SHRIMP BEAM TRAWLS
DESIGN, CONSTRUCTION AND OPERATION

by

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SHRIMP BEAM TRAWLS
Design, Construction and Operation

A Preliminary Report
Report No. 7804

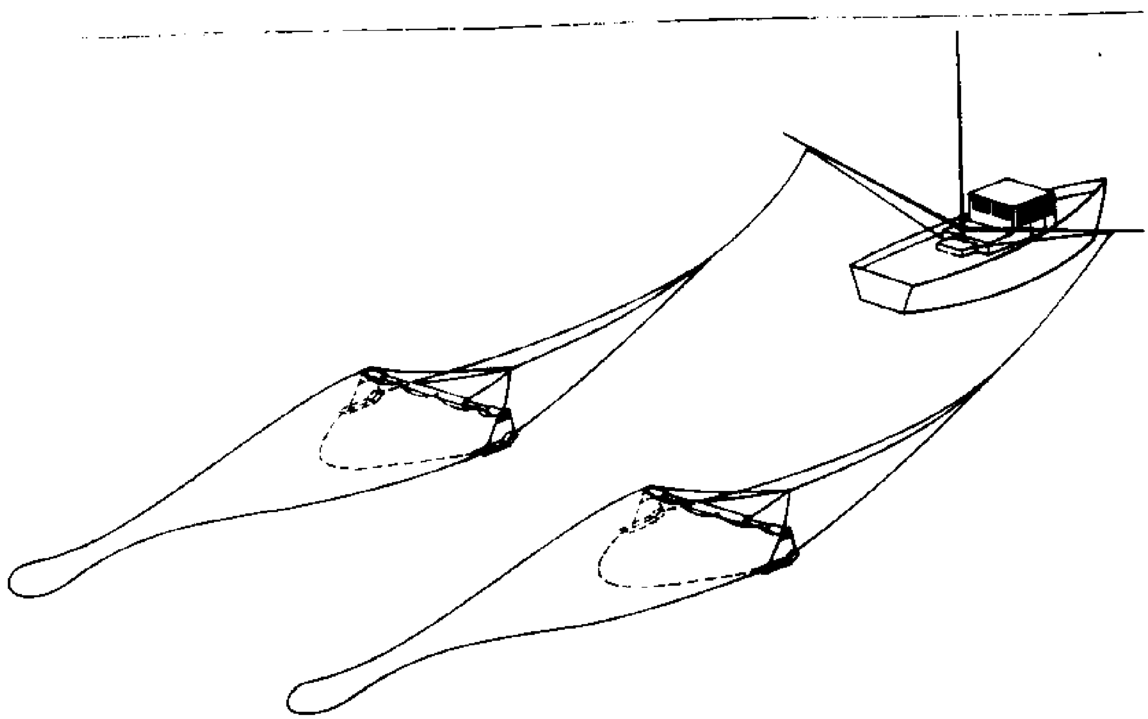

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TABLE OF CONTENT

FOREWORD

This preliminary report is being written and distributed in response to numerous inquiries concerning the beam trawl recently developed by the University of Florida's Hydraulic Laboratory. Although testing of the trawl is not complete at the present time (August, 1978) it is hoped that this information adequately answers at least some of the questions presented. Additional information and test results will be provided when they become available. The following discussion is devoted primarily to those persons who wish to build and operate this type of trawling system.

The development and testing of this trawl was made possible by a grant from:

The Coastal Plains Regional Commission
1725 K Street NW
Washington, D.C. 20006

The Hydraulic Laboratory will be grateful for any data generated by the use of this type of gear. Such information may be mailed to:

Hydraulic Laboratory
Department of Civil Engineering
University of Florida
Gainesville, FL 32611

1. INTRODUCTION

The idea of the beam trawl, namely keeping a trawl or net open by means of a structural member, i.e. the beam, functioning structurally as a column, is in no way new. As a matter of fact, a crude version of the beam trawl was the forerunner of the otter door trawl that is so widely used by the fishing industry today. The modern otter door trawl was easier to use and manipulate than the old clumpsy beam trawls. It required less manpower but more fuel since it applies a hydrodynamic force to keep the net open, a hydrodynamic force which must be generated by the powerplant on board the trawler.

In the days when fossil fuel was plentiful and cheap the switch to the otter door trawl seemed logical. However, today with fuel shortages and increasing fuel prices it does not seem rational to use scarce and expensive fossil fuel to provide the force that keeps the net open when this force may be provided free of charge so to speak by a beam. In other words the time has come when reconsidering the beam trawl and redesigning and modernizing it for improved ease of handling and fishing efficiency may prove an answer to some of the fishing industry's present economical problems.

The beam trawl discussed in this report is now in its third generation. Improvements have been made such that each generation was supposedly better than earlier models, but this does not imply that further improvements are not possible. Each fisherman should be able to make changes that will fully adapt its use to his particular situation. The modifications that have been made, as well as potential modification, will be discussed herein. Photos are provided of the three generations of beam trawls, and drawings with the specifications necessary for their construction are included. Unless otherwise noted, the dimensions given on the drawings are the same as those of the experimental beam trawls shown in the photos.

2. EARLY DEVELOPMENTS. ALUMINUM BEAM TRAWLS. (1st Generation)

Figures 1* through 6 are photos of the first generation of the beam trawl developed by this laboratory. The corresponding dimensions are shown in Figures 27 and 28. The beam with end frames is 3 feet high, 31 feet long and, except shoes and some hardware, is all heli-arc welded aluminum. This beam was built earlier in conjunction with tests being made on door trawls and the development of model laws for trawls. Laboratory and ocean tests revealed that the webbing itself was only responsible for about half of the towing force being used and the remaining force was required to pull the doors. Attempts to devise a system that would perform the same function as the doors, but be cheaper fuel-wise to pull, led to the construction and testing of the beam trawl. Those first tests revealed that the beam was indeed easier to pull, requiring about 25% less total force than the doors to fish a bottom strip of the same width as the one fished by a conventional otter door trawl. Since development of the beam was not the main objective at that time, only little information was recorded concerning its performance. However, work done during the past nine months has been directly oriented toward the evaluation and development of a fuel efficient beam trawl.

The following comments are made in reference to the aluminum beam. The net used was made especially for the beam and is basically a modified flat net less wings. It has 2 inch webbing of #15 twine and a foot rope length of approximately 45 feet. Although the middle of the head rope is shown connected to the pipe, this is not necessary unless it is desired to limit the fishing height. Also, the length of the head rope is not critical to the performance of the beam and may be longer if consistent with the rest of the net. Most of the tests done recently have used longer head ropes attached only to the ends of the pipe. Connecting the head rope to the pipe at its center makes

*All figures appear at the end of text.

the net slightly easier to pull, but the savings will probably not offset the loss in area fished. The length of the foot rope is about right. It should be from 1 1/2 to 2 times the length of the beam. Shorter lengths tend to put too much bending and compression in the pipe. Longer lengths may cause the net to wind up, pick up too much trash, or not fish properly.

It should be noted that the net has no leg lines, although leg lines of 1 or 2 feet are suggested. The shoes on the beam slide straight forward along the bottom and do not kick up as much trash and mud as a set of doors. The long leg lines normally used to clear trash are therefore not needed. Note also that the net has a loop chain along the full length of the foot rope as well as a tickler chain stretched between the two end frames. No information concerning this setup was recorded, but tests made on the second and third generation beams indicate that the tickler chain helps increase the catch.

As evident from the photos, short bridle cables were used on the aluminum beam. The beam could be lifted high enough to clear the water when the junction point of the bridles was pulled to the towing block. One bad effect of short bridle cables is that they cause large bending and compressive forces in the pipe. The aluminum pipes were strong enough to withstand these forces with no ill effects. The second and third generation beams use long bridle cables and smaller pipes. These beams can also be lifted out of the water by pinching the cables together as they are pulled through the block. It is obvious that the cables can only be pulled so far for fear of buckling the pipe. Several different arrangements of long bridle cables have been tested. Some of them performed very well and others were very poor.

Different holes were provided in the end frames of the aluminum beam for connection of the outside bridle cables. Although the cables are shown connected to the center holes, the bottom holes should probably have been used.

Connecting the cables too high on the frames causes the beam to rotate forward and lifts the rear of the frame and shoe. This may or may not be desirable. If the beam rotates too much, the center cable will go slack and the beam will rock.

The photos indicate some of the procedure used to load the beam. It appears that most of the lifting was done by the net. Depending on the equipment available on the trawler and its arrangement, there are any number of ways to handle the beam. One particularly good method will be explained when the second generation beam is discussed. Since trawlers are not set up to handle beams, putting it on board may be difficult in some cases. The development of new methods for storing the beam is one area of potential improvement. Attaching the beam to the outrigger or providing rail mounted storage racks are good possibilities.

Figures 5 and 6 show more of the details of how the beam is assembled than any of the other photos. The end frames have a short section of pipe which slides over the long pipes, and they are secured by putting a bolt in holes bored through the pipes. The center section of pipe is larger than the two outside sections. The pipes used for the aluminum beam were selected such that the outside pipes would telescope into the center section for easier handling, however, this was not done on any of the newer beams simply because handling the fully extended beam did not seem to create any problems for the crews during the actual ocean testing of the trawls.

The pipes for the newer beams were selected for a close fit and not to telescope. Although some changes were made, the same general relationship between pieces of the beam was used for all three generations of beam trawl. They each have three sections of pipe and two end frames. These five pieces are completely separable.

3. STEEL BEAM TRAWLS (2nd Generation)

The following comments concern the second generation beam trawl shown in Figures 7 through 16 with dimensions indicated in Figure 29. Two of these beams were tested in February, 1978, and primary consideration was given to their performance. Reproduction of this beam is not suggested since it was designed for test purposes and not for routine fishing. The third generation beam, to be discussed later, is designed for routine fishing and incorporates all of the improvements found to be necessary from tests of the second generation beam. Both the second and third generation beams are 30 feet long and 3 feet high. They are made of steel and not aluminum.

Two different nets were used on the second generation beams. One was a conventional two seam balloon net; and the other was a new beam net, different from the net used on the aluminum beam. Hanging to hanging, the balloon net was 50 feet long on the head rope and 60 feet long on the foot rope. The beam net was 34 feet long on the head rope and 41 feet long on the foot rope. The leg lines on both head ropes were adjusted to make the nets pull properly from the beams. Both nets used 2 inch webbing and #15 twine. Fishing side by side for two days, the balloon net caught twice as many shrimp as the beam net.

During these tests both beams used a 5/16 inch tickler chain stretched between the two end frames. They were set to pull about 2 feet forward of the foot rope. Figures 7 through 10 show the second generation beam in its original form. The pipes used were the smallest size considered adequate. Figures 9 and 10 show that they were not adequate since both beams bent their center section of pipe due to unexpected problems. Both of these sections were replaced with larger pipes, and the beams performed satisfactorily for the remaining three days of testing. The beams bent partly because of the bridle cable system that was used and partly because the pipe was too small to start with. The beam with the short net was bent considerably more than the other beam, indicating an increase in the forces acting on the pipe because of the short foot rope. Figures 11 and 12 show the beam after being repaired.

Figures 13 and 14 show part of the sequence of steps used to load the beams. Figures 9 and 10 both indicate clearly the two handling lines which were attached to each beam. Using the line on the end of the beam and nearest to the boat, one end of the beam was raised as shown in Figure 13. The block used for this was located above the winch. By easing off on the towing cable the beam was allowed to move toward the boat. When the beam was in far enough, the lifting line was let off and the end of the beam was set on deck as shown in Figure 14. Although it was not done at the time, it is best to make the end of the beam fast after this step. Using the line at the one-third point of the beam and farthest from the boat, the other end of the beam was simultaneously swung and lifted as the towing cable was eased out. The block used for this was located in the rigging at the stern of the boat. When the beam had swung parallel to the boat, the lifting line was let off and the pipe was set on the stern rail and made fast. The end of the beam was allowed to protrude over the stern. This particular loading procedure is safe and efficient. It was devised and implemented by Captain Jimmy Moore, whose trawler pulled the beams.

The last day of testing for the second generation beam was devoted to direct comparison of the beam with conventional doors. The beam with the 50 foot two seam balloon net was pulled from one side of the trawler, and nine by forty doors with a 60 foot four seam flat net was pulled from the other side. Three drags were made. On the first drag the beam caught 2 2/3 pounds of shrimp for each pound caught by the doors. On the second drag the beam caught 2 pounds of shrimp for each pound caught by the doors. The last drag was started by a sharp 180° turn at full throttle which unfortunately was enough to flip the beam upside down as shown in Figure 15. The beam caught 3/4 pound of shrimp for each pound caught by the doors. This is the extent of direct comparison of the two systems in shallow water. Additional testing is planned for shallow water to better verify the performance of the two systems. The results will be released when available.

Figure 16 shows a net that has caught itself. The trawler was stopped quickly from full throttle. The beam also stopped. The bag, however, did not stop because of inertia of the water moving with it. It came far enough forward to cross over the head rope. When the trawl was pulled again, the head rope crossed over the bag. This is not normal for the beam but has been included here because it did happen. It should also be noted that flipping the beam is not normal, but it may happen. The beam can be flipped back upright with the lazy line. A better method is to drop it back down in the water and turn the boat through 180° in a circle with the beam at the center of the circle.

It took about twice as much total force to pull the doors as it did the beam. This ratio would change if the beam was compared with smaller doors.

4. STEEL BEAM TRAWLS (3rd Generation)

Figures 17 through 20 show the third generation beam. Its dimensions are given in Figures 21 through 26. It is very similar to the second generation beam but has many improvements. It is lighter, stronger, easier to pull, easier to handle because of the improved bridle cables, and fishes a larger area.

The steel used to build the end frames of the third beam was not as thick as that used in the second. Also, the unnecessary parts used only for testing were omitted and the shoes were shortened. The center section of pipe is the same size as the replacement pipe used on the second beam, but the outside pipes are larger. The distance between the pipe and the bottom of the shoe is also larger. It is not obvious from the pictures, but the pipes have small steel rods welded to them along their top and bottom about 1 inch forward of the center line of the pipe. These small rods change the character of the flow of water around the pipes and are expected to reduce drag thereby making them easier to pull.

The third generation beam was tested out of Key West during May, 1978, to check its performance in deep water. The beam was pulled from one side of the trawler and seven by thirty-four doors were pulled from the other. Four different nets were used with the beam. The doors pulled a 39 foot flat net with 5 foot leg lines. This net was never changed and was used as a standard for comparison with the beam and its nets. The depth of water fished in ranged from 200 to 245 fathoms, but most of the drags were made at about 230 fathoms (1380 feet). Twenty-four drags of approximately 4 hours duration each were made in 6 days. The following table gives the description of the nets used on the beam and the total catch comparisons.

	Catch Beam	Catch Doors	Ratio
Beam Net 2 inch mesh, #15 Twine Foot Rope 54 ft	79/lb pounds	100/lb	1.27 to 1
Beam Net 2 inch mesh, #18 Twine Foot Rope 48 ft	163/lb	288/lb	1.77 to 1
Two Seam Balloon Net 2 inch mesh, #15 Twine Foot Rope 60 ft Head Rope 50 ft	234/lb	319/lb	1.36 to 1
39 Foot Flat Net 2 inch mesh, #15 Twine Same net as on doors	159/lb	363/lb	2.28 to 1

In every case the doors did better than the beam in deep water. Both drums had 700 fathoms of towing cable, giving a cable length-to-depth ratio of about 3 to 1. This is apparently not sufficient for the beam to make good bottom contact. Although the beam got to the bottom, it probably never had both ends touching at the same time. The force measurements made indicated that the beam drag was below normal and in the same range as measurements made earlier when the beam was pulled without bottom contact. The doors have one advantage in that the force of the water also takes them to the bottom. The beam has only its weight to take it down. This advantage may be reversed for shallow water. Figure 20 shows the shine on the bottom of the shoe which indicates that the beam was at least touching bottom part of the time. This picture was taken at the end of the 14th drag on the fourth day of testing. When the picture was taken, the beam was upside down as shown in Figure 19. The beam is very stable and has flipped only twice. The first time it flipped was mentioned earlier. This time the two rigs caught together. The beam came up upside down, and one of the chains was pulled out of a door.

If the beam was practically flying, as suggested earlier, it should be reflected in the catch made by each net. The beam net with #15 twine and the balloon net both have a long foot rope. When pulled without interference from the bottom, these nets should expand more in the vertical direction. If one end of the beam is allowed to touch bottom, then the net that expanded the most should have more of its net touch bottom. The short flat net probably had the least vertical expansion. As reflected in the catch comparison, the beams catch seems proportional to its nets ability to expand vertically. This effect is also shown from the fact that the catch increased when Texas dropdown was used instead of a tickler stretched between the end frames. The dropdown helped hold down the bottom of the net. This tendency of the beam to fly is not normal but is the result of insufficient towing cable length.

Figures 17 and 25 show the arrangement of the bridle cables for the third generation beam. Please refer to Figure 25 for the following discussion. The four cables connected to the pipe are arranged such that they all come tight at the same time. This helps equalize the forces acting on the pipe. The longer outside bridle cables reduce the bending and compression of the pipe that would be present if short bridles were used. The beam is weakest when the two outside bridle cables are pinched together as it is pulled close to the towing block. It is designed to be pulled to within 8 or 9 feet from the block but not much closer. This bridle system was arranged such that the forward ends of the two outside cables could be disconnected from their normal position and reconnected to the center cable at about 48 feet from the pipe. By doing this the beam could be suspended by the center cable which is connected to the four short cables. The junction point of these four lines may be moved closer to the pipe if necessary; say to within 7 feet. The length of 60 feet was chosen so that when the beam was pulled up, the junction point of the longer cables would be at the winch. If the two outside cables are made fast at this point, the winch can be let out and these two cables disconnected. When the winch is brought in again, the center cable will support the beam. This was done several times during testing and went smoothly. A piece of chain looped around the winch frame was used to make the outside cables fast. The chain held a small shackle which the cable thimbles would not slide through. By arranging the cables so that they can be disconnected, the length of the lines can be changed by adding a short piece of chain or a shackle. When the beam is let out again, it can be made to drag heel heavy, toe heavy or whatever is desired. The position the beam takes while being pulled is defined by the length of the bridle cables and the angle of the towing cable.

Figure 17 shows that there are several different places to attach the outside bridle cables to the end frames. The higher the cables are connected, the smaller the forces in the pipe. Since different types of nets pull differently, it is suggested that the cables be attached as high as possible and still have the beam function properly. If it is desired to increase the fishing height, extensions can be welded or bolted to the end frame to attach the head rope to. The bridle cables may be connected in a higher position if this is done. Extensions of more than 2 1/2 feet are not suggested since they would make the beam tend to tip over backwards. Extensions should be positioned to lean forward.

5. CONCLUSIONS

At the present time, before the final modification of the third generation beam trawl for more efficient deep water shrimping, the following conclusions may be drawn:

a. The beam trawl is substantially easier to pull and will under all circumstances save fuel when compared to a conventional otter door trawl of same size.

b. The newly designed beam trawls are easy to handle. They do not create more handling problems to a two man crew than the otter door trawl.

c. Once in the water the beam trawl seems to be more stable than the otter door trawl. This is true not only on its way to the bottom but also after bottom contact has been established.

d. In shallow water the beam trawl has been demonstrated to fish cleaner and catch substantially more shrimp per unit time trawling than a conventional otter door trawl of the same size.

e. In deep water the experimental beam trawl was surpassed in catch by the otter door trawl. Dynamometer readings show that this was due to lack of weight that prevented proper bottom contact. Improvements are possible by increasing the beam weight without increasing drag.

f. It is reasonable to expect that the beam trawl will be equally successfull for other bottom fish.

6. ACKNOWLEDGEMENTS

The development of the beam trawl has required a great deal of cooperation from many individuals and organizations. Although recognition of everyone involved is not possible, we at the Hydraulic Laboratory would like to express our sincere appreciation and gratitude for the many contributions that have been made and give formal recognition to those individuals whose dedicated effort and talents have been key elements in this research. Without the cooperation we have received, little of our accomplishments would have been possible.

Captains David Cook, Jimmy Moore, Gene Lewis, and their crews have provided the trawlers and manpower necessary for field testing of the three generations of beam trawl. The many contributions and suggestions made by these men have been invaluable and have provided guidelines for many improvements.

Standard Hardware, Inc. in Fernandina Beach, Florida, and its employees have provided many courteous services. Our special appreciation is extended to W. H. "Billy" Burbank, Jr. and his crew in the net shop. They made all of the nets that have been used on the beams and door trawls.

Mr. William F. Feger, Jr., owner and operator of "Feger Seafood" in New Smyrna Beach, Florida, has provided a great deal of assistance throughout the duration of this project. We are grateful to have his continued support.

We would also like to extend our appreciation to the agents of the Florida Marine Advisory Program, who have been a valuable link between our laboratory in Gainesville and the fishermen throughout the state.

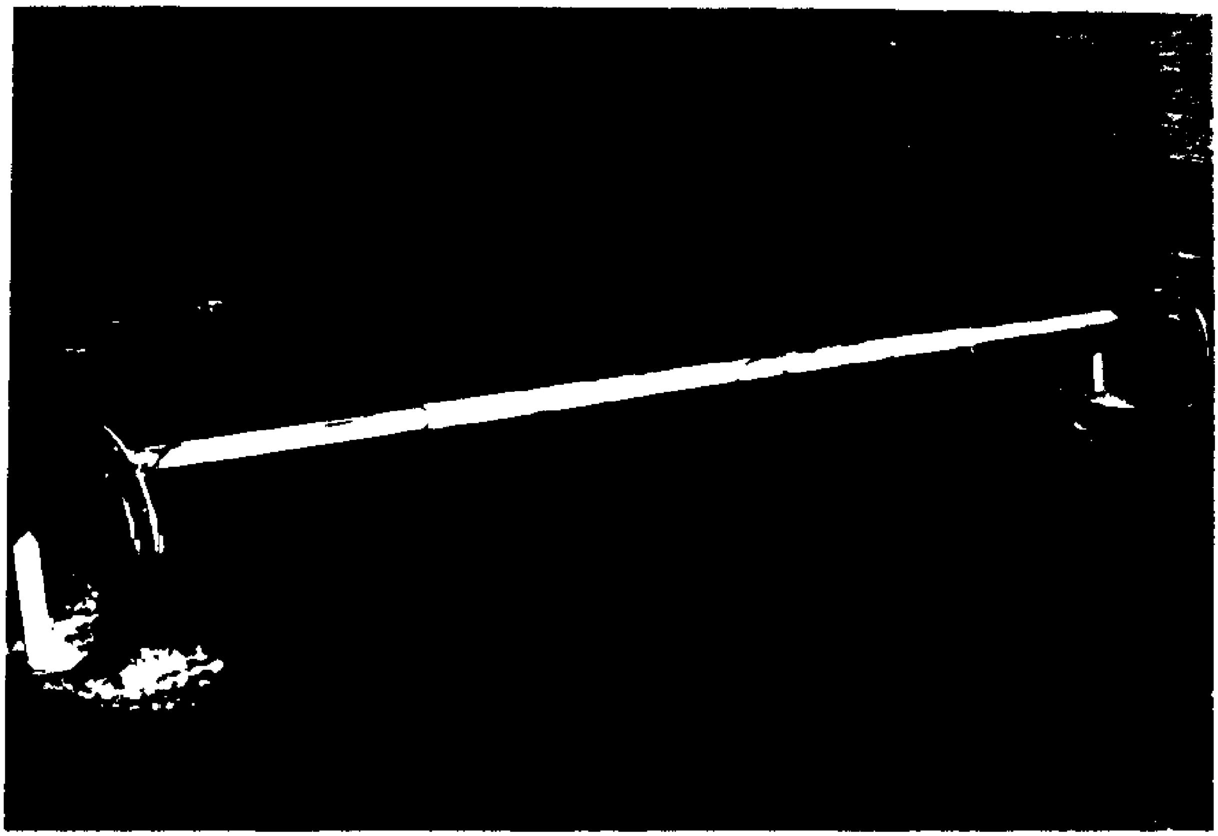


Figure 1 - 1st Generation Beam.

Figure 2 - 1st Generation Beam.

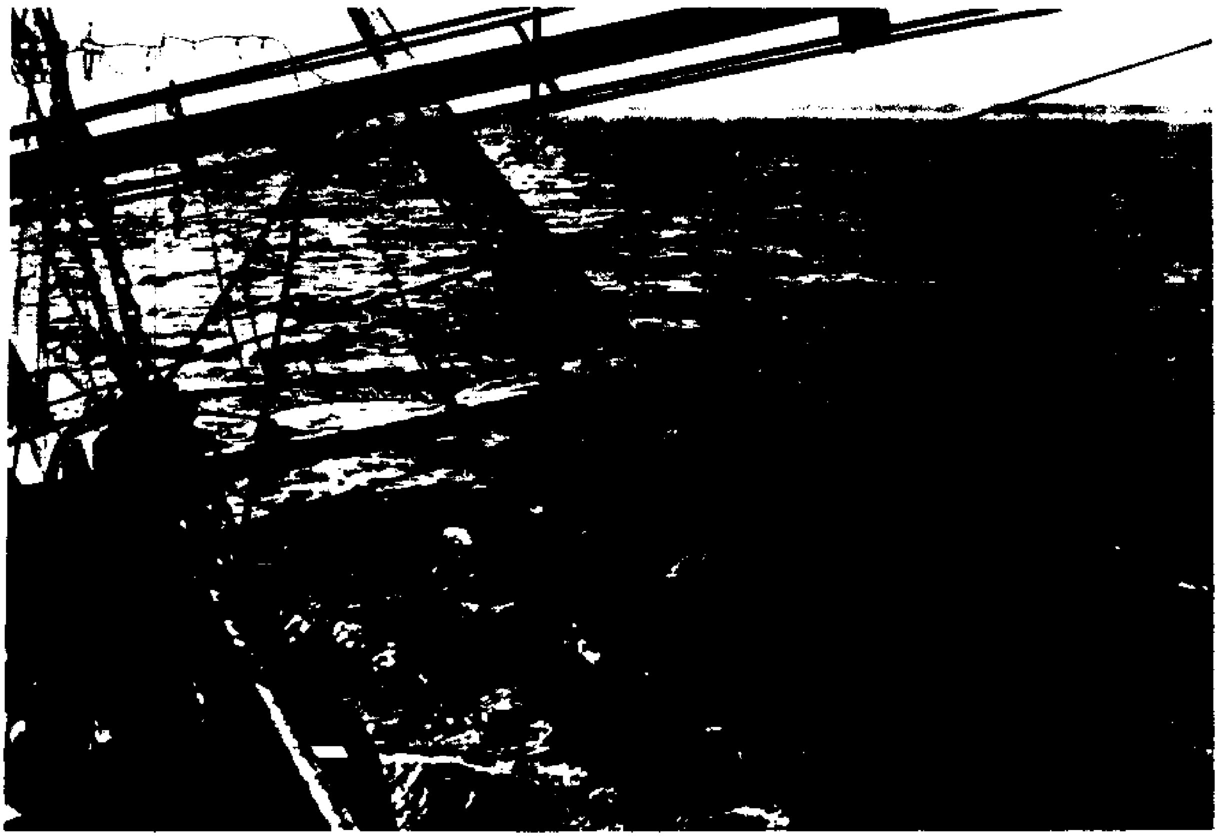


Figure 3 - 1st Generation Beam.

Figure 4 - 1st Generation Beam.

Figure 5 - 1st Generation Beam.

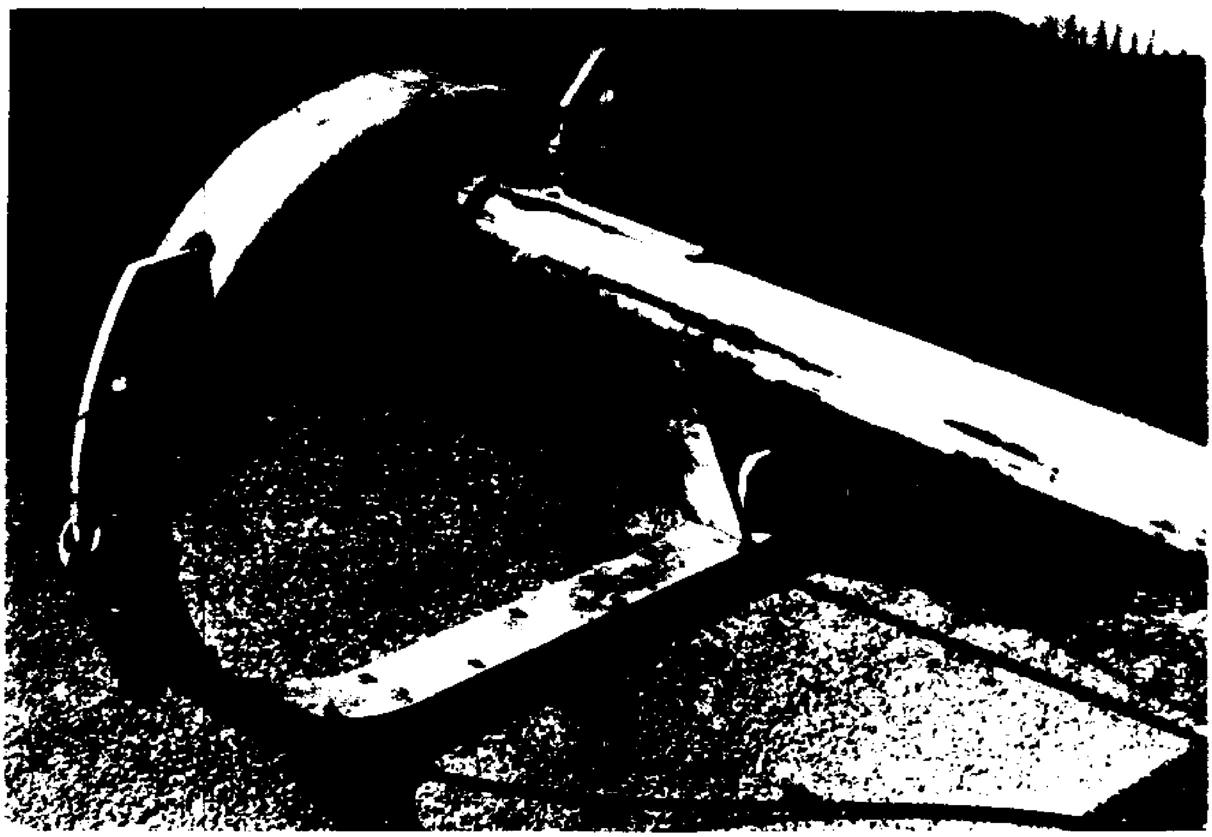


Figure 6 - 1st Generation Beam.

Figure 7 - Original 2nd Generation Beam. Two Seam Net.

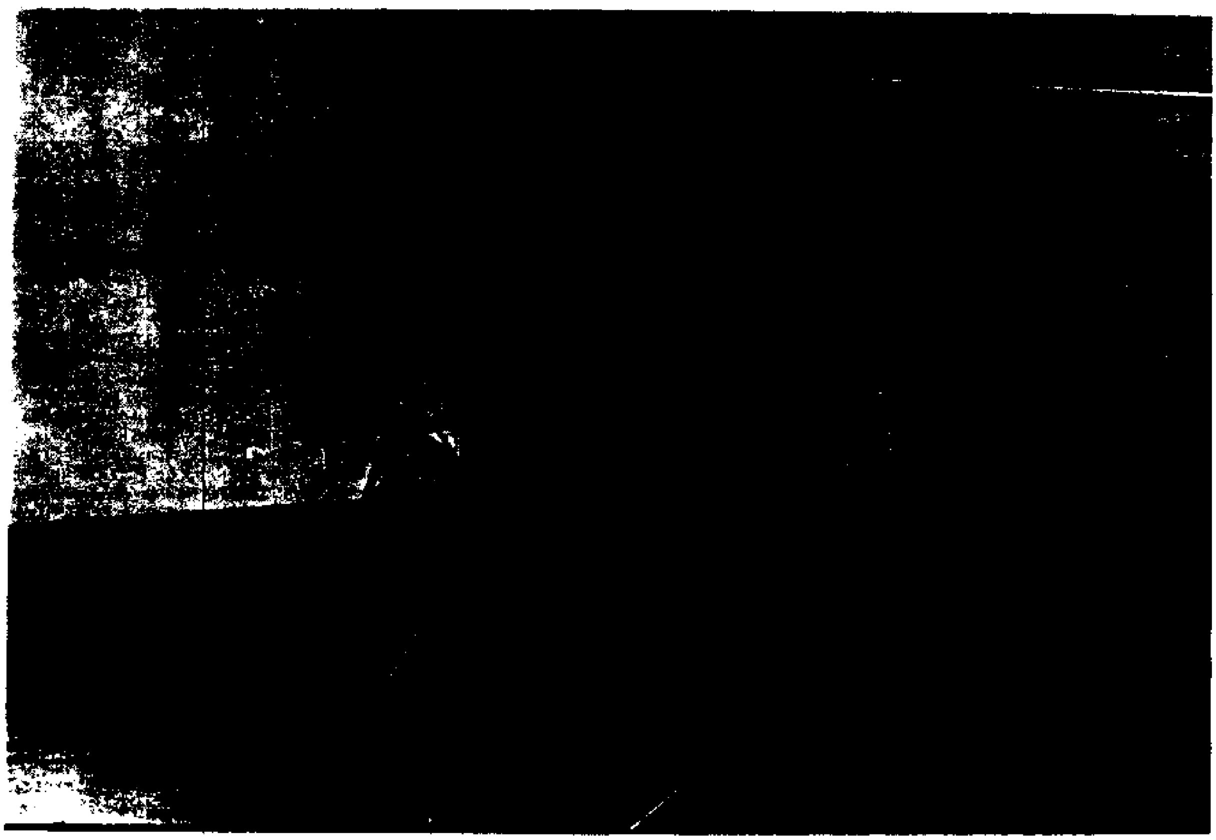


Figure 8 - Original 2nd Generation. Beam Net.

Figure 9 - Original 2nd Generation Beam. Two Seam Net.

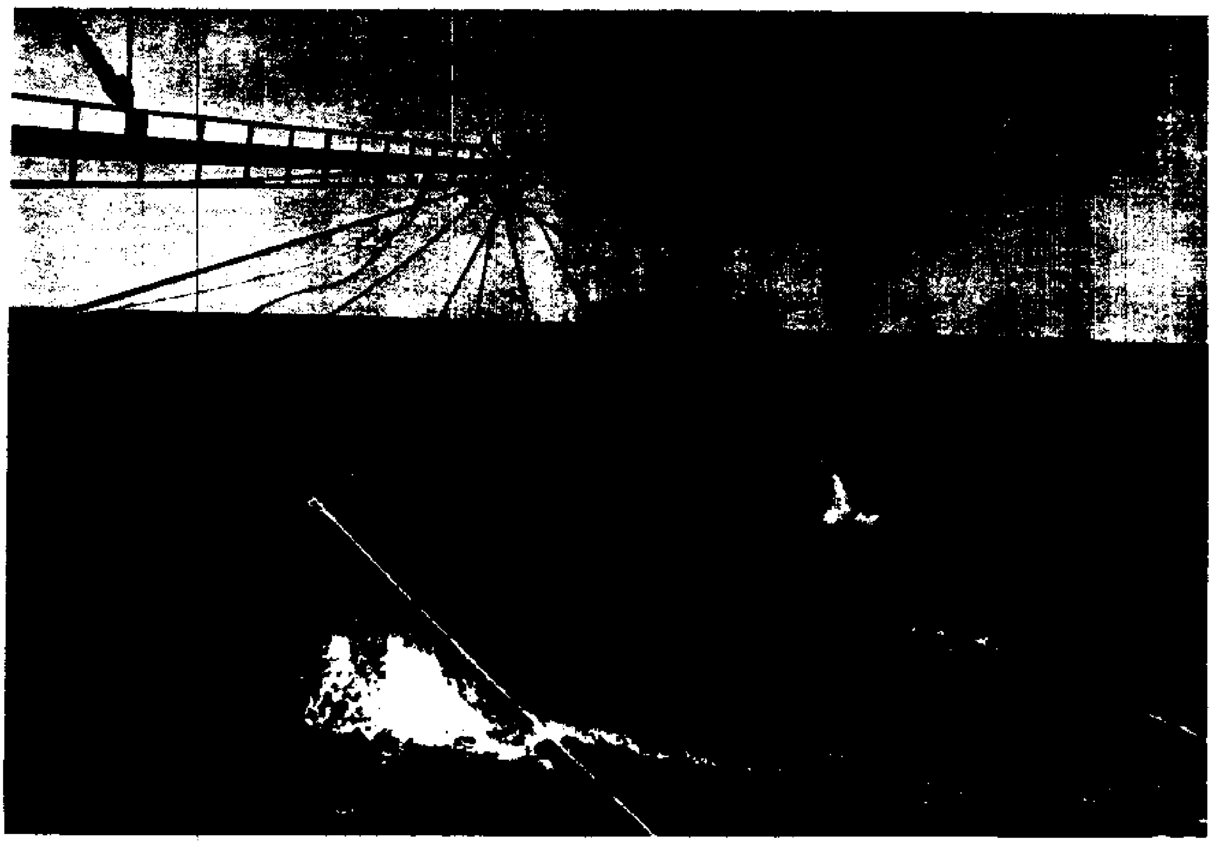


Figure 10 - Original 2nd Generation Beam. Beam Net.

Figure 11 - Modified 2nd Generation Beam. Two Seam Net.

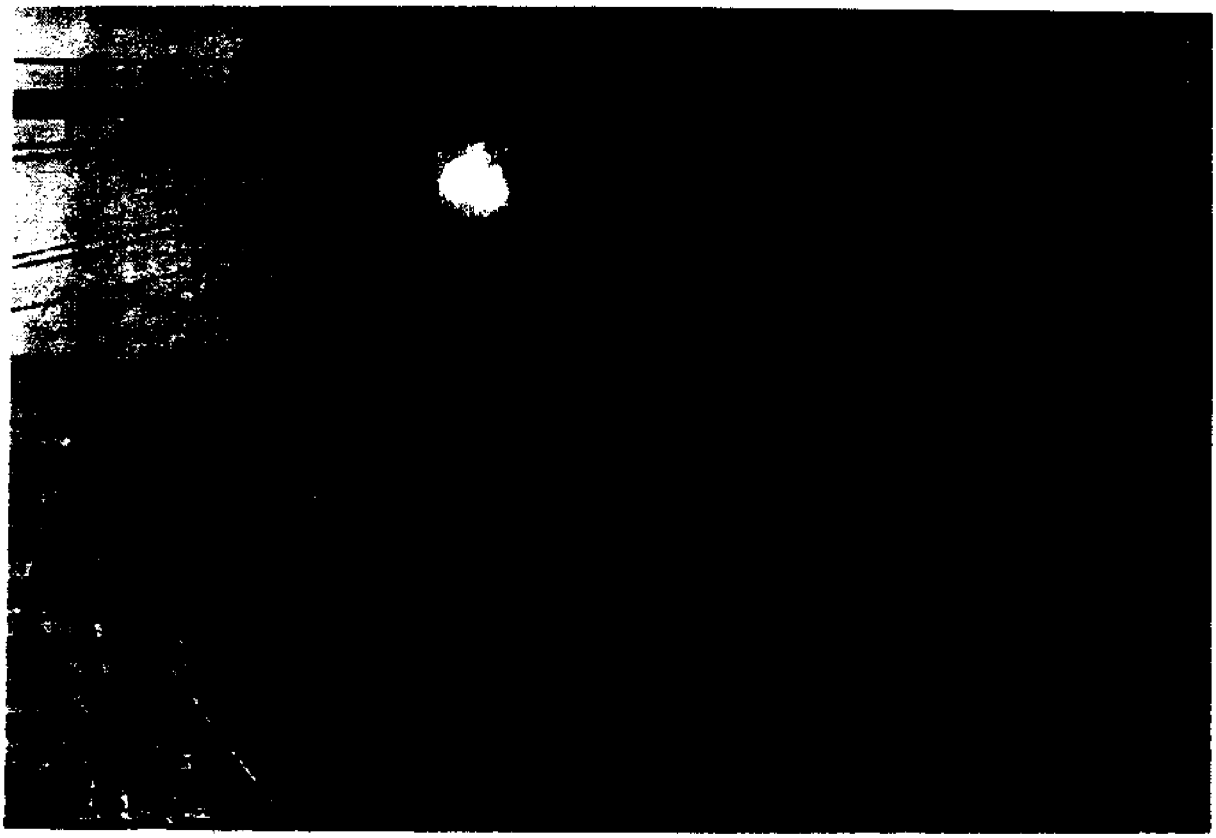


Figure 12 - Modified 2nd Generation Beam. Beam Net.

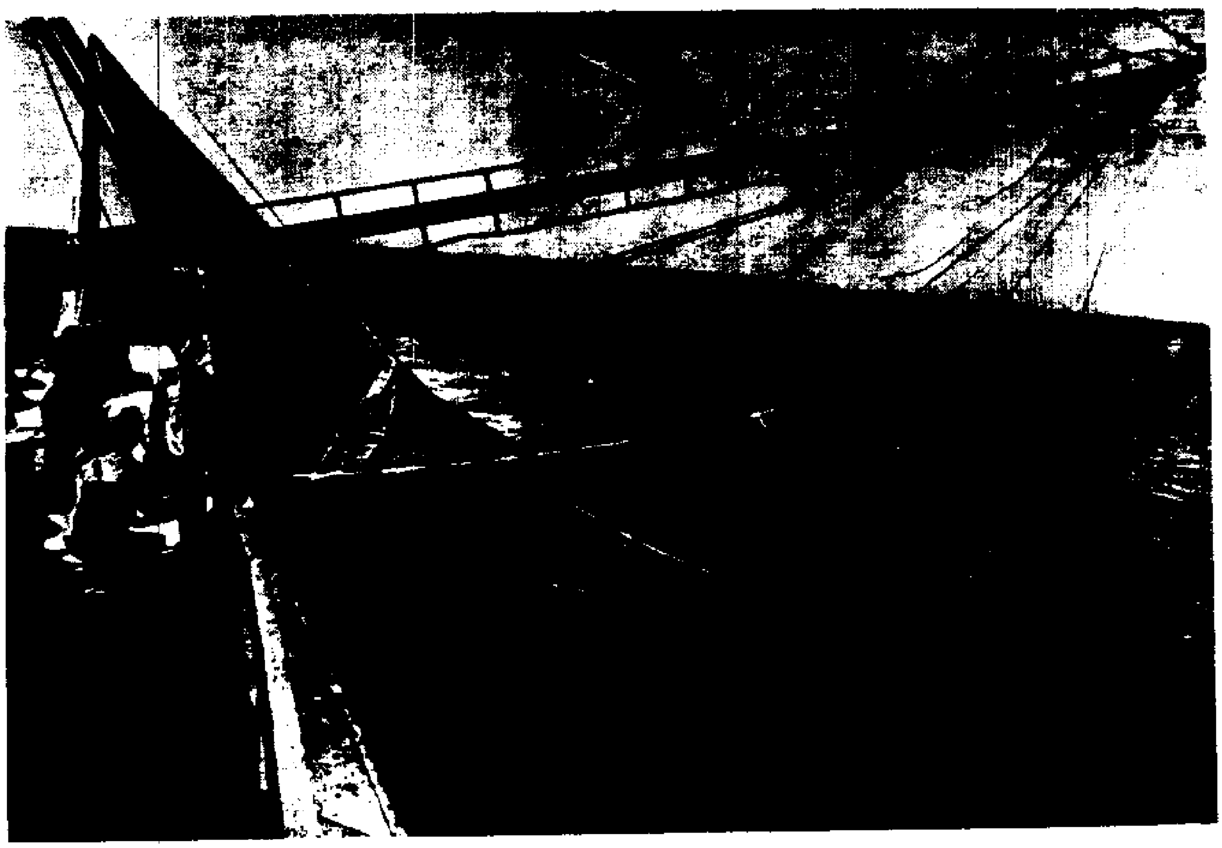


Figure 13 - 2nd Generation Beam During Loading.

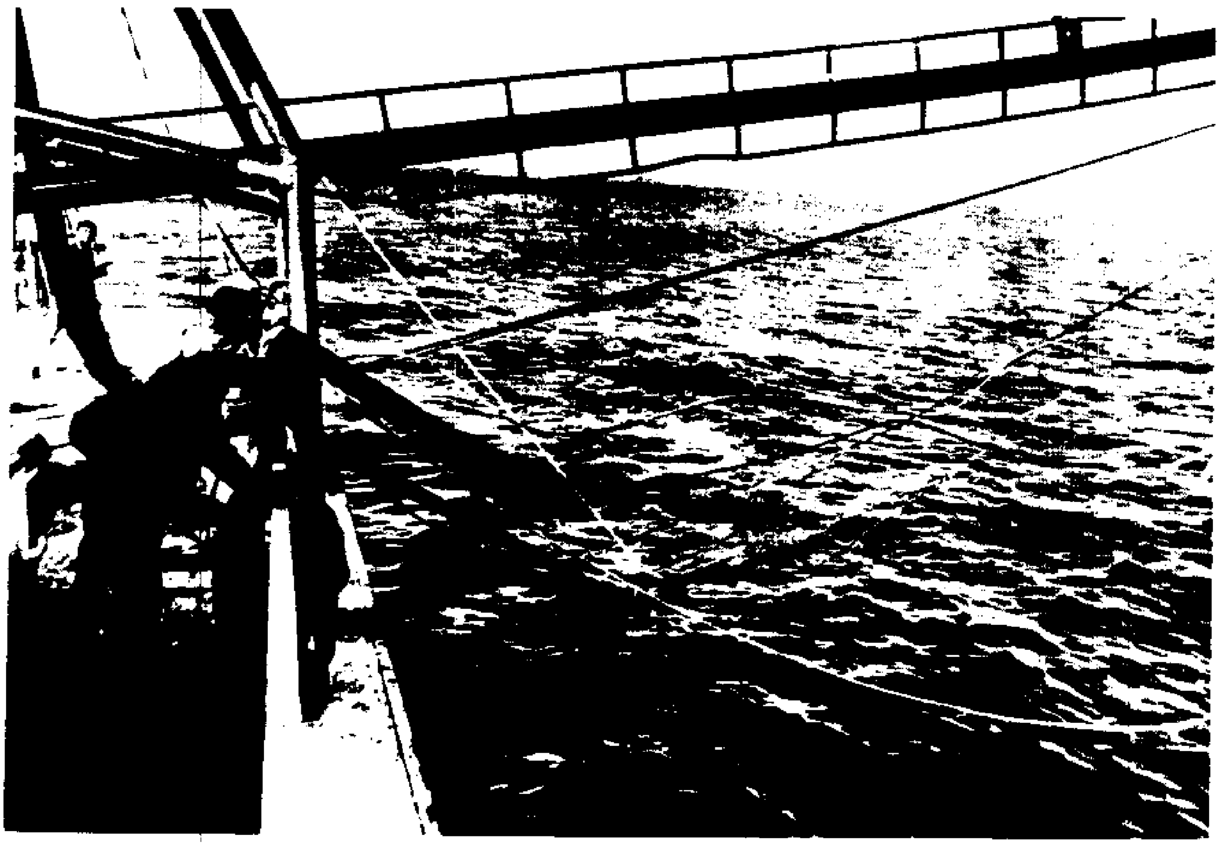


Figure 14 - 2nd Generation Beam During Loading.

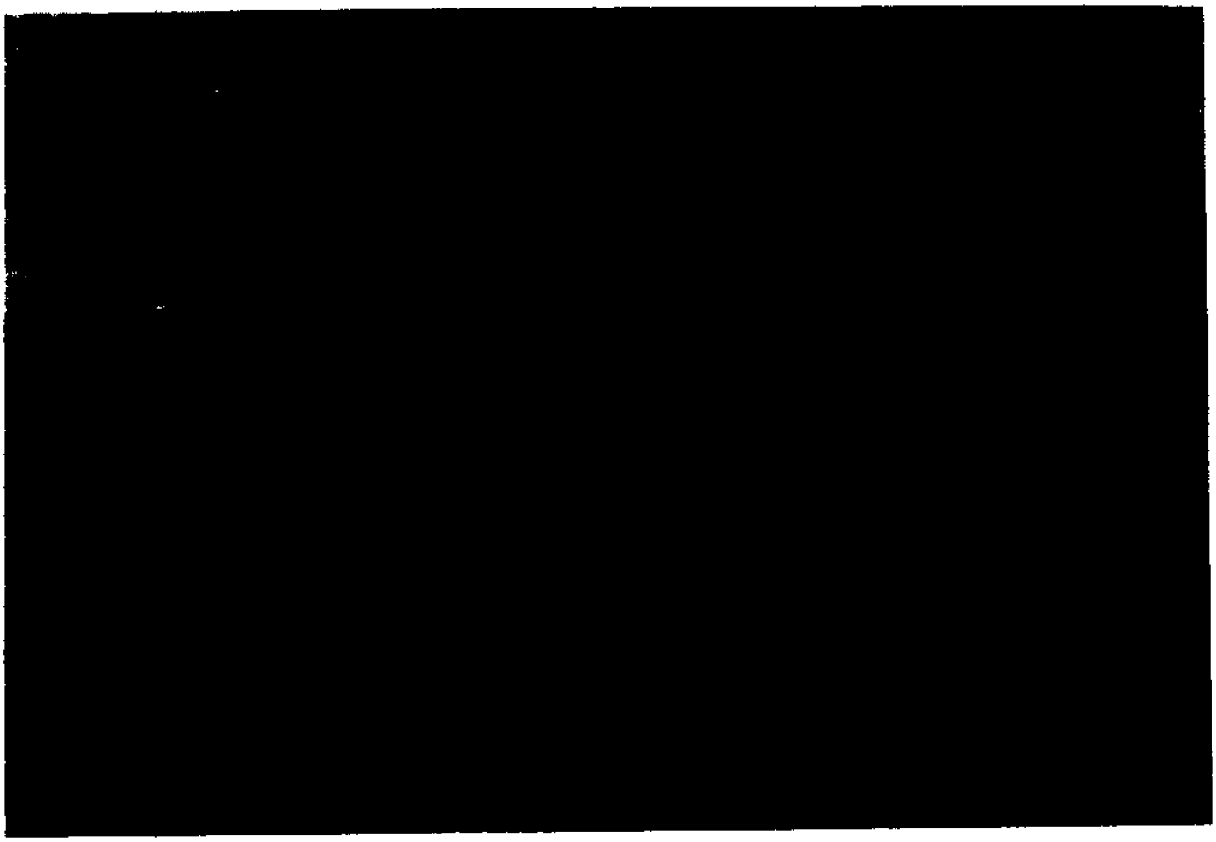


Figure 15 - 2nd Generation Beam.

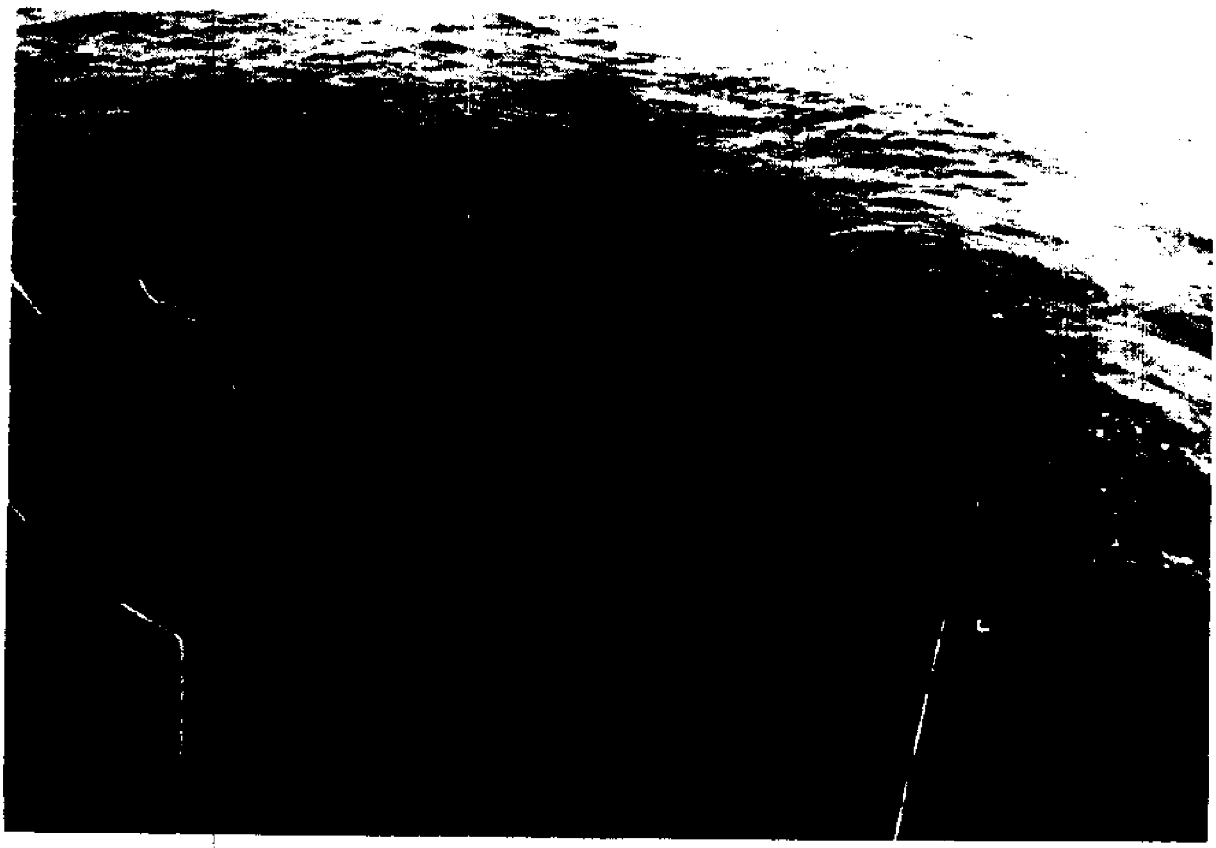


Figure 16 - 2nd Generation Beam. Two Seam Balloon Net.

Figure 17 - 3rd Generation Beam.

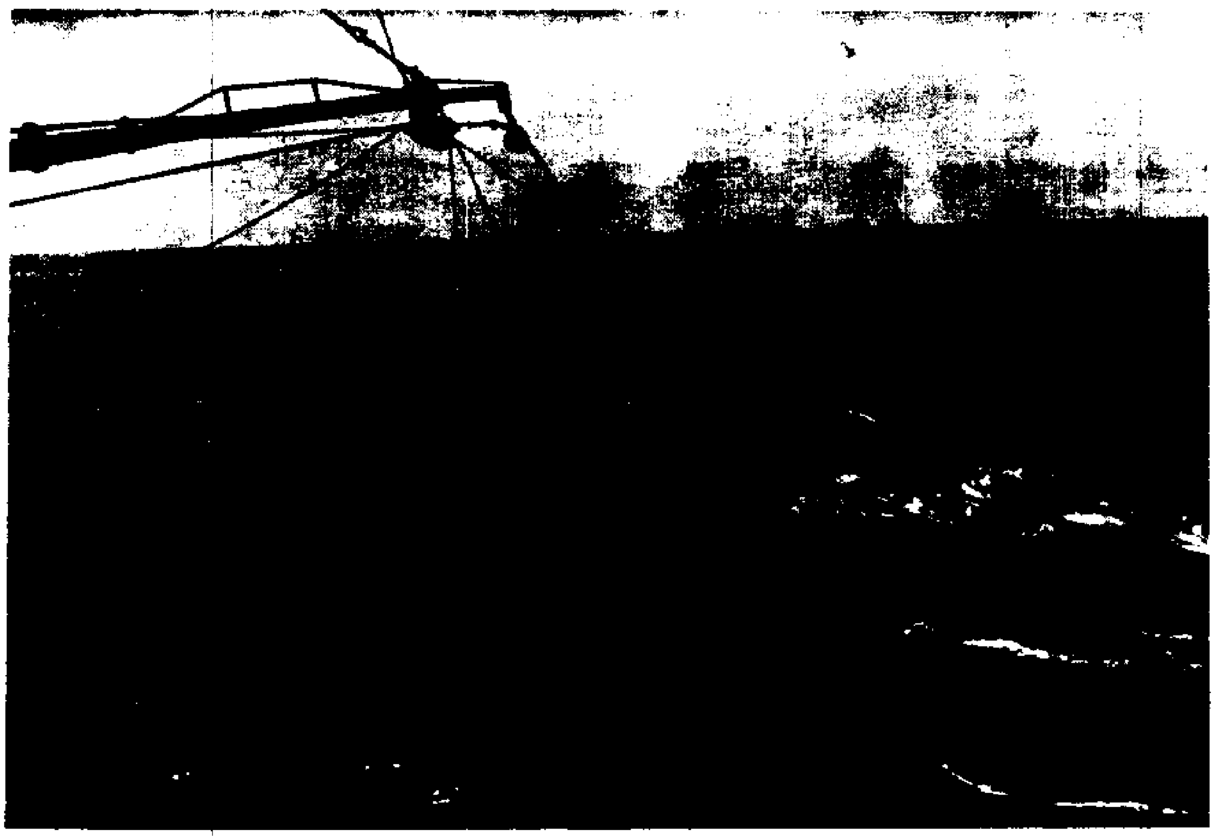


Figure 18 - 3rd Generation Beam.

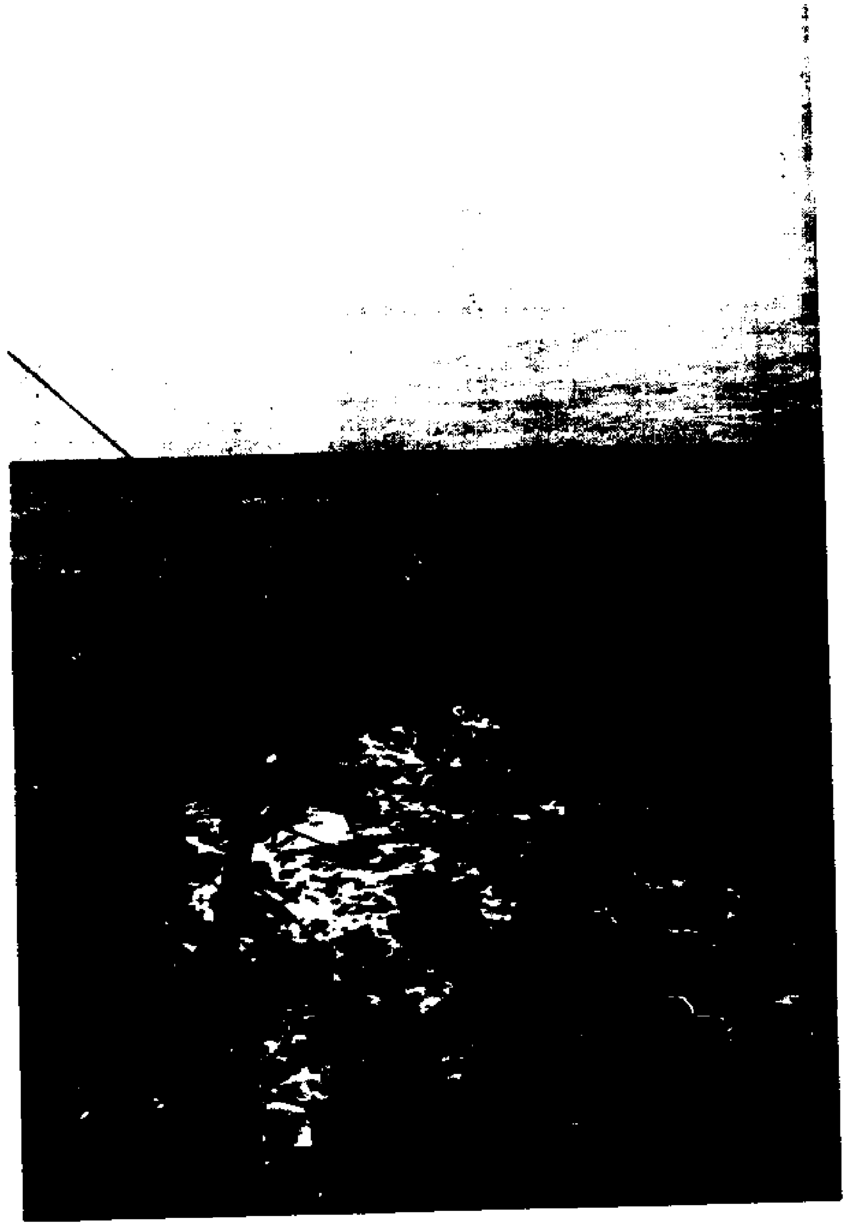


Figure 19 - 3rd Generation Beam.

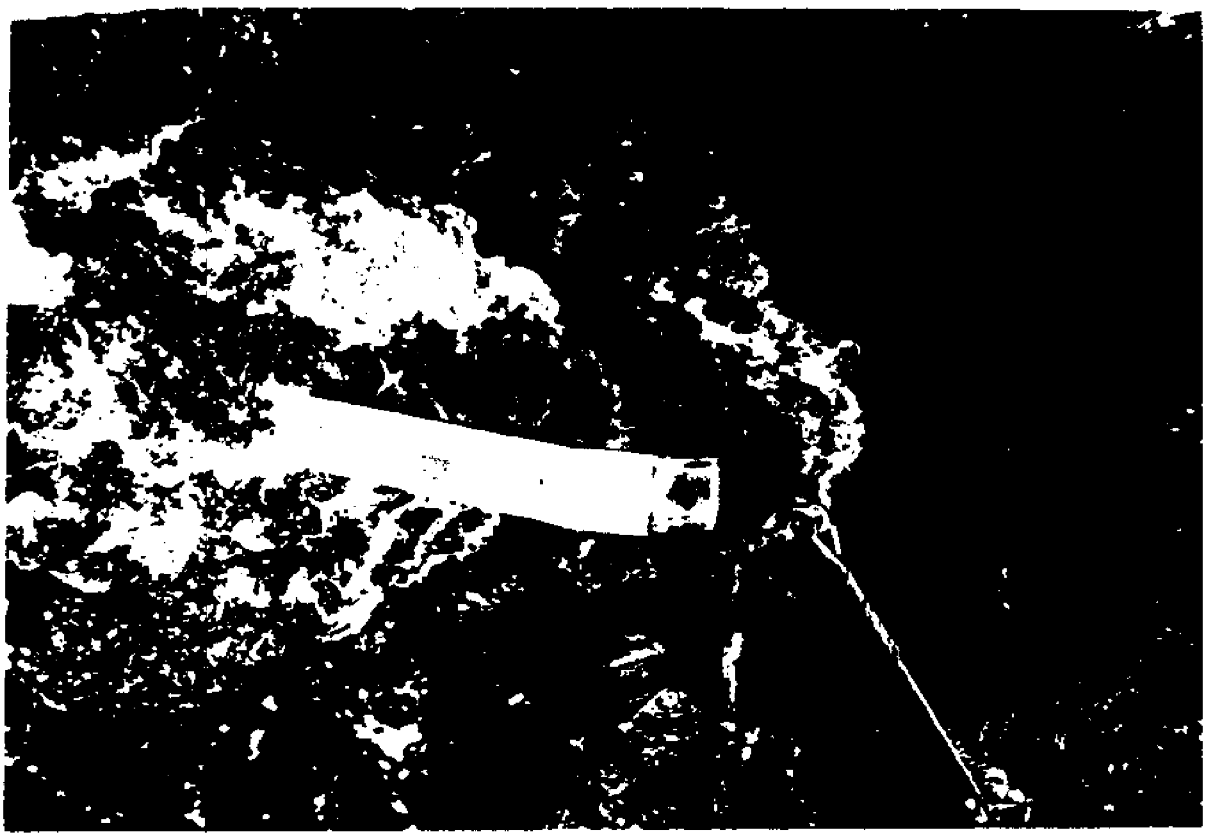
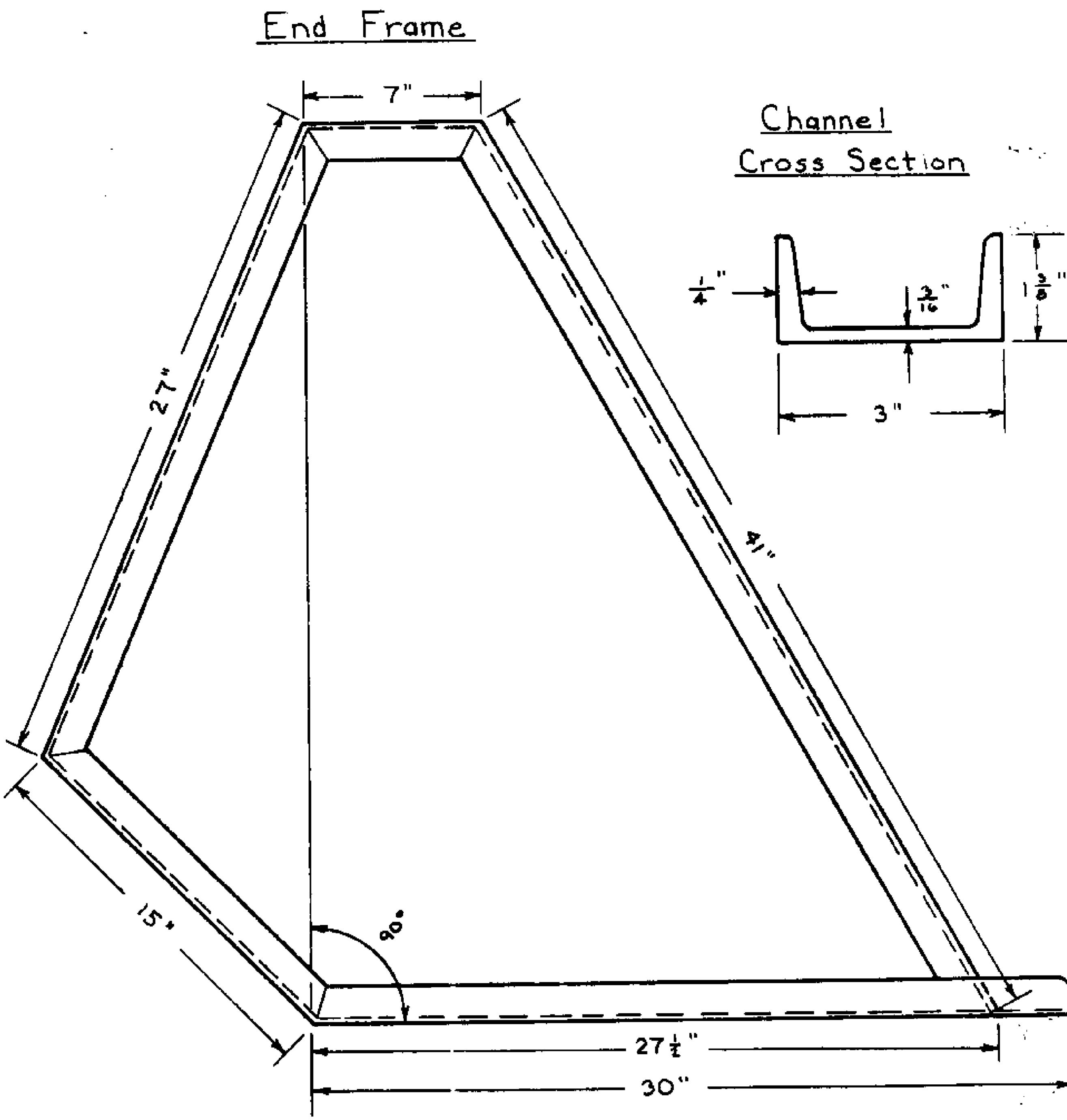


Figure 20 - 3rd Generation Beam Underside of Shoe.

Third Generation Beam (Steel)

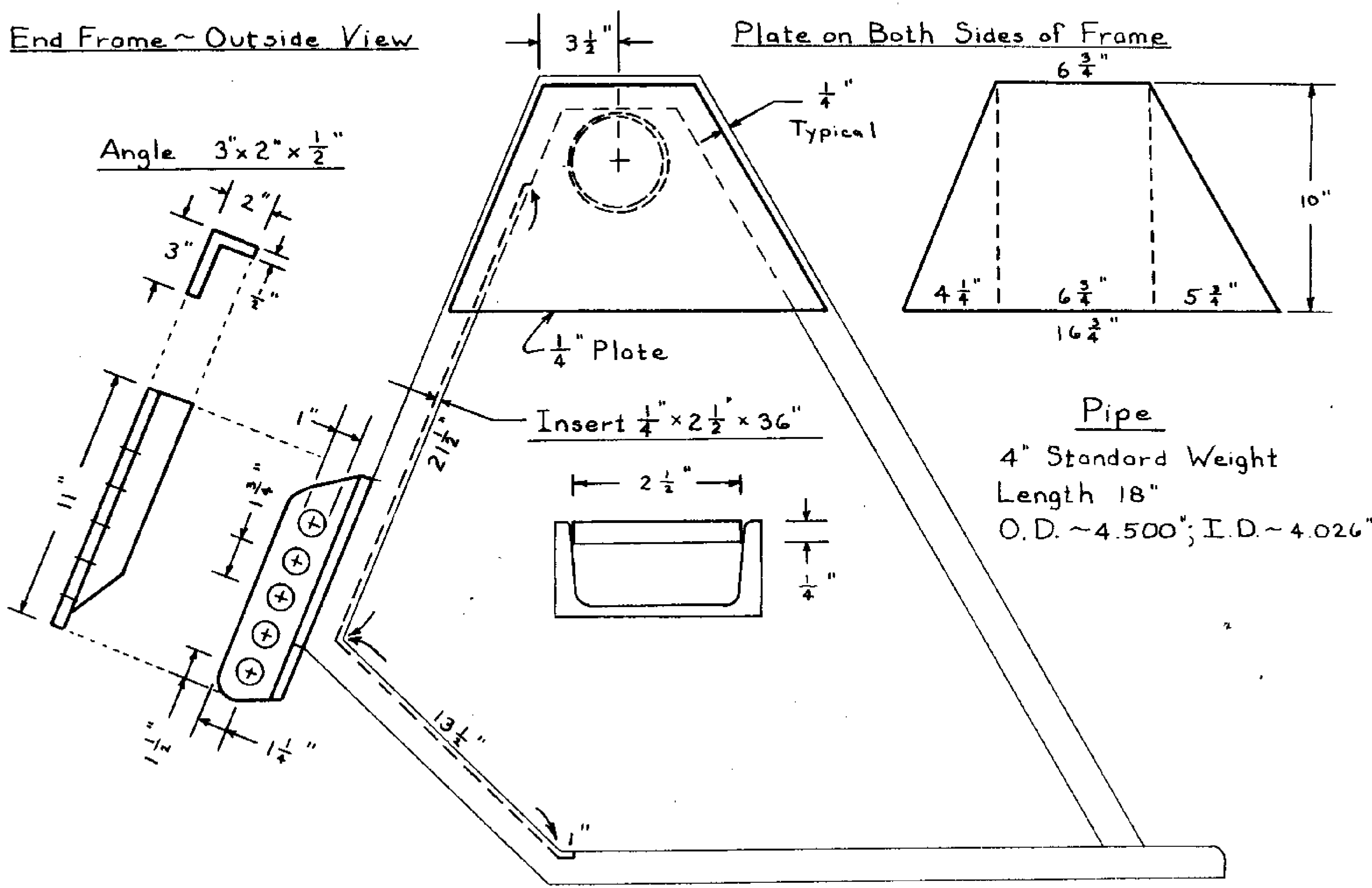


American Standard Channel C 3 x 4.1 (3 in wide x 4.1 lb/ft)

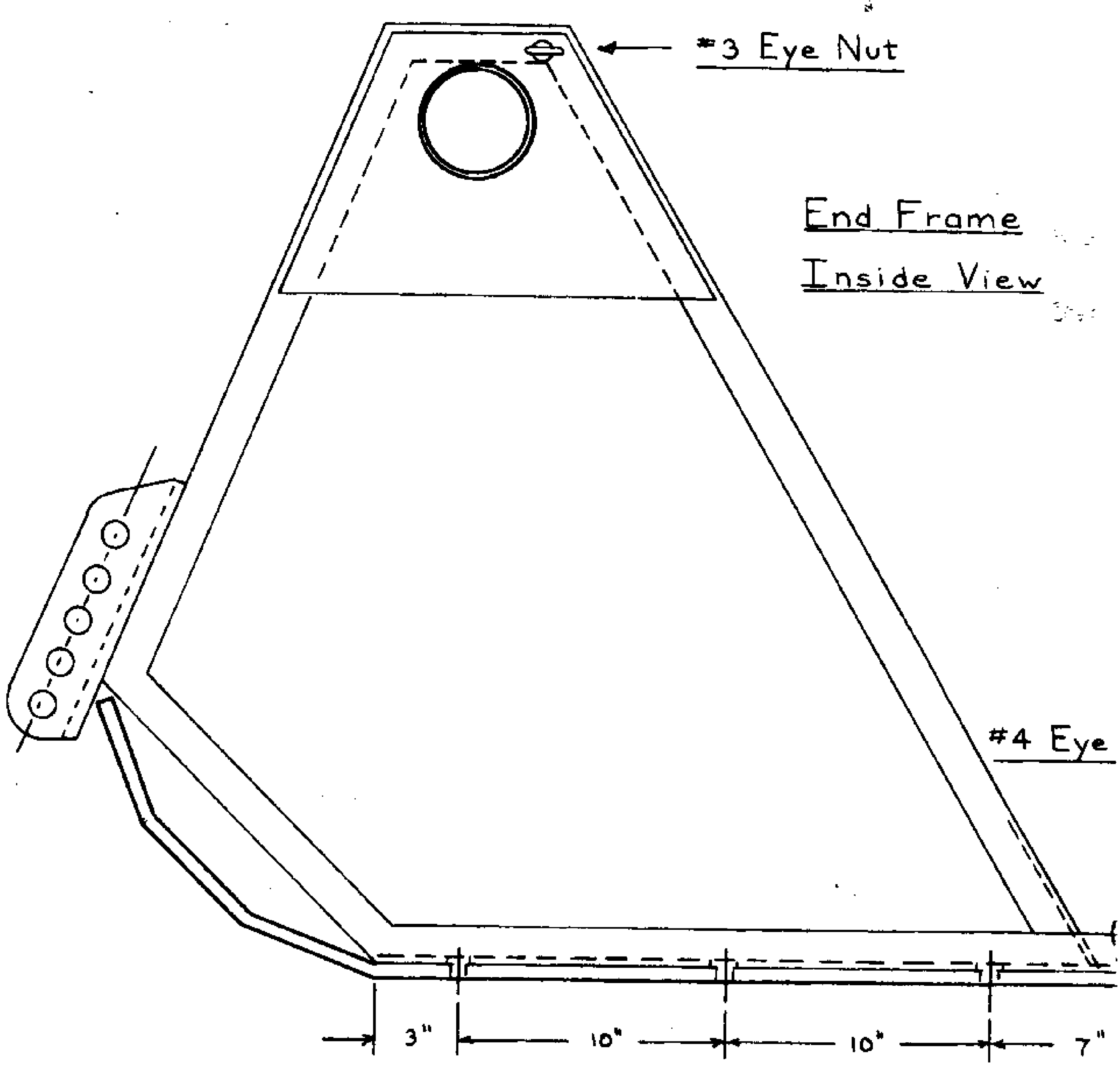
Total Length 10 ft (½ stock length of 20 ft)

Figure 21

THIRD GENERATION BEAM (STEEL)



THIRD GENERATION BEAM (STEEL)



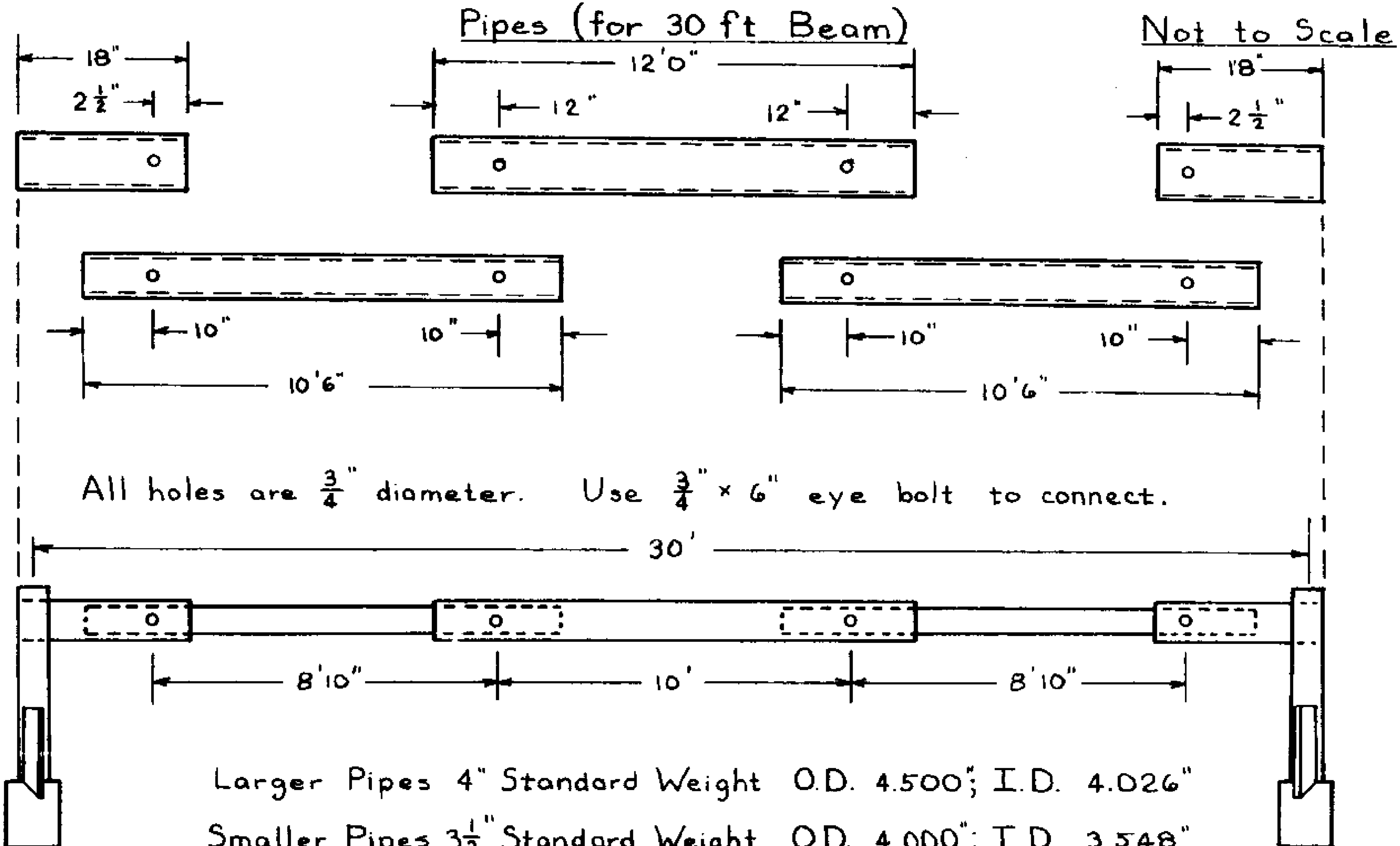
Shoe: $\frac{1}{2}$" × 6" Flat Bar 45" Long ±
Drilled and tapped for $\frac{1}{2}$" bolts on 10" centers.

Eye Nuts: Welded in place as shown. Size optional.

Note: The shape of the curved portion of the shoe is not critical. It may be a smooth curve or a series of bends as shown.

Figure 23

Third Generation Beam (Steel)

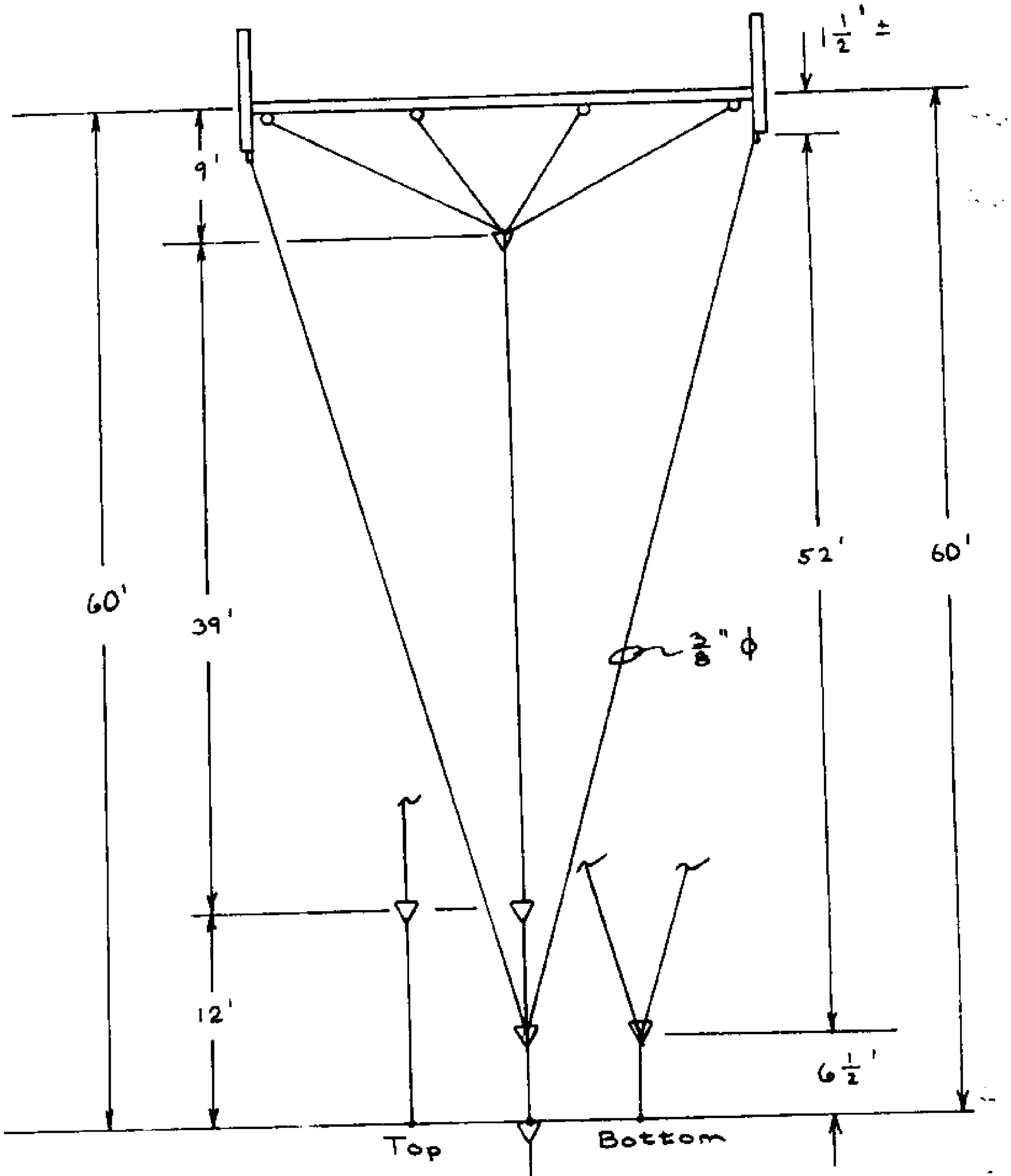


Note: The $3\frac{1}{2}$" pipe is supposed to fit inside the 4" pipe; however, it will usually not do so. It is usually necessary to turn down the ends of the smaller pipes until they fit.

Third Generation Beam (Steel)

Bridle Cable System

Top View — All Cables are 3/8" ϕ



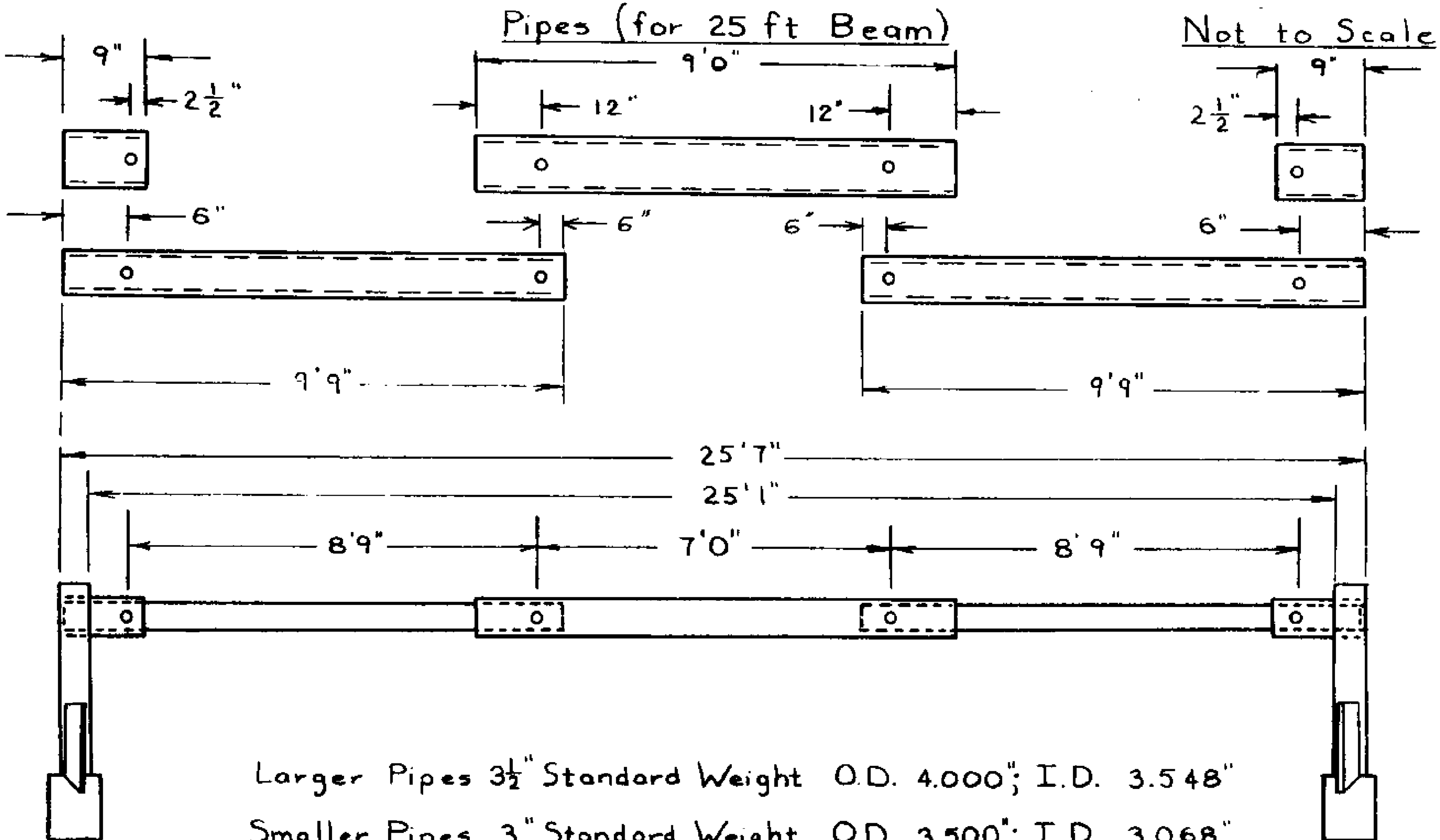
▽ Indicates Shackle — Main Towing Cable

Add Shackle to Top Line to tilt beam back.

Add Shackle to Bottom Line to tilt beam forward

Figure 25

THIRD GENERATION BEAM (STEEL)



Larger Pipes 3½" Standard Weight O.D. 4.000"; I.D. 3.548"

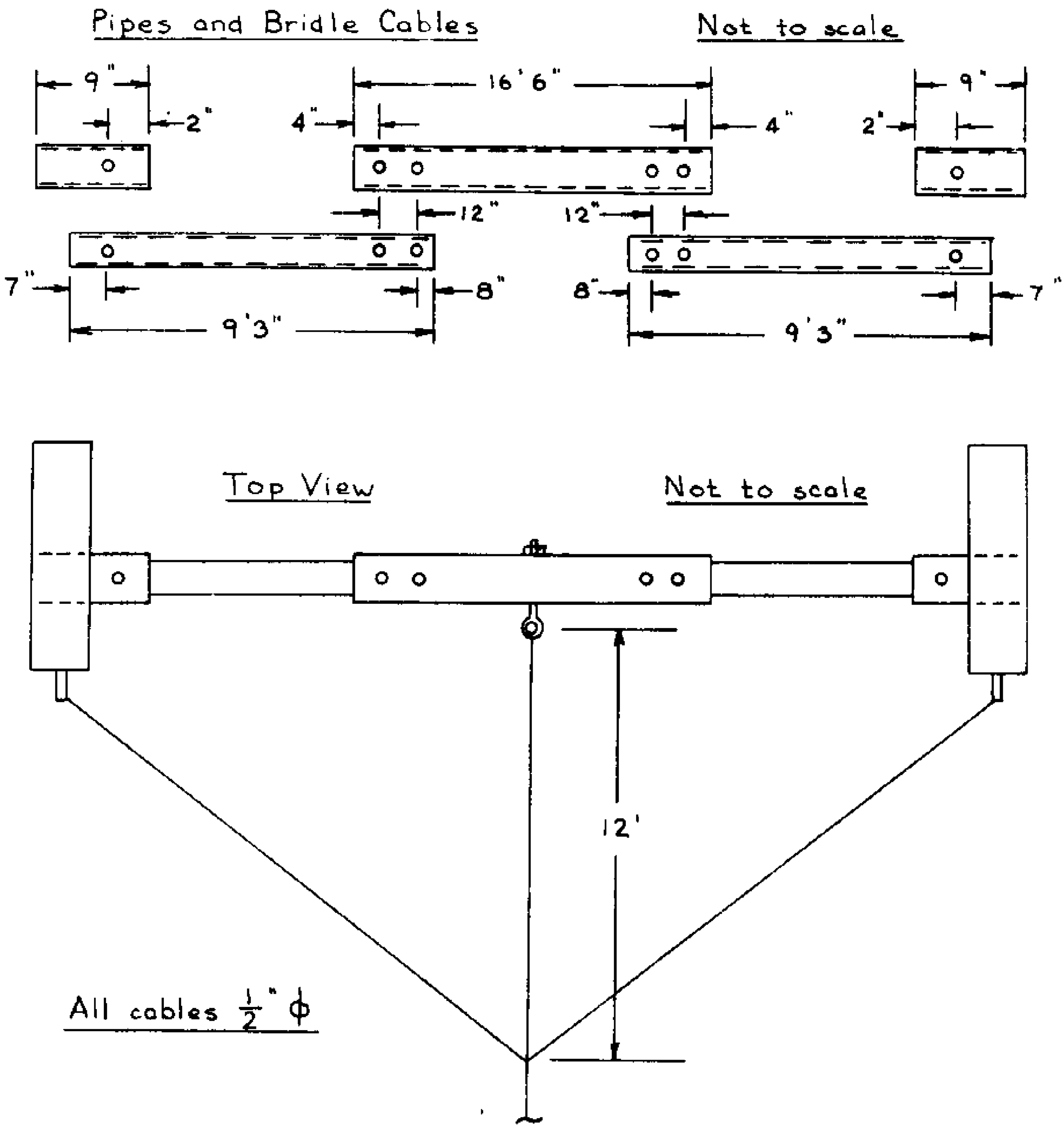
Smaller Pipes 3" Standard Weight O.D. 3.500"; I.D. 3.068"

Use Third Generation End Frame with 3½" Pipe.

Use Third Generation Bridle Cable System.

Figure 26

First Generation Beam (Aluminum)



Larger Pipes 5" Extra Strong O.D. 5.563"; I.D. 4.813"

Smaller Pipes 4" Standard O.D. 4.500"; I.D. 4.026"

Figure 28

Second Generation Beam — Modified (Steel)