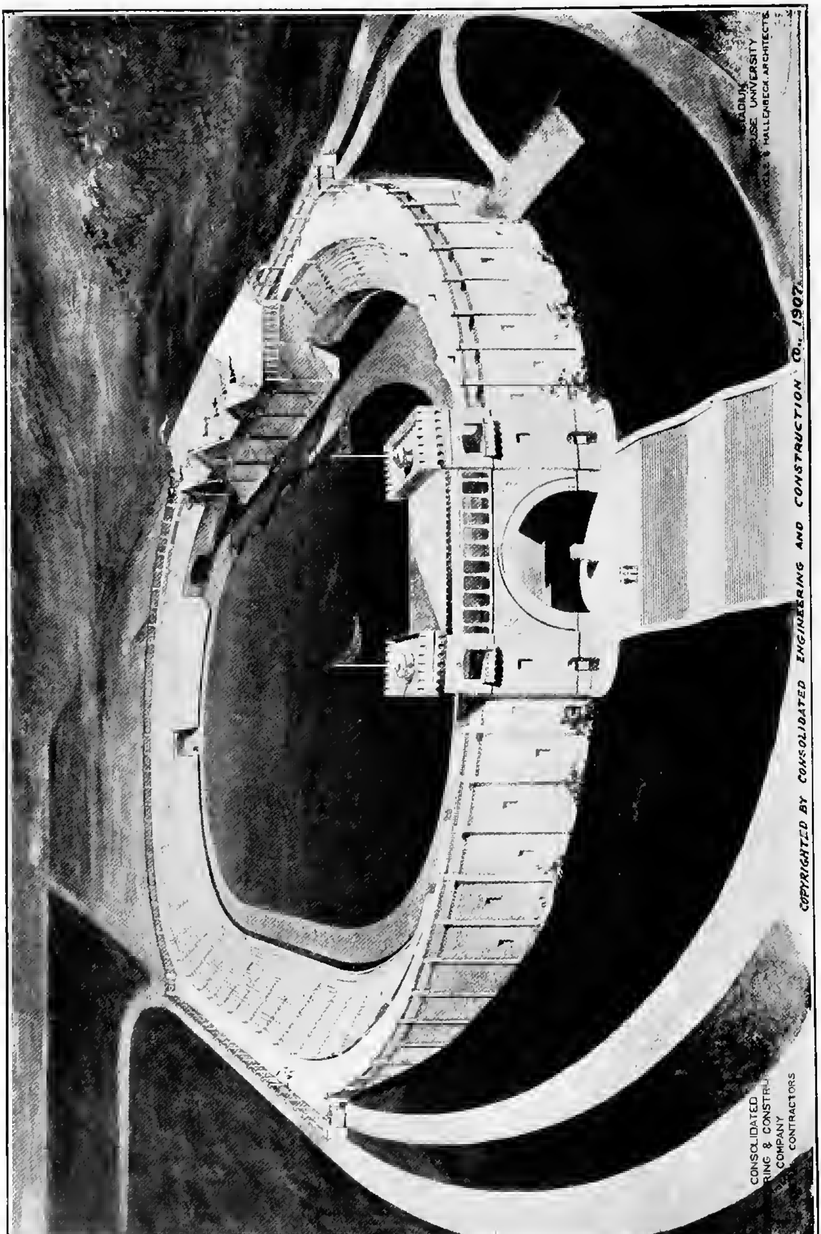
BUILT BY

CONSOLIDATED
ENGINEERING & CONSTRUCTION
COMPANY

ONE MADISON AVENUE
NEW YORK

PICTURES SHOWING
Method *of* Construction
ACCOMPANIED *by*
HISTORICAL *and*
TECHNICAL SKETCH

Reinforced Concrete Stadium at Syracuse University



Reinforced Concrete Stadium at Syracuse University.

THE GREATEST ATHLETIC ARENA IN AMERICA.

DIMENSIONS

Length on Long Axis -	670 feet
Length on Short Axis -	475 feet
Area Covered - - -	6 $\frac{1}{3}$ acres
Normal Seating Capacity	20,000
Possible Seating Capacity	40,000

TOTAL QUANTITIES

Excavation - - - -	250,000 cubic yards
Reinforced Concrete -	20,000 cubic yards
Reinforcing Steel - -	500 tons
Clinton Wire Cloth -	280,000 square feet
Galvanized Metal Lath	220,000 square feet

This picture taken October, 1906. Shows the manner in which the excavated material was drawn over the bridge in scrapers and dropped through a trap into the dump wagons under the bridge.

THE NEW STADIUM

FOR

SYRACUSE UNIVERSITY

It is probable that for no other people in history have athletic games and contests played such an important role as for the ancient Greeks and Romans. The big games and other competitions which were arranged by them from time to time aroused such an interest and enthusiasm as to make them national festivals, the importance of which it is difficult for later generations to realize.

We have striking evidence of these conditions in the many splendid Stadia, Circuses and Amphitheatres which were erected for athletic purposes in Greece and throughout the Roman Empire. Many of these buildings excelled in magnitude and architectural beauty anything similar that has been accomplished in modern times. The Greek Stadia are the oldest of these structures.

The Stadium was originally a measure of distance equalling 600 Greek feet, or 606′-9″ in English measure. The Stadium being the usual distance for foot races, the name came later to be applied to the structures where foot races and other athletic contests were held. Originally such contests took place in some convenient natural hollow, and the spectators were seated on the ground on the sloping hillsides. Later, the natural hollow was brought artificially into more regular shape, and finally it was provided with seats of wood, stone or marble. The most famous of the Greek Stadia were those in Olympia and Athens. In both these structures the seats were laid directly on the ground, while at others, as for instance those at Delphi or Messene, the seats were wholly or partly supported by a masonry sub-structure.

The Stadium at Athens, which was in many respects typical of this class of buildings, had the following arrangement: the lower tier of seats was raised three feet from the floor of the arena, and some six feet in front of this lower tier a breastwork formed a separation between the bank of seats and the arena, the space thus cut off serving as a passage to give access to the flights of steps leading to the seats. The floor of this passage was paved, and below was a drain which kept the passage dry, and carried off the rain water that ran down from the seats. The arena, the level of which was slightly above the surrounding passage, was similarly under-drained. There were separate underground entrances, leading directly to the arena, for the contestants and the judges. This Stadium seems to have been first constructed by the Orator Lycurgus, about the year 350 B. C. About the middle of the second century of our era, a wealthy Roman, Herodes Atticus, added to the structure, seats of Pentelicon marble. The ancient structure had

Note the radiating broken stone and tile drains for quickly draining the field, and the Industrial Railroad used on the excavation. The derrick in the picture is hoisting a double dump steel car with 27 cubic feet of excavated material out of the field.

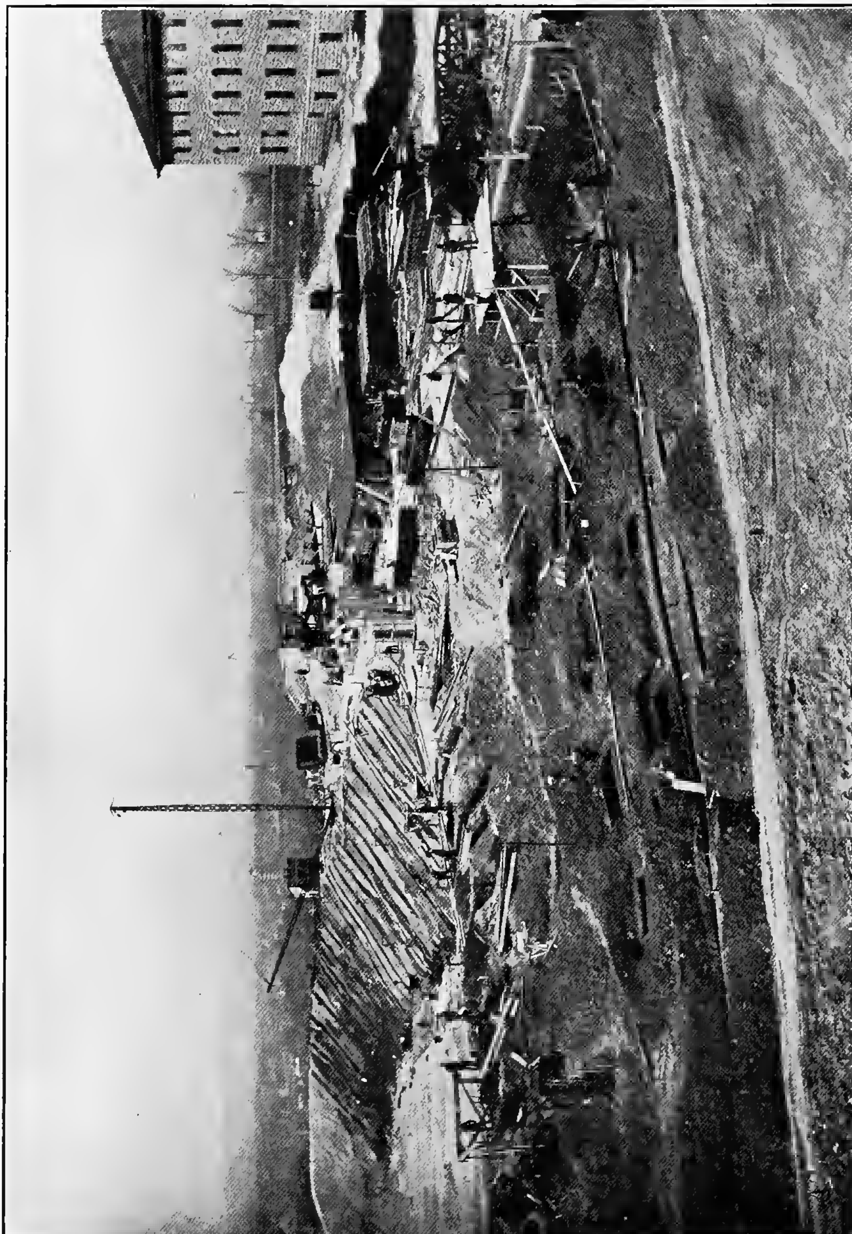
lost nearly all its marble work and had been largely buried, but was excavated at the expense of King George of Greece in 1869-70. It has now been completely restored through the generosity of a wealthy Greek merchant in Alexandria, and has, through the Olympic games, which in recent years have been held there, regained some of its old importance. Like nearly all Greek Stadia, the one in Athens was built in the shape of a horseshoe, semi-circular at one end and open at the other. The arena was 109 feet wide and 669 feet long, and contained fifty thousand (50,000) seats.

Similar to the Stadium, but shorter in length, were the old Greek theatres, of which a great number existed. One of the most famous of these was the one in Syracuse in Sicily.

From the Greek Stadium or Theatre, the Romans developed their more elaborate Circus and Amphitheatre. These buildings were generally constructed on a level site, supporting the tiers of seats on massive arches and vaults of solid masonry, and utilizing the space below the seats for passages and stairways, as well as for other purposes. The Roman circuses, which were used mainly for horse and chariot racing, were colossal structures in which audiences equalling the population of a considerable city could be seated. In plan they were similar to the Greek Stadia, though wider in relation to the length. Many of them contained a great central wall or spina, dividing the arena into halves, so that the chariots could drive up on one side and back on the other. The greatest of these Circuses, the Circus Maximus, at Rome, as finally enlarged, would seat, it is claimed, 380,000 spectators. It was 705 feet wide and 2,200 feet long. The circus of Nero, which stood on the present site of the Cathedral of St. Peter, was about 350 feet wide and 1,200 feet long. The best preserved of the Roman Circuses is that of Maxentius on the Appian Way, two miles from Rome. This structure was 245 feet wide and 1,620 feet long.

The Roman Amphitheatres, which were mainly used for battles with wild animals, and for gladiatorial contests, were much smaller than the Circuses and differed in plan from these structures in forming a complete ellipse. The best known is the Colosseum in Rome. In Nimes and Arles in the south of France, at Pola in Istria, and at Verona, and Pompeii in Italy are, however, Amphitheatres in a better state of preservation than the Colosseum. With the decadence of Greece and Rome, athletics lost their former importance, and the centuries following the downfall of the Roman Empire cannot show any such structures as the Greek Stadia, or the Roman Circuses or Amphitheatres.

In modern times we have, however, witnessed a revival of outdoor sports, and particularly at our universities, athletics is a feature of growing importance. It may be said in fact that no other regularly occurring events are followed with such universal interest and collect as large crowds as the athletic contests between our large colleges, especially the annual foot-ball games. There has therefore grown up a demand for a new type of building with large seating capacity and free from the dangers of fire and collapse. The demand has brought forward the modern



This picture shows the excavation on lines of girders and also the starting of excavation for the Gymnasium, which, when completed, will be the largest Gymnasium in the world. The Consolidated Engineering and Construction Company has this building now under construction.

fireproof Stadium, built with the old Greek and Roman structures as models, but with the most modern of fireproof materials, reinforced concrete.

The first concrete Stadium in the United States was constructed for the University of California in 1903. This building, though termed a Stadium, is more in the style of a theatre. It is in fact a reproduction of the old Greek theatre of Dionysus. More important and more like the old Stadia in its construction is the one in Soldiers' Field at Harvard, which was built the same year.

The third and latest Stadium built in America is that at Syracuse University, which the Consolidated Engineering & Construction Company has just completed. There are probably very few universities in this country which can boast of a location offering such attractive surroundings for the buildings as does the Campus in Syracuse. It is situated on a great height about one mile from the center of Syracuse and commands a fine view of the City, Onondaga Lake and nearby Onondaga Valley. The University grounds contain a number of hills on which are located the different college buildings, several of which are of a very monumental character. In the middle of the west side of the Campus the ground forms a large natural hollow in which the new Stadium has been erected. In plan it forms an oval, 475 feet wide and 670 feet long, with semi-circular ends, joined by a straight part 198 feet in length. The central part of the field is especially intended for foot-ball games and is covered with sod. Outside of this sodded part is a running track one-quarter of a mile long.

In order to insure a good view of the races from every seat, the running track does not come close to the structure, but is separated from the same by a space five feet wide. Immediately outside of this space is a concrete wall five feet high, the top of which forms a curb for a four foot walk, which runs around the structure. The elevation of this walk is 4′-6″ above the field. Above this walk rise eighteen tiers of seats 18″ high and 27″ wide to a level, 31′-6″ above the field. At intervals of 30 or 35 feet small steps two feet long, 13½″ wide and 9″ high have been built on top of the seats, so as to form stairs. At the top of the seats is a concrete wall 12″ thick and 3′-6″ high. Opposite every row of steps this wall has an opening 4 feet wide. Outside of this wall is a promenade of concrete 20 feet wide, covered with asphalt. It is surrounded by a concrete curb 2 feet wide on which rises an iron fence 8 feet high, between concrete posts about 18 feet apart. The rear of the concrete work is covered entirely by the ground which runs up to the level of the promenade, except at the west end, where it falls off suddenly to a level 35 feet below the promenade. The Stadium here has the character of a 2-story structure with curtain walls and piers of reinforced concrete. The central part projects slightly and forms two towers. From both sides of the main entrance, inside the arches, stairs run up to the promenade where the promenade passes under the towers, and from this point the people are distributed to the various sections of the structure by way of the promenade.

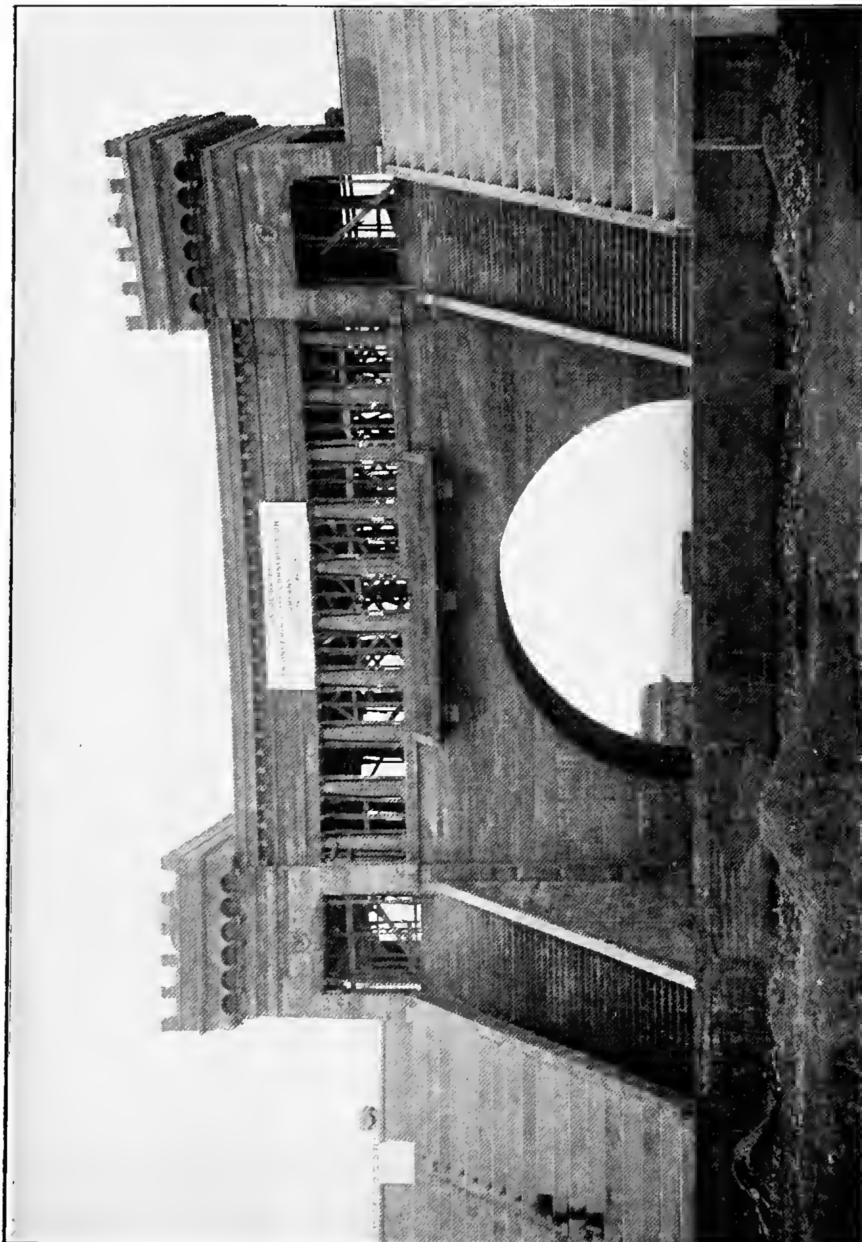
This picture shows the steel derrick erecting the structural steel over the Grand Stand, also the excavation for the rear wall of the Gymnasium and for the tunnel which is to connect the basement of the Gymnasium with the field of the Stadium.

The grand stand is located on the south side, and occupies the whole straight part of same, 196 feet in length. It is covered by a cement roof, supported by steel trusses and columns, and suggests in its design the Gothic style of architecture. On both sides of the grand stand for a distance occupying 45° on the circle, the ten lower tiers of seats are omitted and a retaining wall 20 feet high forms the interior part of the concrete work. This arrangement was made in order to obtain a straight track for 220 yard races, which made it necessary to build two tunnels, through which the track continues outside the Stadium proper. At the east end, still another tunnel connects with the new Gymnasium that is now under construction.

On account of the topography of the Campus, it was realized that special attention would have to be paid to the drainage. For this purpose the promenade at the top, and the walk at the bottom of the seats were graded towards outlets at a distance of about 50 feet apart. These outlets were connected with 4″ cast iron pipe which carried the water to the sewer. Throughout the field in different directions ditches were formed, on the bottom of which were placed open tile drains leading to the sewer. The tile was covered with broken stone, on the top of which the sod was placed. For the running track, drainage was provided by a foundation of broken stone, which is covered with a layer of cinders. During the Fall several heavy rain storms have occurred which have afforded a good test for the drainage arrangements. After each rain storm the field has dried out in a short time. In connection with the drainage, a sprinkler system has also been installed. This consists of water pipe running through the longitudinal axis of the Stadium, branching off to both sides, so as to form outlets near the edge of the sodded foot-ball ground at distances of about 100 feet. These outlets can be connected with rubber hose for sprinkling the field or flushing the seats.

In regard to the design of the concrete work, the whole superstructure is carried on piers which are placed five in a row, as shown in the typical section. These lines of columns are spaced 15 or 16 feet apart for the straight portions, and at distances occupying 4°-30′ for the curved ends. A large part of the banks has been formed by a filling of loose earth. In such cases the piers have been carried down to the original soil; where no fill existed, they have been brought down 4′-6″ below the surface. The ground consists in different places of hard pan, gravel, sand or loam. The footings, which are of concrete without reinforcement, are proportioned for a load on the soil varying from one to four tons per square foot.

It was assumed that 600 lbs. per square inch would constitute a safe load for columns reinforced with vertical rods and hooping, and 400 lbs. per square inch for columns reinforced, but not hooped. These assumptions were, however, without importance, as other conditions governed the size of the columns. In general they were made of uniform size, of rectangular shape, 12″x30″, reinforced with four Kahn bars, weighing 2.7 lbs. per foot. The rectangular shape was adopted in order to resist the effect of any sliding tendency that the bank might have.



Picture showing inside of front entrance. Note the two long flights of concrete stairs leading to the Promenade, the balcony and concrete columns in rough cast and the 40 foot arch.

Where it was necessary to use columns of great length, they were made square, with a side not less than 1-15 of the length of the column. These columns were reinforced with four round rods of ⅞" diameter, and wrapped with Clinton wire cloth 3"x8" mesh, 8-10 wire. In general all parts of the structure were figured for a live load of 100 lbs. per square foot, except the promenade, which was designed for 120 lbs., and the roofs over the grand stand and main entrance, which were figured for a live load of 40 lbs. per square foot.

In calculating bending stresses, the straight line formula was used throughout, and the tensile strength of the concrete was neglected. It is of course realized that this formula is not scientifically correct, but the writer believes that in this respect it does not differ from any of the other formulæ at present in use. These formulæ are, as a rule, based on more or less inaccurate observations of the deformation of concrete subjected to plain compression, not taking into account the fact that the deformation of concrete is governed by quite different laws when the compression stress is caused through bending. Bending tests seem to indicate that in this latter case a reinforcement of the upper layers by the layers below occurs, whereby the elastic properties of concrete are changed so as to cause the compression stress in the top layers to decrease, and that in the layers below to increase. Our present knowledge of the elastic properties of concrete is not sufficient to find a theoretically correct solution of this problem, but the straight line formula has in its simplicity a decided advantage over all others. As far as the practical result is concerned, it is of very small importance what formula is used if the allowable compression and tensile stresses for concrete and steel are assumed accordingly.

The safe compression stress for concrete was in this case assumed to be 600 lbs. per square inch and the safe tensile stress for steel 16,000 lbs. per square inch. The girders, steps, and the slab of the promenade were figured continuous and the maximum bending moment was assumed to be W L ÷ 12 where "W" represents the total dead and live load and "L" the distance between supports. The negative bending moment over the supports was assumed to be W L ÷ 18 and steel was provided according to this assumption. The general arrangement for a typical section is shown by drawing. The main girders are 2 feet deep and 1 foot wide. The slab formed by the steps has a minimum thickness of 4" and the slab of the promenade a thickness varying from 7" to 9", depending upon length of span. This design for the promenade was adopted in order to make it possible to remove the forms, which would have been impossible if ribbed construction had been employed.

The main reinforcement for girders, steps and promenade consists of Kahn bars, with stirrups varying in length from 6" to 30". In addition to the Kahn steel, Clinton wire cloth has been placed 1½" below the surface of all concrete exposed to view. This was done solely in order to prevent cracking, as much as possible and the Clinton wire cloth was not taken into consideration when figuring the bearing capacity of

To the left can be seen the manner of forming the seats and the supporting girders. In the upper left hand corner, in the distance, is Sims Hall, Men's Dormitory Building, which was erected last year by the Consolidated Engineering & Construction Company.

the concrete. The sizes used were 4"x6" mesh 10-10 wire, 30" wide, for the steps and 3"x8" mesh, 8-10 wire, 72" wide, for other places.

One of the most serious problems in concrete construction is to prevent cracking caused by contraction of concrete through temperature changes or through the setting of the concrete. For this purpose it is the practice of a great number of designers to leave in all structures of great length contraction joints, in order to confine the opening up of the concrete to straight lines, and to places where least objectionable. It is the writer's experience that in order to be effective these contraction joints should not be placed farther apart than 25 or 30 feet. At the Syracuse Stadium joints spaced at such a short distance would have seriously interfered with the construction, caused unnecessary additional expense, and would besides have been quite as objectionable in appearance as promiscuous cracking. It was therefore decided not to leave any contraction joints, but an endeavor has been made to prevent cracking as much as possible by using a sufficient amount of reinforcing steel.

In order to decide the quantity of steel required, let us assume that the area in cross section of the concrete is "A" square inches, the area of the steel A', the co-efficient of expansion for concrete and steel 0.0000055 and 0.0000065 respectively, the modulus of the elasticity of the steel 30,000,000 lbs. per square inch, and the elastic limit of the steel is 50,000 lbs. per square inch. A temperature fall of 100° would cause a proportionate contraction of the concrete of 0.00055, which is far more than plain concrete could be stretched. If reinforced, it could easily be stretched this amount, and the stress caused would then equal the breaking stress of concrete. If the tensile strength of concrete is 300 lbs. per square inch, and if we assume that the whole stress in the concrete is transmitted to the steel, we have the stress caused in the steel $300 \frac{A}{A'}$. Through the fall of temperature in the steel itself a tensile stress of $100 \times 0.0000065 \times 30{,}000{,}000 = 19{,}500$ lbs. per square inch is caused. We have therefore the following equation:

$$300 \frac{A}{A'} + 19{,}500 = 50{,}000.$$

The equation gives the proportion of steel to concrete as 1%.

Experiments by Mr. Considere and others seem to prove conclusively that reinforced concrete retains its full tensile strength even for very considerable deformation. It would therefore be reasonable to assume that only a part of the stresses caused by the cooling of the concrete are transferred to the steel. Allowing that ⅔ of the stresses are taken by the concrete itself, the proportion of steel required would be one-third of one per cent. In the design of the Syracuse Stadium an effort has been made to keep the percentage of steel above this figure. To insure continuity of the reinforcement, all Kahn bars in the seats and promenade have been ordered 2 feet longer than the span. A further precaution against cracking is the Clinton wire cloth that is running around the whole structure below all exposed surfaces.

From the equation above, it will be seen that a considerably smaller amount of steel with high elastic limit is required than with low elastic

This picture shows the seats under construction over the tunnel and on the North side.

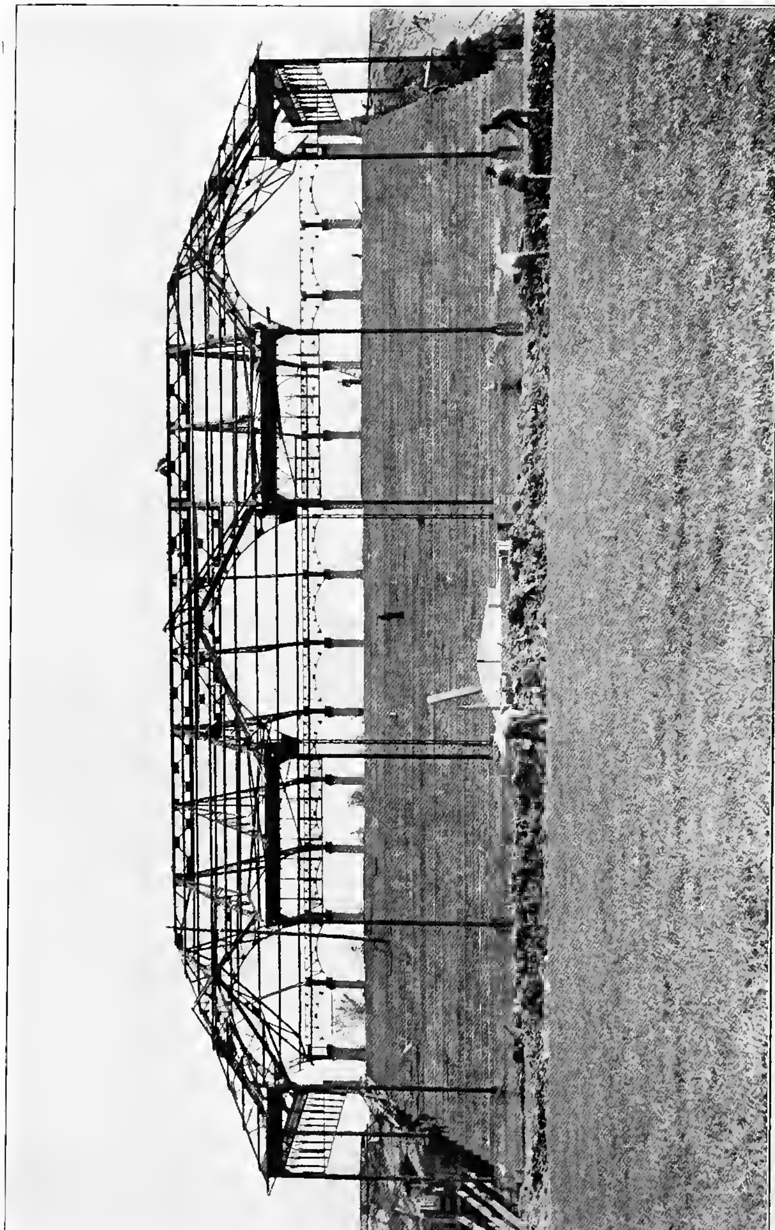
limit. On acount of the nature of the surface treatment, it was impracticable to use wire cloth near the surface at the walls on the west side of the structure. Instead, ¾″ diameter round steel rods spaced vertically 2 feet apart, and horizontally 18″ apart, were placed in the centre of the walls. The horizontal bars were ordered in lengths of 40 feet each, were made to overlap, and were wired together at the ends.

The general arrangement at main entrance will be seen from drawings. The approach from Irving Avenue consists of concrete stairs and platforms, which are carried on girders and columns. The towers on both sides of the big arches contain the ticket offices on the ground floor. At a higher level, about 16 feet above the field, they have another floor, on which are located offices for the managers of the competing teams. Two stairways of reinforced concrete lead from the ground floor to each office. Directly over the main entrance at the level of the promenade the floor is of tile and concrete construction, the tile being 8″ deep and 12″ wide, and spaced 16″ apart, so as to form concrete beams 4″ in width. Each one of these concrete beams is reinforced with a 4.8 lb. Kahn bar. On the top of the 8″ tile is a layer of concrete 3″ thick, making the whole floor construction 11″.

In order to prevent cracking from contraction, the concrete slab is reinforced with ½″ diameter round steel rods placed 6″ center to center, and perpendicular to the Kahn bars. As previously mentioned, the center part of the south side of the Stadium is covered and forms the Grand Stand. The roof itself is a cement roof, reinforced with ferrolithic plates. These consist of steel sheets, gauge No. 24, corrugated to a depth of ¾″ so as to form dovetail grooves. At right angles to these dovetail corrugations, the steel sheets have some lighter corrugations about ⅛″ deep. These ferrolithic sheets are covered with cement mortar to a depth of 1¼″ above the metal and ⅜″ below the corrugations on the under side. The sheets are strong enough to support the concrete before set, and no form work is therefore necessary. Through the dovetail shape a good bond is obtained for the cement plaster, so that the plastering on the underside can be done directly on the sheets. The ferrolithic sheets are attached with clips to the purlins, which consist of 6″ I-beams, spaced about 6′-10″ apart. The roof construction is formed by steel trusses of the type known as "French" trusses. At the right and bottom, the main trusses are joined by lattice and plate girders which carry intermediate trusses. From the top of the two end trusses project cantilever girders which serve to carry the four trussed hips.

For the circular and Gothic arches immediately below the roof, a framework of light steel angles has been used. This steel work has been furred with small steel channels and bars, covered with metal lath and plastered with cement. The roof structure is supported by steel columns in the front and sides, but in the rear, the trusses come down directly upon the concrete piers. The columns are made of four 3½″x3″ angles, and covered with concrete. In the center of columns are located 4″ cast iron leaders which carry the water from the roof.

In figuring the columns the steel was calculated to take all loads.



Steel work over Grand Stand about completed and ready for the concrete roof.

The design of the structure on both sides of the Grand Stand is shown by drawings. The promenade and upper seats, as well as girders carrying same, are similar to the typical sections.

The piers nearest the retaining wall are enlarged so as to reach the walls, whereby they obtain a depth of 8′-2″. They are reinforced with eight vertical steel rods, ⅞″ diameter, spaced 12″ apart, and with the ends bent down into the footing. For a distance of 5 feet above ground the walls have a thickness of 3 feet; above this level, 1 foot. The walls are reinforced with 1.4 lb. Kahn bars, spaced horizontally 6″ and 9″ apart, and turned into the piers 4 feet at each end.

A large sewer pipe runs close to the retaining walls, in some places at a depth of 14 feet below the ground, and it was therefore necessary to extend parts of the walls to this depth. The space behind the retaining walls was filled with broken stone, and an open tile drain leading to the sewer was provided at the bottom of this space. The earth behind the walls consisted of gravelly clay, and in figuring the retaining walls it was assumed that the weight of the earth was 110 lbs. per cubic foot, and that the angle of repose was 30°

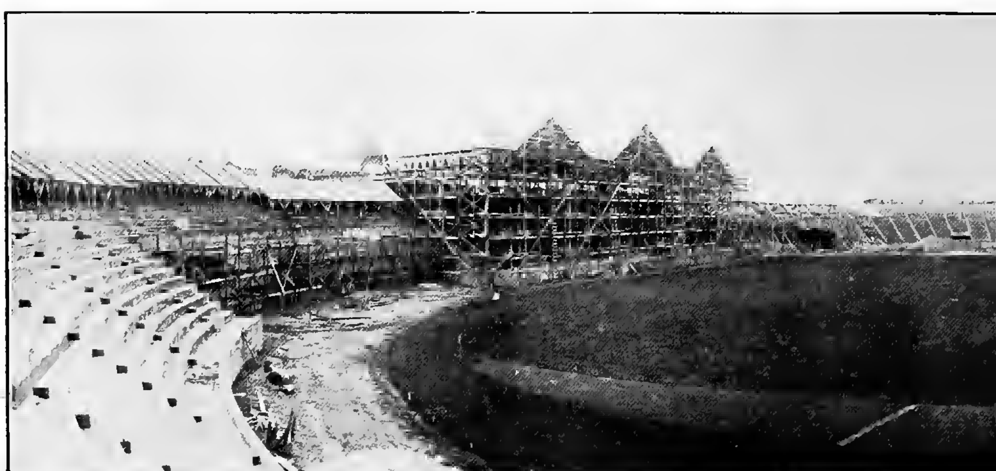
The two tunnels for the straightaway at the east and west ends of the building go through the retaining walls at an angle of 37° and form openings in the same about 34 feet wide. The tunnels which are symmetrical in their design, have a width of 20 feet and a height on the center line of 14 feet. The walls of the tunnels are 2 feet thick, reinforced with 1.4 lb. Kahn bars, placed near the inside and spaced 6″ center to center. Below the ground they are braced against each other by four concrete beams 15″x18″, reinforced with one ⅞″ round steel rod in the center. The concrete arch forming the roof of the tunnel has a rise of 3 feet and a thickness at the crown of 15″. The intrados is a circle and the extrados a straight horizontal line. The reinforcement consists of Clinton wire cloth 3″x8″ mesh, 8-10 wire placed near the under side of the arch at right angles to the center line of the tunnels.

The corners formed by the extrados and the vertical tunnel walls are also reinforced with Clinton wire cloth of the same kind. At both ends, a number of ¾″ round rods run close to the under side of the tunnels and parallel to the end walls. Three feet from the outside ends of the tunnels a pocket is left in the roof and walls of same in which is placed a Kinnear rolling steel shutter. The promenade and seats above the tunnel are built on piers in the same manner as other parts of the Stadium. One of the piers comes down in the center of the tunnel, and the roof is here strengthened by a girder 2 feet deep and 2′-6″ wide, reinforced with three 6.9 lb. Kahn bars.

Just outside the east tunnel the ground is terraced off so as to leave uncovered for a short distance the back of the structure, which in this place, therefore, is surrounded by curtain walls and piers below the promenade. The tunnel leading to the new Gymnasium is located in the east end at the longitudinal axis of the Stadium. It has a width of 20 feet and a height in the center of 14 feet. Immediately below the promenade, the floor of the tunnel is horizontal and 16′-4″ above the field,

View looking East showing the Gymnasium Tunn

THE GREATEST ATHLE



View looking West. Note the main arch of the entrance in the center o
obtained by noting that this arch in the distance is 40 feet clear span.

in the distance and the Grand Stand at the right.

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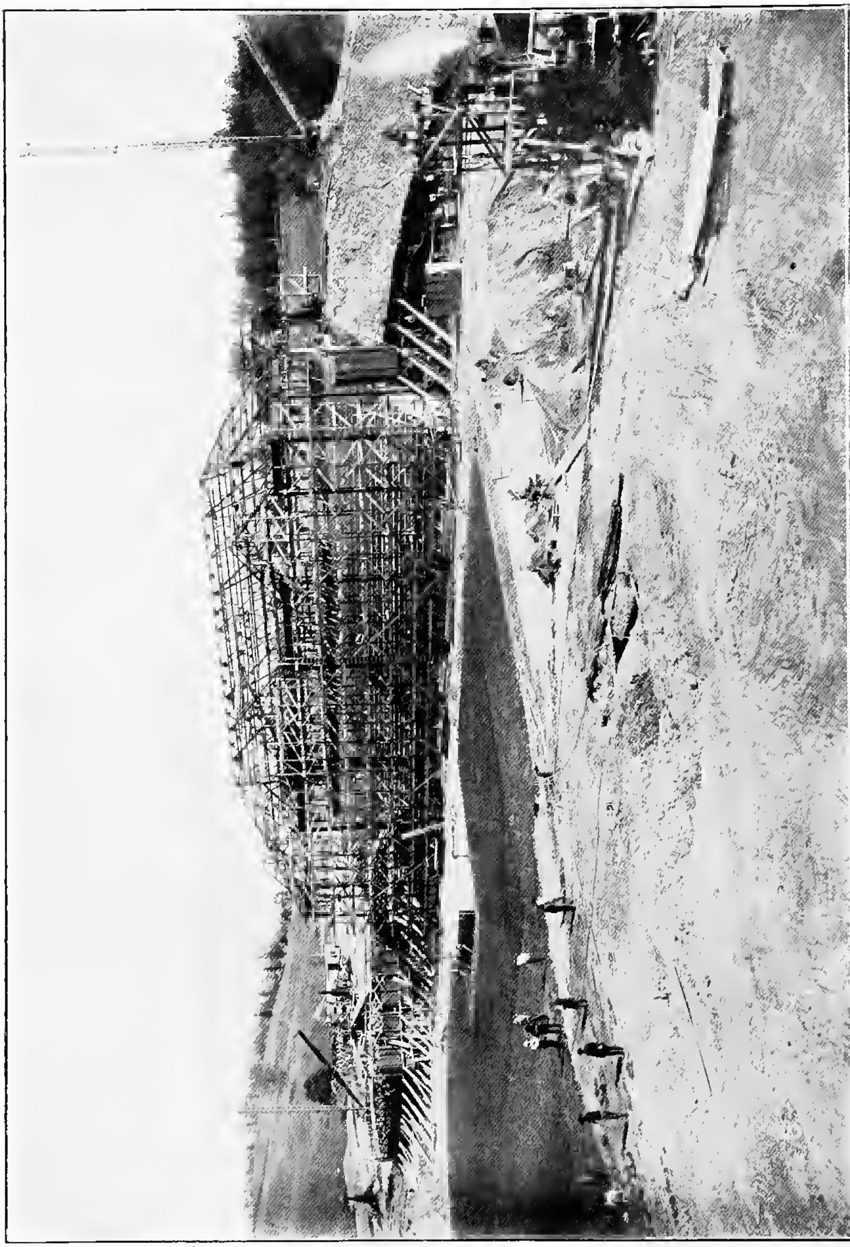
he picture at the furthest extremity. An idea of the magnitude of the structure may be



This picture shows the Grand Stand scaffolded ready for cement work, and in the upper left hand corner, it shows the steel derrick set up for hoisting excavated materials in cars onto the trestle, from which point they run by gravity into the valley.

but in the front part the floor is formed by concrete stairs leading up to this level. The horizontal part of the floor, as well as the stairs, is supported by the tunnel walls, thus having a span of 20 feet. The floor is 8" thick and reinforced with 1.4 Kahn bars 6" center to center. The slab of the stair is 6" thick, and the reinforcement consists of 1.4 Kahn bars, one for each step. The center part of the stair is protected by Mason Safety Treads, 7½" wide and 13 feet long. At the ends, the steps are covered with 1⅜" treads of N. C. pine nailed to wooden sleepers imbedded in the concrete.

The walls of the tunnel are 15" thick, reinforced with 1.4 lb. Kahn bars placed vertically near the inside of the walls at a distance of 9" center to center. They are also reinforced with Clinton wire cloth 3"x8" mesh, 8-10 wire. It will be noticed that the roof of the tunnel is a concrete arch, with the under side forming part of a circle and the outside formed by the regular seats and promenade of the structure. The thickness at the crown of the arch varies from 12" to 14". A layer of Clinton wire cloth runs near the under-side of the arch as well as the surface of the steps.

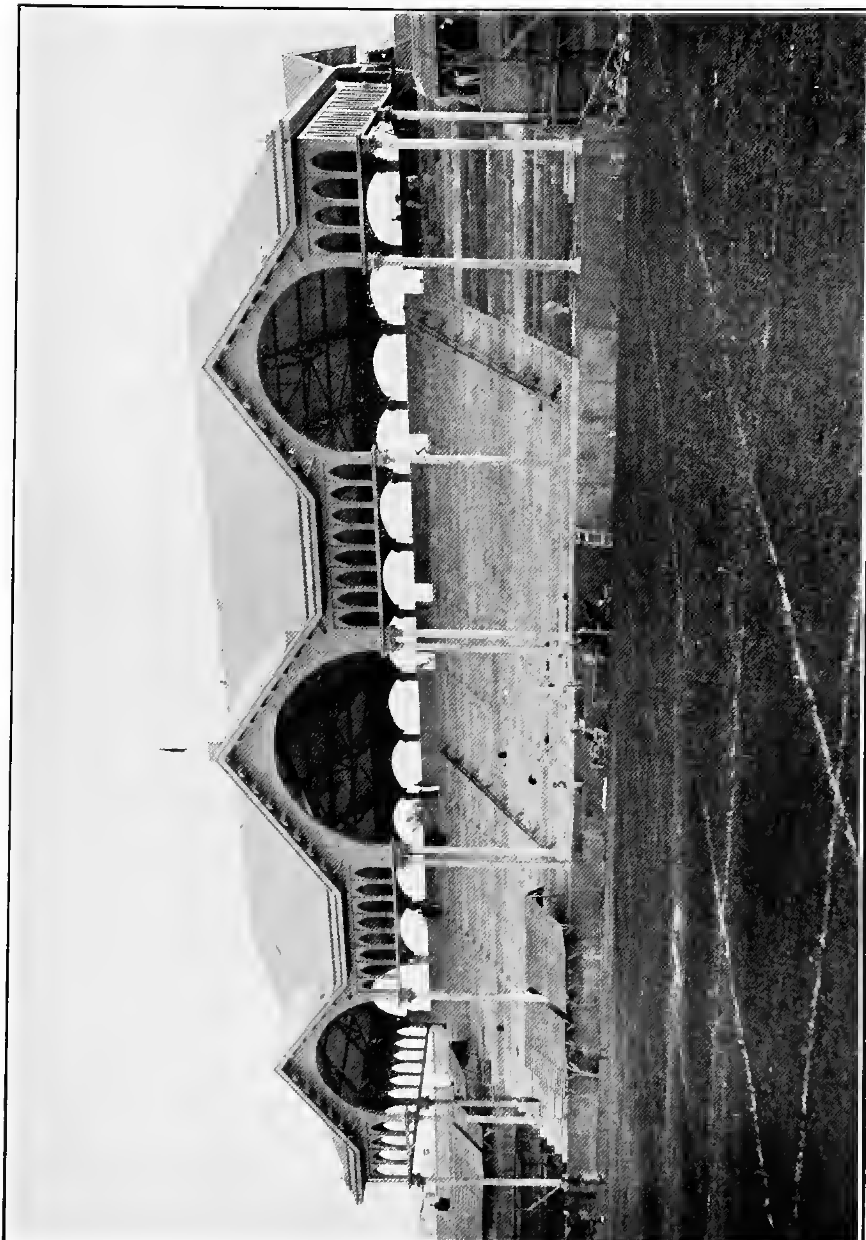
Above the tunnel on the curve at the foot of the seats is to be placed a brass railing three feet high. This will return down the edges of the steps where an opening is formed in the concrete work. A similar railing is to be placed on the curve above the 20 foot retaining walls and in other parts of the structure where the height above the ground makes it necessary. A smaller brass railing 2 feet high will run on the curb at the foot of the seats on top of the five foot breast wall.

On the outer edge of the promenade surrounding the structure are located ornamental posts 2 feet square,9 feet high, at a distance of 15 to 19 feet, center to center. In about every third post an electric conduit is incased which runs to the center of the top of the post. Here an arc light will be placed. On all the other concrete posts brass pins have been imbedded for the purpose of carrying pennants.

Between these concrete posts is an iron fence about 8 feet high. This fence consists of 1" square pickets, 6" apart, and two top and two bottom rails, each 2"x ⅝". About every five feet one of the pickets extends down into the concrete curb for the purpose of holding the fence panels rigid. In each concrete post four pieces of 2"x¾" steel about 8" long are buried so as to project 2½". The iron fence panels are fastened to these pieces of steel with ⅝" bolts.

At the center of the curved East end two sections of the fence are omitted, as it is the intention to connect the promenade at this point with the new Gymnasium building, which the Consolidated Engineering & Construction Company has now under construction.

This building, for which only the foundations are at present constructed, will be a fireproof, steel frame building, 150 feet wide and 220 feet long. It is claimed that when completed it will be the largest and best equipped gymnasium in the world. Two large reinforced concrete tanks for swimming and rowing respectively are located in the basement and are now completed as far as reinforced concrete work goes.



This picture shows the front Elevation of the Grand Stand with roof completed.

The swimming tank is 32 feet wide and 90 feet long, measured to the finished surfaces. At the corners the tank is rounded to a radius of 2 feet, in order to give less obstruction to the flow of the water. The tank will be finished in white tile.

At the deepest point, 10 feet from one end, the tank has a depth of 7'-6", diminishing to 4'-6" at each end. The tank rests directly on the ground, which here consists of loose clay. The bottom has a minimum thickness of 12" and is stepped on the underside, so as to obtain the desired slope. It is reinforced with Clinton wire cloth near the upper and undersides. The sides of the tank have a thickness varying from 12" to 22". They have on the inside one layer of Clinton wire cloth, as well as 1.4 lb. Kahn bars, spaced 18" apart. The Clinton wire cloth used in the bottom and sides of the tank has a mesh of 3"x8" and 8-10 wire.

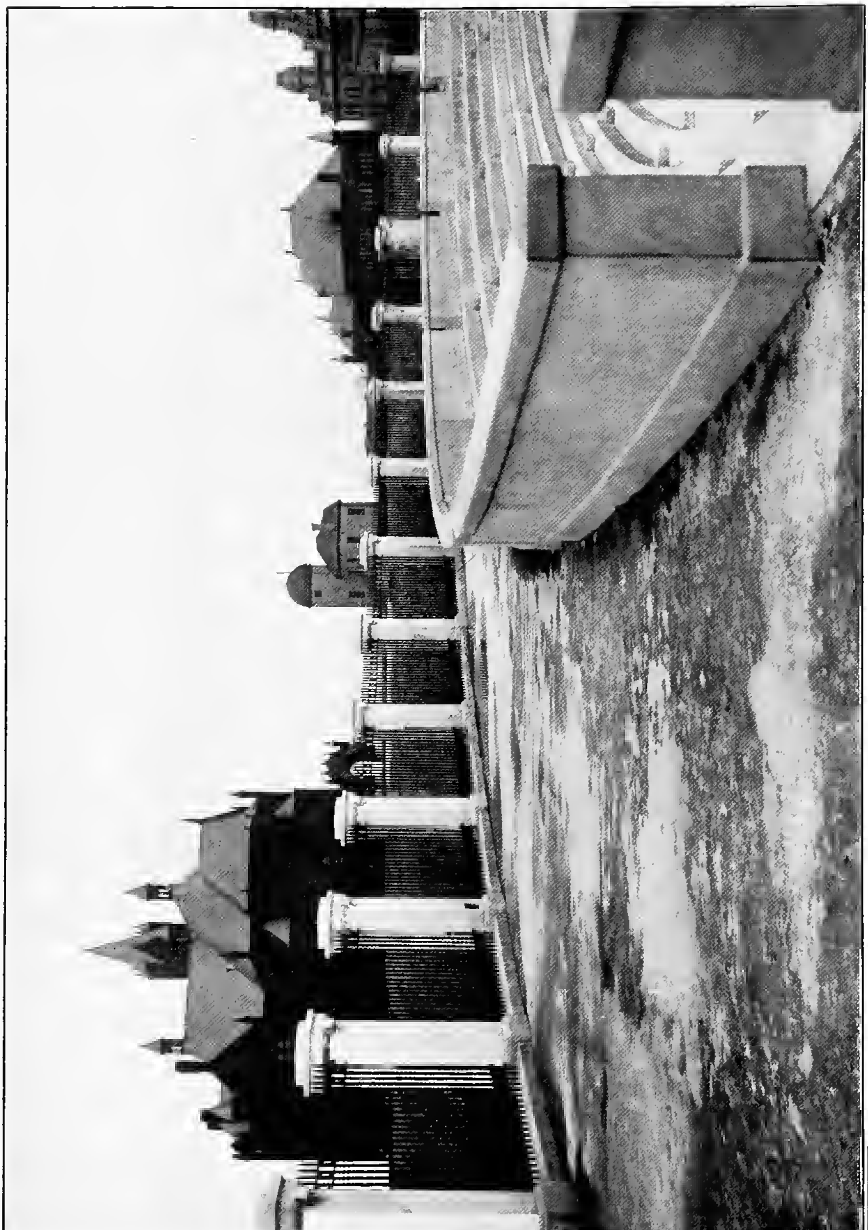
The design of the sides of the swimming tank has been influenced largely by the fact that they serve as a foundation to the outside walls of the building, as well as for interior and exterior steel columns. The rowing tank is similar in design to the swimming tank but has a length of 60 feet and a width of 32 feet. The bottom slopes evenly from a depth of 4'-6" on one end to 6'-6" on the other end.

In regard to the execution of the work for the Stadium, this was started by Syracuse University without the aid of any contractor, and a considerable amount of excavation was done on this arrangement. In the place where the Stadium is located, the ground forms a natural hollow, not very different in size from the proposed structure. A great deal of excavation was, however, necessary to bring it to the desired shape.

The methods employed for this purpose consisted in loosening the earth by plowing the ground, and by working it with picks and shovels. The earth was then brought, by wheel and drag scrapers over a temporary wooden bridge provided with a hopper, through which it was dropped into dump wagons, teamed out of the hole and deposited where desired on the Campus.

The haul from the hollow field of the Stadium to the ground above was very steep, and considerable difficulty was experienced in keeping the road in good condition, due largely to the fact that all the surface drainage of a large valley and hill to the east drained down to the low level of the Stadium through the only passage that could be used for teaming. In several instances, after a heavy rain storm, work had to be stopped for a few days as it was practically impossible to haul a load out of the hole up to the high level of the Campus.

When, however, the contract for the completion of the excavation and for the construction was awarded to the Consolidated Engineering & Construction Company, it was decided to make different arrangements for getting out the materials and eliminating all delays. A large derrick was erected on the top of the bank at the north of the hollow, and an industrial track, 24" gauge, was run from the derrick, on a trestle, to a point on the Campus, a distance of about 500 or 600 feet to the north,



This picture shows the outside posts and steel fence enclosing promenade, also the upper parapet and concrete seats, and one of the many entrances from promenade to the tiers of seats.

at which point it was decided considerable of the excavated material could be used for filling.

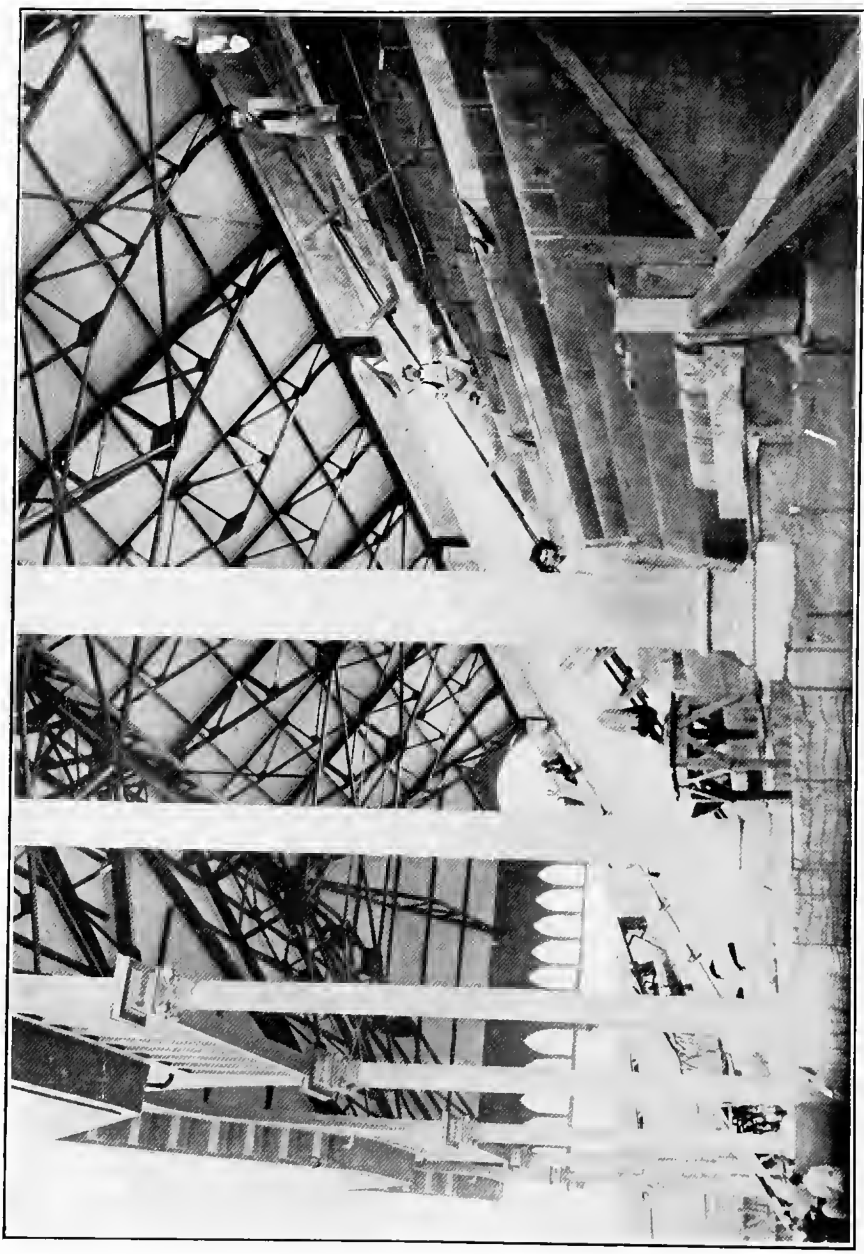
In the hollow, directly below the derrick, within boom reach similar tracks were laid to the different places where excavation was to be carried on. The earth was dug by Italian laborers, placed in steel double dump cars made to run on the industrial track to the point under the derrick from where it was lifted by the derrick out of the hole and placed on the trestle above, from which point the cars of excavated material were hauled by horses and trains to the point where the material was to be dumped. At intervals, switches were placed in the track so that the cars could pass in different directions. The derrick used was a steel lattice derrick with a 70-foot mast and a 60-foot boom. It was provided with a 10-foot bull wheel and slewed by steam. Its capacity was eight tons. A Ransome concrete mixer was also placed within boom distance of this derrick, on top of the bank, and the same derrick was able to pick up a car of concrete and lower it into the hole onto the tracks, from which place it was pushed to the various locations for building the concrete foundations. The industrial tracks also ran from this concrete mixer around the top of the bank where the promenade is now located, and by this arrangement, a car-load of concrete could be quickly delivered at either the top or at the bottom of the bank, at any point on the structure.

On the bank above the retaining wall, at the south-east corner of the structure, where a very heavy cut occurred, another large steel derrick was placed for hoisting car-loads of excavated material to a trestle on the upland, from which point these cars ran by gravity into the valley where the material was dumped. The Cars then returned empty, by gravity, on tracks laid directly on the ground to the foot of the derrick. Another Ransome steam concrete mixer was located within boom distance of this derrick, and the tracks were arranged so that the car of concrete could be placed by this derrick on the tracks down at the level of the field or up at the level of the promenade, from which point the concrete was quickly and economically distributed. This last mentioned derrick had a 75-foot boom, an 80-foot mast, a 14-foot bull wheel slewing rig, with a capacity of 9 tons.

The lumber used in general for forms was hemlock and N. C. pine, the sizes consisting largely of 1″x6″; 1″x8″; 2″x4″; 2″x8″ and 2″x10″. For the round concrete columns, the forms were made of 2″x2″ or 2″x3″ N. C. pine, dove-tailed and held together by iron bands. These circular forms were corrugated on the inside for the purpose of giving a better hold to the cement finish.

The forms for girders supporting the seats were made of 1″ material braced by a frame of 2″x4″, about 2 feet apart. It was necessary to cover the upper side of the girders on account of their slope in order not to interfere with the tamping of the concrete. This was done in the following manner:

For every batch of concrete filled into the girders a few pieces of 1″x6″ were nailed to the upper side of the girder. These pieces



This picture shows the interior view of the structural steel supporting the reinforced cement roof.

were not put close together but placed at a distance of about ½". Large spikes were placed in these pieces in order to give good bond between the girders and the seat slab that rested on top. The supporting forms of the promenade and the seats were made of 1" matched stock on 2"x4" supports. Wherever possible they were built in sections and used over again six to eight times. The forms for the risers were made of 2" stock, forms for the walls in general 1" matched material in sections of 3 or 4 ft. wide and 12 or 16 ft. in length. Steel wire was used for keeping forms from spreading. The wooden braces were used to prevent collapsing. The concrete work of the Stadium is composed of cement, sand and broken stone in proportion 1, 3 and 5 for the plain concrete and 1, 2 and 4 for the reinforced concrete.

The sand used in the concrete work was largely obtained from a bed in the west part of the field, which was found when excavating there. A considerable amount of sand was also taken from Fulton, N. Y. The stone consisted mostly of limestone. For plain concrete work it was broken to pass through a 2" ring, and for reinforced concrete work to pass through a ¾" ring. The stone was not screened. The local dealers were unable to supply the required quantity of broken stone, and a large quantity had to be taken from Rochester, Utica and other places. All concrete was mixed very wet, and very thorough stirring was necessary to get the forms properly filled, particularly where Clinton wire cloth was used as reinforcement.

All concrete was mixed with machinery. The plant for mixing the concrete consisted of five Ransome mixers with engines and boilers. Two of the mixers were size No. 3 and three of them size No. 2. In addition to these five mixers, a small Smith mixer on wheels was used as an auxiliary. All the mixers except the one near the main entrance were located at the top of the bank.

At the main entrance an elevator and hoisting engine was placed, with which the concrete was carried up in wheelbarrows to the elevation required. At the other mixers the concrete was carried in dump cars running on an industrial track around the promenade. From the cars the concrete was dumped on wooden platforms and thrown with shovels into the forms or into chutes carrying it down to another platform. In some cases the concrete was put down into the forms directly with wooden chutes, but generally it was placed in the forms with shovels.

Probably the least satisfactory feature about concrete work is the difficulty of obtaining a pleasing appearance. The boards of the forms will always leave impression on the surface, and even with the most careful execution, an even color cannot be obtained. The appearance can, as a rule, be materially improved by working the rough concrete with pick hammers or similar tools.

Another method consists in coating the forms on the inside just before the concrete has been poured into them with a mortar of cement and sand. The attempts that have been made of plastering the concrete work after the forms have been removed, have as a rule, not been successful, owing to the difficulty of obtaining a good bond between the plaster and the old concrete.

This view shows the method of applying the cement finish to the rough concrete seats.

In considering the method to be employed at the Stadium, it was thought that the finish obtained by tooling the concrete would not be suitable for the nature of the work, and that the plastering of the forms before pouring the concrete into them would be impracticable on account of the large amount of reinforcing steel located near the surface. It was therefore decided to finish the concrete work by plastering the same after the removal of the forms, as the only way in which the construction work could be carried on without being held up by the finishing work.

To obtain a good bond between the plaster and the old concrete special means have been employed. At frequent intervals wire nails were driven into the forms on the inside so that the pointed ends projected about 2″ outside of the rough concrete after the forms were removed. Before applying the plaster a small iron nut was put on each projecting nail; the concrete work was then covered with wire lath, and the nails bent over it with the blow of a hammer. The nuts serve to keep the wire lath at a distance of about ¼″ from the old concrete. The wire lath used was 2½ meshes to the inch and No. 20 wire. The nails were about 4″ long, with a bend of ¾″ at one end. The nuts were either square or hexagonal, about ¼″ high.

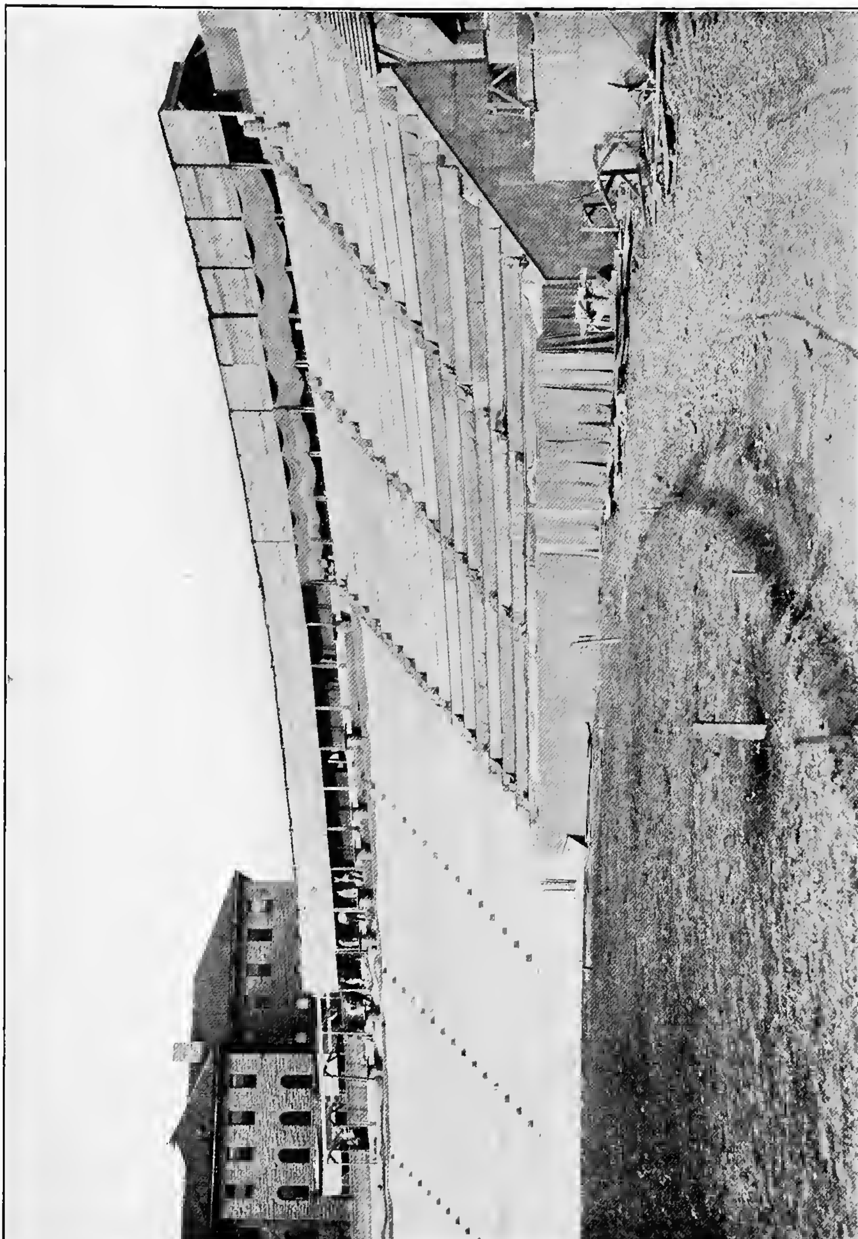
The plaster was put on in two coats, with a total thickness varying from ¾″ to 2″. The scratch coat was composed of one (1) part cement, ¾ part lime, and three (3) parts sand. The finishing coat, which is about 3-16″ thick, is composed of one (1) part cement, to 1¾ parts of sand. The sand used in the finish is white beach sand from Long Island.

To carry the plaster to the desired lines iron templates were placed at intervals, and the plastering finished to them. Before the finishing coat had commenced hardening the templates were removed, and the void left by them filled in. The second coat of plaster was put on when the scratch coat commenced hardening, and was troweled to a smooth finish.

While the cement finishing was being executed the work was protected from the sun by wooden sheds, which were erected over it and moved according to the progress of the work. During the hardening of the plaster it was covered with burlap and on top of same layer of sand, which was continually kept wet.

Where the concrete work is of an ornamental character the outlines of the ornaments were followed by the rough concrete and it was afterwards finished by plastering on wire lath attached to the body of rough concrete in a similar manner as for ordinary work. The only case where a different procedure was followed was for the capitals at the steel columns of the Grand Stand. These were moulded in four parts and put together round the columns with copper wire. The shaft of the columns was made of solid concrete enclosing the steel and finished by plastering on wire lath. To keep the wire lath from the rough concrete this was made corrugated and the lath wrapped around.

The sides of the Grand Stand below the roof were formed by a



This picture shows the cement finishers working under the sheds on the small wall at the top of the seats. It also shows the manner of covering the seats with burlap and sand, after they are finished, to prevent the cement from setting too rapidly.

frame-work of steel from which metal lath was furred out with small steel channels and flat bars. The metal lath was then covered with cement plaster applied in two coats.

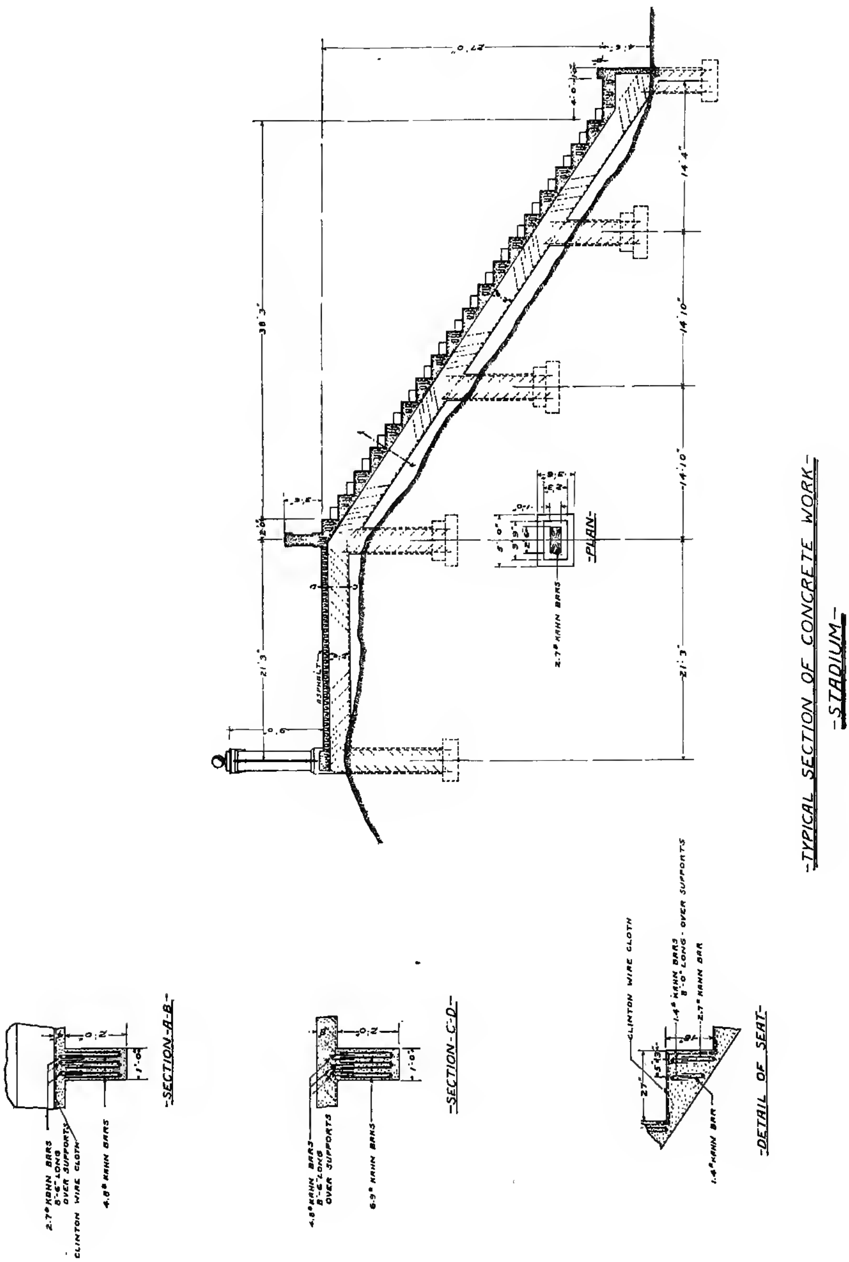
In erecting the steel work for the Grand Stand one of the steel derricks described above, with 80 feet mast and 75 feet boom, was placed on the promenade at the top of the bank and half way from each end of the Grand Stand. The derrick was connected with a hoisting engine, but no bull wheel was used. The steel was delivered at the rear of the Grand Stand and was picked up by the derrick and placed in position. The main trusses were riveted together on the ground and hoisted up in one piece. The weight of one truss was approximately six (6) tons. The central bay of the Grand Stand was first erected. The derrick was then moved to the east end and employed to complete this part of the structure. It was finally moved to the west end, to erect the steel work in this place. The tonnage of the structural steel was one hundred and forty-five (145) tons, and a time of three weeks was required for the erection of same. The laying of the ferrolithic plates for the roof was commenced in the rear at the lower ends of the hips and carried on from both ends towards the middle. Each sheet is fastened to the purlin at the end next the eave with two beam clips, which are bolted to the sheet.

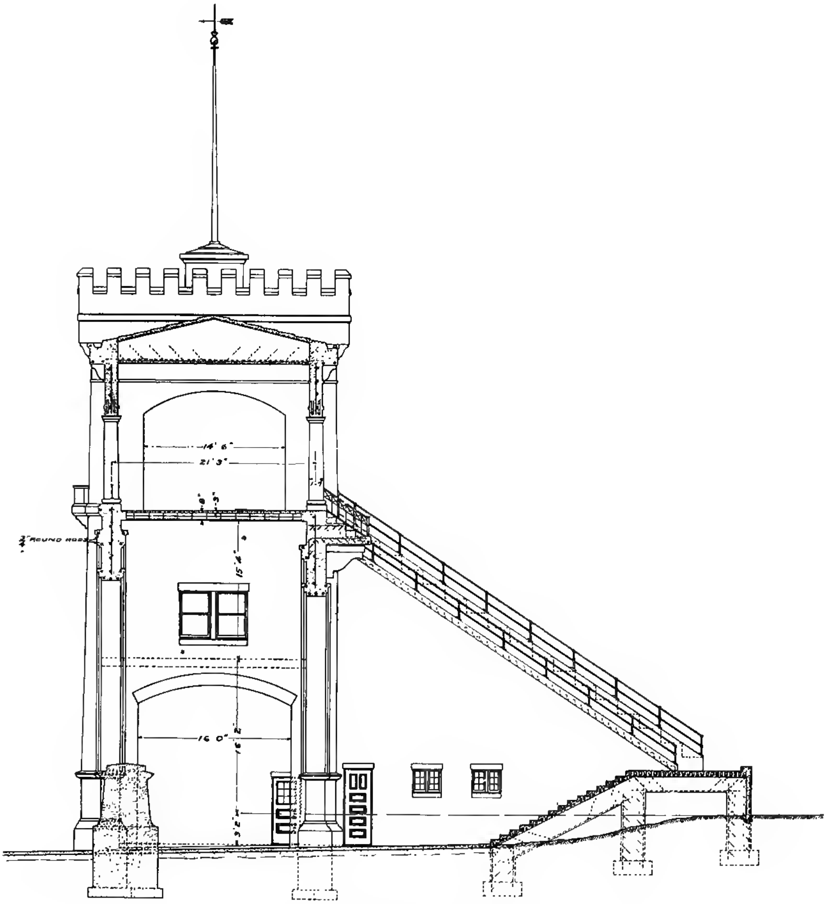
The upperside of the Ferrolithic was coated with a mixture of one part of Portland cement to three parts of clean sharp sand. The sand and cement were mixed very thoroughly in the dry state. The thickness of the coating above the top of the corrugation is 1¼". The entire coating was put on in one mass, without the use of a scratch coat. The surface was roughly floated, and the corrugations were thoroughly cleaned before the concrete was applied.

The underside of the roof was coated with a mixture of one part of Portland cement, ¾ parts of hydrated lime, measured dry, three (3) parts of sand and a little hair. One pound of hair, weighed dry was used, for 25 cubic feet of concrete.

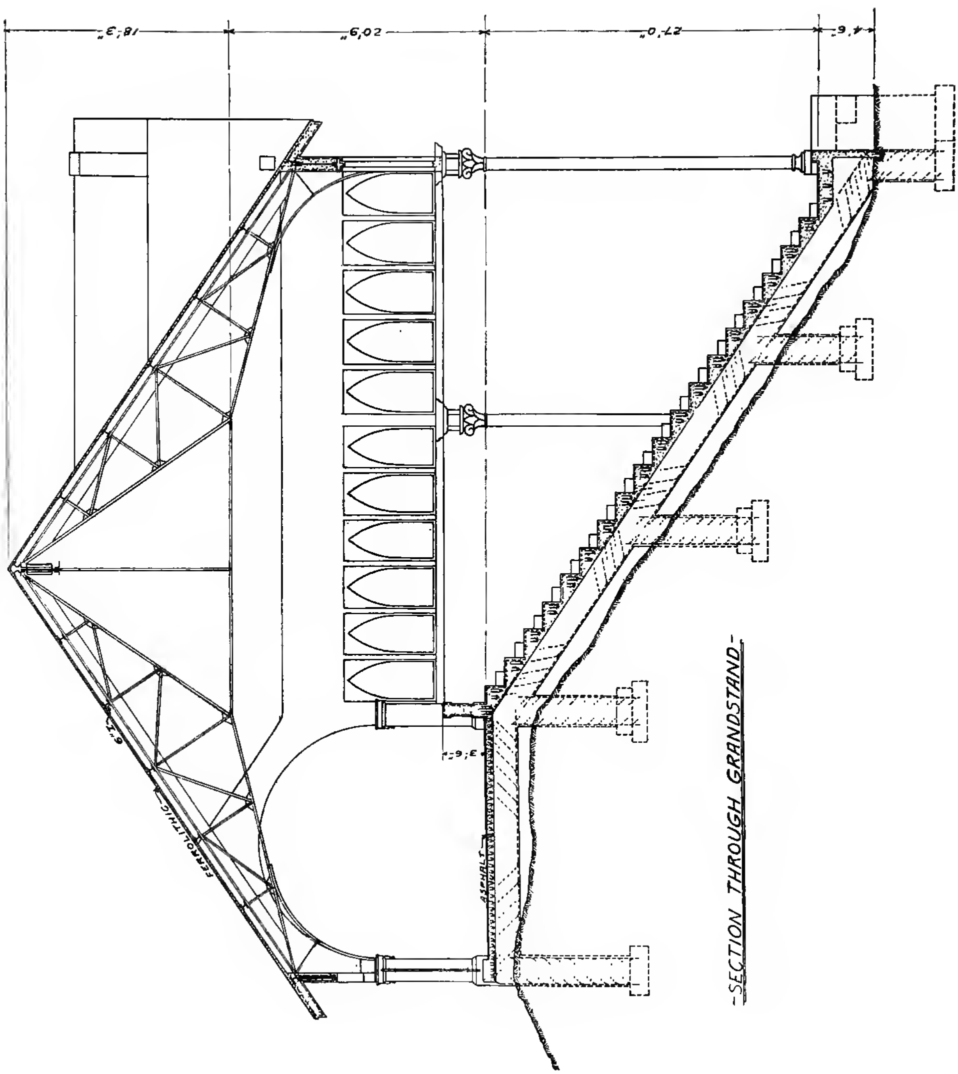
The original idea for the erection of the Stadium belongs to the Chancellor of Syracuse University, Dr. James R. Day. Mr. John D. Archbold became interested in the project and all the funds for the undertaking have been provided by him.

The general contract was awarded in September 1906, to the Consolidated Engineering and Construction Company. During the Winter of 1906 the work was shut down on account of the cold weather and started up again in the Spring of 1907. The last of the reinforced concrete work was put in place October 22, 1907. In other words the entire structure was built in ten working months. The Architects were: Professors Revels and Hallenbeck, of Syracuse University.


-TYPICAL SECTION OF CONCRETE WORK-
-STADIUM-
-PLAN-
ASPHALT
2.7" KAHN BARS
-SECTION-A-B-
-SECTION-C-D-
-DETAIL OF SEAT-
CLINTON WIRE CLOTH



SECTION THROUGH MAIN ENTRANCE
STADIUM


-SECTION THROUGH GRANDSTAND-
ASPHALT
FERROLITHIC

The new Gymnasium for Syracuse University, showing its connection with the Stadium. This building is now under construction by the Consolidated Engineering & Construction Co., and will be, when completed the

LARGEST GYMNASIUM IN THE WORLD

JAMES R. DAY, Chancellor
FRANK SMALLEY
Dean of College of Liberal Arts
GEORGE A. PARKER
Dean of College of Fine Arts
GAYLORD P. CLARK
Dean of College of Medicine
JAMES B. BROOKS
Dean of College of Law
WILLIAM KENT
Dean of College of Applied Science
JACOB RICHARD STREET
Dean of Teachers College

Syracuse University

Office of the Chancellor

Syracuse, N. Y. Oct. 22nd, 1907

Consolidated Engineering & Construction Co.,

Metropolitan Life Building,

New York.

Gentlemen:- You have asked me for an expression of my opinion of the Consolidated Engineering and Construction Company. In reply, I take pleasure in stating that all the work your Company has done for Syracuse University has been satisfactory in thoroughness and promptnees.

By awarding to you the contract for the construction of Sims Hall Dormitory Building, on a basis of coet-plus-a-fixed-sum, the transaction resulted in a saving to the University of several thousand dollare.

The reinforced concrete Stadium, erected by your Company on a percentage basis, costing approximately half a million dollars, repreeents an enormous amount of work done very satisfactorily and completed in a remarkably short time in view of magnitude of the work and obetacles to be overcome.

The fact that we recently placed with your Company the general contract for our great Gymnasium Building may be considered as largely the result of our past experience.

We have found your Organization always on the alert to carry out rapidly and economically any construction entrusted to you.

Very truly youre,

James R. Day

SCHOOL OF ARCHITECTVRE

COLLEGE OF FINE ARTS
SYRACVSE VNIVERSITY

JAMES R. DAY, CHANCELLOR
GEO. A. PARKER, DEAN

FREDERICK W REVELS, PROF. IN CHARGE
EARL HALLENBECK, ASSOCIATE PROFESSOR
CARL T. HAWLEY, PROFESSOR OF ART
FRED R. LEAR, INSTRVCTOR IN ARCHITECTVRE

SYRACVSE, N. Y. October 18, 1907.

Consolidated Engineering & Construotion Co.,
Metropolitan Life Building,
New York City, N.Y.

Gentlemen;

We are glad to express our appreciation of the systematio, economical and oareful manner in which Sime Hall and the Stadium for Syraouse University have been construoted. These two piecee of construotion, representing an expenditure of over half a million dollars, have been put up by you in what may fairly be coneidered a remarkably short time.

We have had several large buildings erected under our eupervieion on various forme of contract. Your method of cost-plus-a-fixed eum we have found the moet satisfaotory, and it hae reeulted in the least friction. By working in conjunction with your Organization, we realize that we have effected a large saving to the University in time and money.

We will be glad, at any time, to have you refer to us thoee from whom you are soliciting business.

We wish to congratulate you on having reoeived the contract for the new Gymnasium Building.

Very truly yours,
Frederick W. Revels
Earl Hallenbeck
ARCHITECTS.

METROPOLITAN LIFE BUILDING

THE HIGHEST BUILDING IN THE WORLD,

48 STORIES

Building in which the main offices of the Consolidated Engineering & Construction Company are located.