WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

MISSISSIPPI RIVER COMMISSION

MODEL STUDY

OF

PONTONS AND PNEUMATIC FLOATS

TECHNICAL MEMORANDUM NO. 215-1

U. S. WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

1 MARCH 1945

CONTENTS

MODEL STUDY OF PONTONS AND PNEUMATIC FLOATS

SYNOPSIS

1. This memorandum constitutes a comprehensive report on the results of a model study performed at the U. S. Waterways Experiment Station for the Engineer Board, Fort Belvoir, Virginia, on pontons and pneumatic floats used in the construction of floating military bridges. The purpose of the study was to (a) develop an attachment for the bow of the present 25-ton ponton; (b) determine the optimum bow shape of future pontons to be constructed; (c) study the most effective methods of anchorage; and (d) investigate the upstream bow shape of the pneumatic type float. The above alterations and investigations were desired with a view to increasing the freeboard of the present American 25-ton ponton and pneumatic float in high-velocity flow. All tests were conducted in a 4-ft wide flume with flow maintained at a depth equivalent to 20 ft in the prototype. The pontons were built to the linear-scale ratio, model to prototype, of 1 to 8.

2. It was determined from the model study that the present American 25-ton ponton would not perform satisfactorily in high-velocity flow under conditions of heavy loading. As the ponton became submerged in high-velocity flow, the steep rake of bow prevented the use of the dynamic force of the stream as a lifting force, thus decreasing the freeboard at the bow.

3. To improve the freeboard conditions of the present heavy pontons in use several types of attachments were developed that helped considerably. In order to increase freeboard it was found that either of two things could be done: (a) the rake of the bow could be flattened, or (b) the height of the bow could be increased. No improvement in freeboard could be made by revising the method of anchoring the ponton. Additional tests on the development of an entirely new bow shape revealed almost the same information as the attachment tests but did serve to emphasize the fact that the shape of the bow in plan (streamlining) had little effect in improving the amount of freeboard.

4. Comparison of the German, British, and American 25-ton ponton of original and alternate design revealed that when loaded to the same freeboard on the side, the flat rake of the German bow makes it superior to the other types. The flat rake of the British ponton operates very well in providing freeboard but the extra bow height of the German and American pontons accounts for additional freeboard.

5. The type M1 pneumatic float operated satisfactorily in high-velocity flow until the loading was such as to cause waves to break over the bow. As soon as this occurred the bow of the float would dive at frequent intervals, remaining beneath the surface for some time.

PART I: AUTHORIZATION

6. Authority to undertake the model study of pontons and pneumatic floats was granted by the Chief of Engineers in a telegram dated 16 June 1943 and confirmed verbally in subsequent conversations with Lieutenant Colonels Clayton E. Mullins and George W. Howard, and in a letter dated 10 July 1943 from the Chief of Engineers. The study was conducted on a 24-hr schedule, 7 days a week, during the period June 1943 to November 1943. All the data from the tests were supplied immediately to the Engineer Board, Fort Belvoir, Virginia, in the form of interim reports.

PART II: THE PROTOTYPE

Ponton[1]

7. The American 25-ton heavy ponton is rectangular in cross section between the rakes of the two scow-type ends, either of which may serve as bow or stern (see plate 1). The ponton is 32 ft 9 in. long, 6 ft 5-5/8 in. wide, and 3 ft 4 in. deep increased by 5 in. at the ends. Its construction is similar to that of the light pontons, being divided into four compartments by bulkheads. Each of the end bulkheads mounts a capstan used in tightening the anchor cable. The ponton itself is built of aluminum alloy sheets and shapes fastened together with rivets. A carrying rail is located midway between the gunwale and the bottom of the ponton. The bottom of the ponton is protected by aluminum skids riveted through the skin and the framework. Cleats are located at each end of the ponton to facilitate securing the anchor or other lines.

8. The ponton weighs approximately 2700 lb, and has a maximum displacement of 41,400 lb. At freeboards of 14, 10, and 6 in. used throughout the model tests, displacements of 26,135, 30,459, and 34,838 lb, respectively, exist.

Pneumatic Float

9. The American M1 type pneumatic float is 33 ft long, 8 ft 3 in. wide, and 33 in. deep increasing 12 in. at the bow (see plate 42). The ends are raked upward to prevent bow waves from breaking over the float. It is made of rubberized fabric and consists of an outer tube, a floor, and a removable central tube. The central tube adds to the rigidity of the float and maintains buoyancy when the float is submerged. Each tube is 33 in. in diameter and is divided by bulkheads into separately inflated air chambers. Attachments consist of straps for holding float sills to the float, straps to hold the central tube in place, and D-rings for carrying the float and for attaching lashings and bridle lines. The float weighs approximately 900 lb. It has a buoyancy of approximately 39,000 lb when floating with no freeboard. When the float is submerged and water fills the space between the center and outer tubes, buoyancy is reduced to approximately 36,000 lb. Deflated the float is folded and packed in a carrying case.

---

[1] Information on the prototype was obtained from "Technical Manual, 5-273" of the War Department entitled "25 Ton Ponton Bridge, Model 1940".

PART III: THE MODELS

Purpose

10. The general purpose of the model studies was the improvement of freeboard conditions in high-velocity flow and made necessary: (a) the development of an attachment for the bow of the present heavy type ponton, (b) the determination of the optimum bow shape of future pontons to be constructed, (c) the study of the most effective means of anchorage, and (d) the investigation of the upstream bow shape of the pneumatic type floats.

Description

11. The models of the pontons and pneumatic float were constructed to the linear-scale ratio, model to prototype, of 1 to 8 (see photographs 1-21). All models were constructed entirely of plastic material to more nearly simulate to scale the effect of skin friction between the pontons or pneumatic float and the water. All outside details of the ponton, including skids and handrails, were reproduced accurately to scale but no effort was made to reproduce inside details. Similar construction was also used for the pneumatic float.

Model Test Procedure

12. All models of the pontons and pneumatic float were tested in a 4-ft wide flume with the flow maintained at a depth equivalent to 20 ft in the prototype.

13. Various measuring and controlling devices were used to obtain the necessary data and to control the several variables in the operation. These several variables and the methods of control and measurement were as follow:

a. Discharge. The correct discharges to secure the desired velocities were introduced into the model by means of a battery of pumps discharging through venturi tubes.

b. Depth of flow. An adjustable tailgate was provided at the end of the flume to maintain the desired depth (20 ft) for all conditions of loading and velocity.

c. Velocities. All velocity measurements were made with a pitot tube located 16 ft (prototype) upstream from the bow of the pontons. Velocities were measured 18 in. (prototype) below the surface to correspond to prototype measurements and recorded on a manometer gage containing a fluid which magnified all head differentials, thus

minimizing errors in velocity measurements.

d. Loading. Prior to the start of the tests the pontons and pneumatic float were loaded to a freeboard of 14, 10, or 6 in. on the side in still water. These freeboards are equivalent to loads of 26,135, 30,459, and 34,838 lb respectively. Loading was accomplished by placing small lead billets in the bottom of the center portion of the pontons and along each side of the central tube of the pneumatic float. No consideration was given to the extra buoyancy added by use of the various attachments or by an increase in the over-all length. Consequently the actual weights required to load the pontons and pneumatic float to the desired freeboard on the side varied with the amount of displacement.

e. Anchoring. In practically all tests an anchor line with a length of 10 times the depth of flow was connected to the bows of the pontons and the pneumatic float. In a few tests to determine the effect of various methods of anchoring, the length of line was shortened or connected by means of a halter arrangement to the handrail of the pontons. A bracket arrangement connected to the pontons and pneumatic float and resting against the walls of the flume kept the pontons and pneumatic float parallel to the flow but permitted them to move vertically and longitudinally with the force of the current. Actually in the prototype the superstructure holds each ponton in a very rigid position. No bobbing or longitudinal movement is apparent.

f. Freeboards. Freeboards at the bows and sides of the pontons and pneumatic float were measured by means of two small aluminum gages made for this purpose. The average freeboard and point of maximum surge or minimum freeboard were recorded for each condition of velocity and loading investigated. The location of the point of measurement of freeboard on the sides of the pontons and pneumatic float varied with different velocities. All measurements at the bow and side were made in a vertical direction.

Presentation of Test Results

14. All model data are presented in the form of freeboard-velocity curves or tables based on data recorded on the bow and side of the pontons and pneumatic float. In practically all cases only average freeboard-velocity data are presented and it is these data that should be compared for the determination of the best type of attachment or best ponton bow shape. For a quick determination of the

amount of improvement effected by each attachment or new bow shape, 5 transparent plates have been included for superimposition over the freeboard-velocity curves developed for each attachment or new bow shape. No alterations were made to the bow of the pneumatic float so no comparison can be made. Although data were secured for velocities as high as 10 ft per sec, it is understood that the critical velocity considered in the field is about 5 mi per hr or 7.3 ft per sec.

PART IV: DESCRIPTION OF TESTS

American 25-Ton Ponton

Description

15. A detailed description of the 25-ton American-type ponton has been presented previously in paragraph 7 and on plate 1. All tests were, with one exception, conducted on a single ponton loaded to the desired freeboard and located in the center of the test flume. In one series of tests, conducted to observe the effect of adjacent pontons, two pontons spaced at 15 ft center to center were investigated. Inasmuch as the results of tests on the present 25-ton ponton formed the basis to which all other data were compared, extreme care was taken with all measurements to insure that they were made as accurately as possible.

Test results

16. The tests conducted with the single ponton loaded in still water to freeboards of 14, 10, and 6 in. on the side revealed that the average freeboards on the bow were zero for respective velocities of 9.6, 8.4, and 6.5 ft per sec. At the above-mentioned velocities, freeboards of about 8.7, 6.5, and 3 in. still existed on the side of the ponton. At the critical velocity of 7.3 ft per sec freeboards of 10.3 and 4.3 in. existed at the bow for loadings of 14 and 10 in. in still water. The results of the tests with the single American-type ponton are shown on tables 1, 2, and 10, photographs 1 and 2, and plate 2. Wave conditions around the ponton were slightly different when a single ponton or two adjacent pontons were tested. With the single ponton an even wave broke away from the bow, whereas with adjacent pontons the waves formed at the bows impinged on each other creating a standing wave midway between the two pontons. The change in wave appearance, however, had practically no effect on freeboard conditions at the side or bow of the ponton. The data obtained with adjacent pontons checked within 0.5 in. of the freeboards measured on the side of a single ponton and within 2 in. of the freeboard measured on the bow; the maximum difference between the left and right pontons was less than 1.5 in. and was measured on the bow.

Comparison of model and towing tests

17. Comparison of the results of towing tests conducted at Fort Belvoir, when freeboard-velocity curves were developed by towing the boat through still water at the desired velocity, with the results of the flume tests revealed that the point of zero freeboard determined by the towing tests occurred at a velocity of 7.9 ft per sec, whereas the flume tests indicated 8.4 ft per sec (see plate 3). For velocities

less than 4.8 ft per sec the towing tests indicated about an inch more freeboard, whereas for velocities in excess of 4.8 ft per sec the towing tests indicated about 2 in. less freeboard. The above tests were conducted with the ponton loaded in still water to a freeboard of 10 in. on the side.

Comparison of model and prototype tests

18. In order to check the applicability of model results to the prototype, freeboard-velocity curves were developed in the prototype on two pontons loaded respectively to depths of 14, 10, and 6 in. on the side in still water. The results of these tests are shown on plates 4-6. The data reveal that in most cases the model indicated several more inches of freeboard than measured in the prototype; the greatest differences occurred at high velocities. Check runs of model data, however, gave the same results as previous tests, and it was concluded that model measurements were accurate. Some inconsistencies existed in the prototype data which are believed to account for the difference between model and prototype results. These inconsistencies are discussed in the following subparagraphs:

a. Drawings indicate that the bow of the American ponton is 5 in. higher than the sides. The plots of the prototype data at zero velocity, however, indicate this dimension to vary between 4.0 and 5.5 in.

b. The prototype freeboard-velocity curve for the bow of the ponton loaded to a freeboard of 14 in. on the side in still water (plate 4) as drawn is almost a straight line. This would mean that the loss of freeboard between a velocity of 0 to 1 ft per sec would be the same as between 6 and 7 ft per sec. There is considerable reason to doubt that this can be true.

c. The model and prototype freeboard-velocity curves developed with a 6-in. freeboard agree very well if correction is made in the prototype data for the extra inch freeboard at the bow and 0.5 in. at the side indicated at zero velocity.

d. Other miscellaneous prototype data secured at an earlier date checked model results within several tenths of an inch.

Methods of anchoring

19. In an attempt to secure additional freeboard, several methods of anchoring the pontons were investigated in addition to the present method wherein the length of the anchor line equals 10 times the depth of flow and extends over the bow of the pontons and attaches to the cavel. These additional methods of anchoring involved the use of a

shortened anchor line and the use of a halter arrangement to connect the anchor line to various points along the handrail rather than running it over the bow of the ponton. The results of the tests to investigate the various methods of anchoring, however, failed to reveal any change in the amount of freeboard available unless the anchor line was so shortened that the distance upstream to the anchor was the same as the depth of flow. For this length of anchor line, a loading of 10 in. and a velocity of 7.3 ft per sec, the freeboard at the bow was decreased about 2 in.

Development of Ponton Attachment

20. In order to increase the existing freeboard in high-velocity flow of the present 25-ton pontons now in use in large numbers, it was necessary to develop an attachment that would satisfactorily accomplish this purpose; important factors in the consideration of the type attachment were simplicity of design and ease of installation. All attachments, with one exception, were designed so as not to extend more than 4 ft upstream from the ponton bow. Reference is made to plate 7 for details of all attachments tested. Freeboard-velocity curves developed at three conditions of loading form the basis for determination of the best attachment for field use. In all tests of ponton attachments the length of the anchor line was maintained at 10 times the depth of flow.

Type 1 attachment

21. The type 1 attachment extended 2.89 ft upstream from the bow of the American-type ponton and had an alignment similar to the vertical alignment of the British-type ponton bow. The extra buoyant effect of the attachment was disregarded and the ponton loaded respectively to freeboards of 14, 10, and 6 in. on the side in still water at the start of each test. The buoyant effect of the attachment was disregarded inasmuch as it was believed that in the prototype the attachment in all probability would not be absolutely watertight.

22. Results of tests of the type 1 attachment are shown in tables 3-5, and on plate 8. Comparison of these results with those for the American ponton reveals that an increase in freeboard of about 1.5 and 3.3 in. existed at the bow for loadings of 14 and 10 in., respectively, and a velocity of 7.3 ft per sec. At a loading of 6 in. and a velocity of 6.5 ft per sec a freeboard of 4.4 in. existed through use of the type 1 attachment, whereas zero freeboard existed without the attachment.

Type 2 attachment

23. The type 2 attachment extended 0.96 ft upstream from the bow of the American-type ponton and was designed to improve the freeboard only under heavy loadings and high velocities. The small size of the attachment should permit easy carrying and installation whenever necessary.

24. As expected the results of the tests with the attachment revealed no improvement was effected at the 14 in. loading. For loadings of 10 and 6 in., however, the freeboard was increased respectively about 1.8 in. at a velocity of 7.3 ft per sec and 2.7 in. at a velocity of 6.5 ft per sec. Reference is made to tables 3-5, and plate 9 for results of tests of type 2 attachment.

Type 3 attachment

25. The type 3 attachment extended about 1.5 ft upstream from the present type ponton bow and like the type 2 attachment was designed primarily to improve freeboard conditions only under heavy loadings and high-velocity flow.

26. Reference is made to photographs 3 and 4 and plate 10 for details of design and results of tests. The results of the tests indicated that this attachment was one of the most satisfactory tested. The 1.5-ft extension was also within the 3-ft over-all length increase set up as permissible in the design of a new ponton; this meant that the type 3 attachment might also be incorporated in the design of a new ponton. At a velocity of 7.3 ft per sec and loading of 14 and 10 in., freeboards at the bow were increased respectively 0.6 and 2.8 in.; however, at a loading of 6 in. the freeboard on the bow was increased 5.2 in. at a velocity of 6.5 ft per sec and at a velocity of 7.3 ft per sec was still equal to 3.8 in.

Type 4 attachment

27. The type 4 attachment was somewhat similar to the type 3 attachment in that they both extended approximately 1.5 ft upstream from the bow of the present ponton. The rake of the bow of the type 4 attachment, however, was steeper and the change in shape constant rather than the reverse curve alignment used in the type 3 attachment.

28. The fact that less freeboard was obtained with the type 4 attachment than with the type 3 is attributed to the difference in the rake of the bow. Comparison with the results obtained with the present ponton design reveals only a slight improvement in freeboard was effected through use of the attachment. Reference is made to plate 11 for presentation of freeboard-velocity curves and details of the type 4 attachment.

Type 5 attachment

29. The type 5 attachment was developed to study the effect on freeboard of a drastic change in the shape of the bow; it was realized that the type 5 attachment was not practical for actual use. Although the curvature of the bow is about as steep as that of the present ponton bow alignment efforts were made to streamline the flow past the attachment (see plate 12).

30. Reference is made to plate 12 for results of tests. The test results indicated an increase in freeboard of from 1 to 2 in. for all conditions of velocity and loading, which is believed insufficient to warrant further consideration of the type 5 attachment.

Type 6-8 attachments

31. The types 6, 7, and 8 attachments are similar except for the steepness of rake of the bow; they extended respectively 4, 3, and 1.5 ft upstream from the bow of the ponton. The type 6 attachment has almost the same rake as the German ponton and has the flattest rake of any attachment tested; no flatter rake was investigated in order to remain within the limiting extension of 4 ft set up prior to the tests.

32. Reference is made to plates 13-15 for results of tests conducted on the above attachments. Comparison of the results of the tests reveals that the flatter the rake the more the increase in freeboard at equivalent velocities. At a velocity of 7.3 ft per sec and a 10 in. loading the freeboards at the bow for the types 6, 7, and 8 attachments respectively, were 10.8, 8.8, and 6.8 in.; for the same condition of velocity and loading a freeboard of 4.3 in. existed without any attachment. Comparison of the freeboard results obtained with the type 6 and type 3 attachments indicates that at a velocity of 7.3 ft per sec freeboards with the type 6 attachment were greater by 4.7, 3.7, and 1.4 in. respectively, at loadings at 14, 10, and 6 in. on the side.

Type 9 attachment

33. The type 9 attachment was developed in the attempt to eliminate the curved alignment of the type 3 attachment without interfering with the freeboard-velocity results. The type 9 attachment extended upstream from the ponton bow about 2 ft.

34. Comparison of the results of tests on the types 3 and 9 attachments (table 3 and plates 10 and 16) reveals that for loadings of 10 and 6 in. the type 3 attachment provided slightly more freeboard, whereas at a 14-in. loading the type 9 attachment improved the type 3 freeboards by from 1 to 2 in. At a velocity of 7.3 ft per sec and loadings of 14, 10, and 6 in. the freeboards existing with the type 3 attachment were respectively 11, 7.1, and 3.8 in., whereas corresponding freeboards with the type 9 attachment were 13, 6.8, and 2.5 in. The use of either of the above attachments effected an appreciable improvement over those observed with the present design ponton.

Type 10 attachment

35. The type 10 attachment was simply a 12-in. vertical extension to the bow of the present American 25-ton ponton (see photograph 5). It did not attempt to secure more freeboard by changing the alignment of the bow but was thought practical in view of the ease of construction

and installation.

36. The shapes of the freeboard-velocity curves with the type 10 attachment were the same as those developed with the present ponton design except the magnitude of all existing freeboards were increased by 12 in. Data on the type 10 attachment are presented in tables 3-5 and plate 17. All previous attachments investigated were maintained at the same elevation as the bow of the ponton in order to improve freeboard conditions by variation in the rake of bow.

Type 11 attachment

37. The type 11 attachment was similar to the type 2 attachment except the curved alignment of the latter design was eliminated and the height of the bow was increased 6 in.

38. Comparison of the results of tests of the types 2 and 11 attachments (plates 9 and 18) reveals that similar freeboards occurred except that the 6-in. increase in height of bow of the type 11 attachment provided approximately 6 in. more freeboard for equivalent velocities.

Type 12 attachment

39. The type 12 attachment was suggested by Lieutenant Colonel Clayton E. Mullins of the Engineer Board during a visit to the Experiment Station on 16 July 1943. Although the type 12 attachment extended farther upstream from the bow than the 4-ft limiting extension, it was thought that if the attachment improved freeboard conditions sufficiently, consideration could be given to the incorporation of the attachment in the design of a new bow. The type 12 attachment extended about 4 in. higher than the ponton bow and was different from all other attachments tested in that the sides converged upstream from the bow.

40. The results of the tests with the type 12 attachment (plate 19) reveal that a definite improvement in freeboard was made although a large part of the increase was due to the extra 4 in. added to the height. The rake of the bow with the type 12 attachment is almost identical with the type 7 attachment and, if allowance is made for the extra 4 in. in height, the freeboard-velocity results are similar. The similarity of results indicates that the converging sides of the type 12 attachment had little effect on freeboard conditions. Comparison of the test results with the type 6 attachment reveals that if the extra 4 in. gained through the increased height of the type 12 attachment is neglected the flatter rake of the type 6 attachment gives better results.

Summary of results of tests of ponton attachments

41. Reference is made to plate 20 for a graphical comparison of results of the tests of attachments. The results of the tests of

attachments to the American 25-ton ponton revealed that all attachments investigated effected some improvement in freeboard. This fact is attributed to the flattening of the rake of the bow in each case. Analysis of the results indicated that for the same height bow the flatter the rake the more freeboard at equivalent velocities. This condition seemed to be true regardless of the shape of the attachment in plan.

42. It is believed that the most economical and easiest attachment to construct would be the "windshield" affair proposed as type 10. If for some reason the type 10 is not practicable, it is recommended that either the types 11, 3, 9, or 6 attachments be used. The type 9 attachment has the advantage over the type 3 in that it would be easier to construct; and the types 3 and 9 have the advantage over type 6 in that they are shorter, require less material, and would be easier to install.

43. As mentioned previously in this report all comparisons have been based on average freeboard measurements. The point of maximum surge or minimum freeboard, however, was obtained for all conditions of loading and velocity. The results of the measurements are included on table 5 for one condition of loading only. No comparisons were made using the points of maximum surge, because the bobbing of the ponton together with the surging flow made the development of freeboard-velocity curves difficult.

Determination of Optimum Bow Shape and Alternate Ponton Design

44. In order to develop improved future ponton designs, tests on three styles of ponton bows were proposed for testing by the Engineer Board. Following the investigation of the three style ponton bows, four new designs were developed at the Experiment Station. All tests were conducted as described previously; freeboard-velocity curves were developed for velocities varying from 0 to 10 ft per sec at loadings to freeboards of 14, 10, and 6 in. on the side in still water.

Description of three style ponton bows

45. The three style ponton bows varied in plan; one style (types A-D) was rectangular in plan similar to the present American design bow shape; another style (types E-H) was semicircular in plan with a radius of 3.25 ft; the last style (types I-L) was elliptical in plan. The investigation of each style ponton bow was planned to show the relative effect on freeboard of the ponton bow shape in plan and a 90, 60, 45, and 30 degree rake of bow. In order to maintain a constant displacement the length of each ponton tested varied in accordance with the shape in plan and rake of bow.

a. Types A-D. The ponton bow was rectangular in shape with a width of 6.5 ft, a constant height of 3.33 ft, and a

varying length depending on the degree of rake of bow. The over-all ponton lengths were 30.7, 32.62, 34.03, and 36.46 ft, respectively, for bow rakes of 90, 60, 45, and 30 degrees.

b. Types E-H. The ponton bow was semicircular in plan with a radius of 3.25 ft; the width of the ponton was 6.5 ft, height 3.33 ft, and the length was 32.1, 34.4, 35.36, and 37.84 ft, respectively, for 90, 60, 45, and 30 degree bow rakes.

c. Types I-L. The ponton bow was elliptical in plan with a major axis of 13 ft and a minor axis of 6.5 ft; the width and height of the ponton was maintained at 6.5 and 3.33 ft, whereas the length was 33.25, 34.45, 36.86, and 38.81 ft, respectively, for 90, 60, 45, and 30 degree bow rakes.

Test results

46. Results of tests for the three style ponton bows are shown on photographs 6-11, tables 6 and 7, and plates 21-32. Analyses of these data reveal results similar to those obtained during the tests of the attachments in that the flatter the rake of the bow the more freeboard gained. The data further reveal that only a slight improvement in freeboard conditions was gained through streamlining the ponton bow; therefore, it is not believed that the improvement is sufficient to justify the extra construction difficulties involved. The actual freeboard gained by streamlining the bow amounted to about 2 in. for 90 and 60 degree bow rakes, whereas no improvement at all was effected for 45 and 30 degree bow rakes. In general, the freeboard gained in high velocity flow by changing the rake of the bow from 90 degrees to 30 degrees increased the freeboard about 8 in. for a loading of 14 in., 4 in. for a loading of 10 in., and 2 in. for a loading of 6 in.; the loadings listed are all freeboards on the side of the ponton at zero velocity.

Additional ponton designs

47. As mentioned in paragraph 44, four new ponton designs were investigated following the tests of the three style bows. Ponton designs 1 and 2 incorporated the main body of the American 25-ton ponton with bows in accordance with the horizontal and vertical alignments of the British and German shape bows, respectively. In order to gain additional buoyancy, however, the over-all length of the pontons was increased about 3 ft over that of the American ponton. The 3-ft increase made an over-all length of about 35.75 which was the limiting length that could be used in order to permit their transportation on present designed carriers. The types 3 and 4 designs were developed to study the effect of a radical change in the shape of the ponton bow. The type 3 design was modeled after the streamlined hull of a tug boat while the type 4 design was modeled after a barge. In view of the

fact that the tests indicated a streamlining of the bow was not warranted and that the rake of the bow was the all-important item, no further ponton designs were investigated.

Type 1 design for new ponton

48. The type 1 design for a new ponton developed at the Experiment Station was 3.17 ft longer than the American 25-ton ponton but identical in breadth. The bow shape was similar to the horizontal and vertical alignment of the British-type ponton. The extra buoyant effect of the additional length was disregarded in the first series of tests and the ponton loaded respectively to freeboards of 14, 10, and 6 in. on the side in still water at the start of each test.

49. Results of the tests of the type 1 design are shown on tables 8-10 and plate 33. Comparison of these results with those for the American 25-ton ponton reveals that an increase in freeboard of about 1.2 and 2.4 in. existed at the bow for loadings of 14 and 10 in. respectively, and a velocity of 7.3 ft per sec. At a loading of 6 in. and a velocity of 6.5 ft per sec a freeboard of 3.1 in. existed on the type 1 design, whereas zero freeboard existed on the American 25-ton ponton. The increase in freeboard of the type 1 design is attributed to the vertical alignment of the bow rather than to the horizontal alignment. Comparison of the freeboard-velocity curves developed for the type 1 ponton with the results of tests conducted on the type 1 attachment (see plate 8) will demonstrate this fact. The type 1 attachment has a similar vertical alignment but the horizontal alignment was identical to that of the American ponton.

50. Additional tests were conducted on the type 1 ponton in an attempt to determine the effect of the difference in buoyancy between the American and type 1 pontons. Prior to the start of tests on the American 25-ton ponton, the ponton was loaded with small lead billets to a freeboard of 10 in. on the side in still water. In the buoyancy tests of the type 1 ponton the same lead billets were used with a correction made for the difference in the weight of the empty pontons. The freeboard measured on the side in still water for the design length of 35.92 ft was 9.89 in., or an initial loss of 0.11 in. in freeboard. The type 1 ponton was then placed in the flume and freeboard-velocity curves determined for that loading. These reveal that the additional freeboard gained by the new shape of the bow more than offset the slight loss in buoyancy (see table 11). The type 1 design was then modified by reducing the length to the same as the American 25-ton ponton and a test conducted similar to the one discussed above. Results of this test indicated that a freeboard of 6.53 in. existed on the side of the ponton in still water which was an initial loss of freeboard of 3.47 in. Table 11 shows the freeboard-velocity relations existing for this condition. The results of the above tests indicate that the length of the type 1 ponton would have to be approximately 35.92 ft to be considered for a new design. In the case of the shortened ponton the loss in buoyancy was more important than the shape of bow.

Type 2 design for new ponton

51. The type 2 design for a new ponton was 2.93 ft longer than the American 25-ton ponton but identical in breadth. The bow shape was similar to the horizontal and vertical alignment of the German-type ponton. The extra buoyant effect of the additional length was disregarded in the first tests and the ponton loaded respectively to freeboards of 14, 10, and 6 in. on the side in still water (see photograph 12).

52. Results of the tests of the type 2 design are shown on tables 8-10, photograph 13, and plate 34. Comparison of these results with those for the American 25-ton ponton reveals that an increase in freeboard of about 4.6 and 3.3 in. existed at the bow for loadings of 14 and 10 in., respectively, and a velocity of 7.3 ft per sec. At a loading of 6 in. and a velocity of 6.5 ft per sec a freeboard of 4.6 in. existed on the type 2 design, whereas zero freeboard existed on the American 25-ton ponton. Comparison of the freeboards for the type 1 and 2 designs under loadings of 14, 10, and 6 in. on the side indicates that more freeboard was gained through use of the type 2 design.

53. Additional tests similar to those described in paragraph 50 were conducted to study the loss in buoyancy effected by the type 2 design. Results of the tests showed that the type 2 design with a design length of 35.68 ft had a freeboard of 8.16 in. on the side in still water as compared to a freeboard of 10 in. on the American ponton under the same weight loading. Results further reveal that when the length of the type 2 design ponton was reduced to the American 25-ton ponton length of 32.75 ft, the freeboard on the side in still water was only 4.61 in., a freeboard loss of 5.39 in. Average freeboard-velocity curves are tabulated in table 11 for both the above lengths of the type 2 design ponton. Although the flat rake of the bow was very effective in increasing the freeboard at equivalent velocities the loss of buoyancy was sufficient to eliminate further consideration of the shortened type 2 ponton.

Type 3 design for new ponton

54. The type 3 design for a new ponton was 3.25 ft longer and 0.808 ft wider than the American 25-ton ponton. Attention is also invited to the fact that the bow of the type 3 ponton was 3 in. higher than any of the other designs tested; the side of the ponton was also increased in height. The extra buoyant effect of the additional length, height, and breadth was first disregarded and the ponton loaded respectively to freeboards of 14, 10, and 6 in. on the side in still water at the start of the tests.

55. Results of the tests of the type 3 design are shown on tables 8-10, and plate 35. Comparison of these results with those for the American 25-ton ponton reveals that an increase in freeboard of about 0.2 and 2.0 in. existed at the bow for loadings of 14 and 10 in.,

respectively, and a velocity of 7.3 ft per sec. At a loading of 6 in. and a velocity of 6.5 ft per sec a freeboard of 3.25 in. existed on the type 3 design, whereas zero freeboard existed on the American 25-ton ponton. If tests had been made to study the loss or gain in buoyancy by use of the type 3 design, the freeboard on the side of the ponton would have been increased slightly as a result of additional displacement, rather than decreased as was the case for the types 1 and 2 designs.

Type 4 design for new ponton

56. The type 4 design for a new ponton was 2.826 ft longer and 0.008 ft wider than the American 25-ton ponton. The height of the bow, however, was the same as the height of the side. The extra buoyant effect of the additional length and breadth was disregarded and the ponton loaded respectively to a freeboard of 14, 10, and 6 in. on the side in still water at the start of each test.

57. Results of the tests of the type 4 design are shown on tables 8-10 and plate 36. Comparison of these results with those for the American 25-ton ponton reveals that a decrease in freeboard of about 3.9 and 2.25 in. existed at the bow for loadings of 14 and 10 in., respectively, and a velocity of 7.3 ft per sec. At a loading of 6 in. the type 4 design approached zero freeboard at a velocity of 5.2 ft per sec, whereas the American 25-ton ponton approached zero freeboard at a velocity of 6.5 ft per sec. Consideration of the fact that the height of the bow was the same as the side, thus decreasing the amount of freeboard on the bow at zero velocity as compared with other ponton designs, would increase the degree of improvement over the American-type ponton.

Summary of results of tests on bow shape and development of new ponton

58. The results of the tests on the three style ponton bows as suggested by the Engineer Board corroborated the results of the attachment tests in that freeboard conditions were improved as the rake of the bow was flattened (see plate 37). These tests indicated more clearly, however, that streamlining the bow of the ponton did not effect enough improvement in freeboard to warrant the construction difficulties involved.

59. The results of the tests on the four ponton designs developed by the Experiment Station revealed that all the designs, with the exception of type 4, effected some improvement in freeboard (see plate 37). The type 4 design would be as efficient as other designs if the bow height was increased above the side a like amount. Of the four designs it is believed that the most economical and easiest ponton to construct would be the type 2 design. This design was also the most satisfactory when the various pontons were loaded to the same freeboard on the side. Consideration of the loss of buoyancy through use of a flat rake of the bow, however, would indicate the use of the

type 1 design with a length of approximately 35.92 ft. The flat rake of the type 1 design provides more freeboard than the present American 25-ton ponton and with a length of 35.92 ft causes practically no change in the buoyancy. The gain in freeboard through use of a flat rake on the type 2 design is offset by the loss in buoyancy. The types 3 and 4 designs provide freeboard conditions about similar to those existing for the type 1 and 2 designs but would be difficult to construct.

British Ponton Mark V

Description - British ponton Mark V

60. The British ponton Mark V has an over-all length of 20 ft, a width of 5 ft 9 in. and a constant height of 2 ft 10 in. The bow has a flat curved rake and in plan tapers to a width of 4 ft 2 in. The stern is square and provided with connections that will permit the use of two pontons connected stern to stern to carry heavier loads. In the event that it is necessary to carry loads beyond the capacity of two pontons, a third center section with a square bow and stern is available. All three sections are shown on photograph 14 and a detailed drawing is shown on plate 38. Formerly the British ponton was covered with a deck but it is understood that the decking has now been eliminated.

Test results

61. Average freeboard-velocity curves were developed under various conditions of velocity and loadings to freeboards of 14, 10, and 6 in. on the side in still water. Tests were conducted with the single ponton, the double ponton, and with the center piece installed, but inasmuch as the extra buoyant effect of the additional pontons was disregarded the freeboard-velocity curves for all three conditions were identical. Accordingly, only the curves developed with the single ponton were plotted (see plate 38). Reference is also made to tables 1 and 2 for freeboard results. At the critical velocity of 7.3 ft per sec freeboards of 7.25 and 0.77 in. existed at the bow for loadings of 14 and 10 in. freeboard on the side in still water (see photograph 15); at a 6-in. loading zero freeboard existed on the bow at a velocity of 5.7 ft per sec. The fact that the height of the ponton was the same throughout made the bow the most critical point in the matter of available freeboard. In other ponton designs investigated the bow was raised above the sides, which permitted additional freeboard to be gained. It is not believed that the tapered bow in plan had an appreciable effect toward increasing the freeboard at the bow.

German Ponton

Description

62. The German ponton has an over-all length of 24.5 ft, a width

of 5.0 ft, and a height of 3 ft 3 in. increased by 9 in. at the bow (see plate 39). The rake of the bow is flatter than that of the British ponton and in plan is square, similar to the American ponton. The stern of the German ponton is square and provided with connections similar to the British ponton for connecting two pontons stern to stern for the purpose of carrying heavier loads. Photograph 16 shows view of two German pontons.

Test results

63. Average freeboard-velocity curves developed under loadings to freeboards of 14, 10, and 6 in. on the side in still water reveal that the extra height of the German ponton bow plus the flat rake provides adequate freeboard at all velocities tested (see tables 1 and 2 and plate 39). At a velocity of 7.3 ft per sec and for loadings to freeboards of 14, 10, and 6 in. on the side in still water, freeboards were 20, 16, and 9 in., respectively, at the bow of the boat (see photograph 17). The most critical conditions of freeboard existed at the side, although freeboards still were sufficient, being in the range of 12.2, 8.2, and 4.5 in., respectively, for the conditions of loading and velocity enumerated above.

American Ponton - Alternate Design

Description

64. As a result of the previous tests of attachments and various ponton designs the Engineer Board decided upon an alternate design to replace that of the present American 25-ton ponton. The alternate design is rectangular in cross section with a flat rake of bow and a square stern similar to that of the British and German pontons. Although the rake of the bow is not as flat as some of those tested, certain structural design considerations indicated the rake selected. The alternate design ponton is 33 ft 6 in. long, 6 ft 6-5/16 in. wide, and 3 ft 4 in. deep, increasing 9 in. at the bow. Comparison of the over-all dimensions with those of the present 25-ton ponton indicates that the length has been increased 9 in. and the bow height 4 in.; practically no change was made in the width and depth of the ponton (see photograph 18 and plate 40).

Test results

65. Tests to develop the freeboard-velocity relations for the alternate design were conducted under conditions assuming the same total loading on the alternate design as on the original ponton, i.e., the alternate design ponton was loaded in still water to freeboards of 14.5, 10.75, and 6.58 in. on the side. At a velocity of 7.3 ft per sec, the increase in freeboard on the bow of the alternate design (when loaded to still-water freeboards of 14.5 and 10.75 in. on the side) over that of the original design (when loaded to still-water freeboards of 14 and 10 in. on the side) was 5.7 and 7.2 in.,

respectively (see photograph 19 and plate 40). At a loading of 6 in., the original design ponton approached zero freeboard on the bow at a velocity of 6.5 ft per sec, whereas the alternate design ponton showed a freeboard of 6.7 in. (0.58 in. due to increase in buoyancy plus 6.12 in. due to increase in freeboard by bow change). The difference in freeboard can be attributed to the increased length of the alternate ponton, together with the greater height, and flatter rake of bow. Reference is made to tables 1 and 2 wherein the extra effect of buoyancy of the ponton of alternate design has been disregarded and the ponton considered as being loaded to freeboards of 14, 10, and 6 in. on the side in still water.

Pneumatic Float M1

Description

66. The American type M1 pneumatic float is made of rubberized fabric and consists of a 33-in. diameter outer tube, a floor, and a removable 33-in. diameter central tube. The central tube increases the rigidity of the float and maintains buoyancy when the float is submerged. The over-all length of the float is 33 ft. The ends are raked upward to prevent bow waves from breaking over the float. Photograph 20 and plate 42 show details of the pneumatic float.

Test results

67. The pneumatic float in the first series of tests was loaded respectively to freeboards of 14, 10, and 6 in. on the side in still water at the start of each test. Plate 42 shows the freeboard-velocity curves developed for each condition of loading and photograph 21 shows flow conditions at a velocity of 7.3 ft per sec and a loading to a freeboard of 10 in. Reference is also made to tables 1 and 2 for freeboard results. The freeboard-velocity curves tend to drop more rapidly than similar curves developed on the pontons. This is attributed largely to the behavior of the pneumatic float as frequent surges began to break over the bow of the float. The pneumatic float when placed in high-velocity flow and under a heavy load bobbed around, the bow remaining entirely below the surface at frequent intervals. For example, with a loading of 10 in. freeboard on the side in still water, as the velocity was increased, the float remained submerged at longer intervals until at a velocity of 8.3 ft per sec water flowed over the bow almost constantly. Corresponding velocities at which the float tended to submerge for 14- and 6-in. freeboard loadings were 9.2 and 7.7 ft per sec, respectively. In the second series of tests on the pneumatic float the float was loaded in still water until it was immersed to the full depth of the tube. The velocity of flow past the float was then increased until a velocity of about 7 ft per sec was reached, at which the average freeboard at the bow appeared to be zero. The bow of the float would remain submerged or rise above the surface at frequent intervals.

PART V: DISCUSSION OF RESULTS OF TESTS

68. The model studies of the pontons and pneumatic float served their purpose in providing answers as to methods of improving freeboard conditions in high-velocity flow. Although the tests of the present American 25-ton ponton revealed that it can carry heavier loads than other type pontons in low-velocity flow because of additional buoyancy gained by the scow type shape of both ends, it is far surpassed in available freeboard in high-velocity flow by pontons having a flatter rake of bow.

69. The results of the tests dealing with different methods of anchoring revealed that no change in freeboard conditions could be brought about either by a reasonable shortening of the anchor line or in the use of the halter arrangement to connect the anchor line to various points along the hand rail rather than extending it over the bow of the ponton. The model tests varied from the prototype results in that a 2-in. increase in freeboard was noted in the full-scale tests with the halter arrangement. Comparison of model and prototype results in general, however, indicated similar results although it is believed that, if flow conditions and measurements in the prototype could be controlled as accurately as in the model, model and prototype results would check even more closely than they do.

70. Observation of flow at the bow and on the sides of the ponton revealed that with a flat rake of bow the flow striking the bow seemed to have a vertical roller motion upstream which caused the actual water surface to be slightly higher a short distance upstream from the bow. With a steep rake of bow the flow piled up at the bow with the highest water surface adjacent to the ponton. No quantitative conclusions can be drawn as to the effect of various attachments on the freeboard at the side but in general, the flatter the rake of the bow the more tendency for an increase in freeboard at the side. Although the model tests indicated a flatter rake of bow for improvement of freeboard conditions, it is believed that the type 10 attachment which provides an additional 12 in. in height at the bow is the most economical and easiest attachment to construct. If for some reason type 10 attachment cannot be used it is recommended that types 11, 3, or 9 be used.

71. The results of the tests for the development of a new ponton confirmed results indicated by the tests to develop a good attachment to the present American 25-ton ponton. The most important outcome of the tests of the three style ponton bows proposed by the Engineer Board was to provide more data and emphasis on the fact that the shape of the bow in plan was not as important as formerly believed. Although streamlining the bow did effect some improvement, the increase in freeboard was not sufficient to justify the extra construction difficulties involved. Attention is invited to the fact that the term

streamlining as applied to the tests described herein refer for the most part to the alignment of the ponton in plan. Supplementary tests conducted at the Stevens Institute of Technology under the direction of Sparkman and Stephens, Incorporated, indicated that if the bow was streamlined in plan from the bottom through to the top of the ponton some improvement in freeboard could be effected. The ponton design designated type 4 in this report is the most streamlined bow shape tested by the Experiment Station; however, when compared to the type 2 ponton design the effect of streamlining is not apparent.

72. The results of the tests on the British ponton Mark V and the German ponton indicate that the German-type ponton is far superior to the British ponton as regards freeboard in high-velocity flow; comparison of the German ponton with the American 25-ton ponton of original and alternate design also indicates its superiority (see plate 41). The following table presents a brief comparison of freeboards at the bow for a velocity of 7.3 ft per sec and three conditions of loading:

Freeboard at Bow (Inches) for Velocity of 7.3 Ft Per Sec

Freeboard on Side in Still Water	14 in.	10 in.	6 in.
British ponton	7.3	0.8	-
German ponton	20.0	16.0	9
American ponton (original design)	10.4	4.3	-
American ponton (alternate design)	15.6	11.0	-

73. Analysis of the above comparison indicates the superiority of the American pontons of original and alternate designs to the British ponton. Attention is invited to the fact, however, that for the British ponton the bow height is the same as the side, whereas the German bow rises 9 in. above the side and the American pontons of original and alternate designs rise 5 in. and 9 in., respectively, which automatically increases the freeboard over that obtaining for the British ponton at zero velocity. Consideration of the rise in bow height reveals that the flat rake of the British and German-type bows are both superior to the American pontons of original or alternate design.

74. The results of tests conducted with the M1 type pneumatic float revealed that the float performed very satisfactorily in low-velocity flow. As the velocity increased, however, and as flow began to surge over the bow the freeboard decreased rapidly. As explained in the test results, at loadings to freeboards of 14, 10, and 6 in. on the side at zero velocity the bow was submerged almost constantly at velocities of 9.2, 8.3, and 7.7 ft per sec, respectively.

PART VI: LIAISON AND PERSONNEL

Liaison

75. During the course of the model study, close liaison was maintained between the Experiment Station; the Engineer Board, Fort Belvoir, Virginia; and the Engineer Board, Bridge Branch, Desert Test Section, Yuma, Arizona. This liaison was accomplished by means of: (a) progress reports submitted every two weeks to the Engineer Board; (b) interim reports on results of certain tests which were forwarded to the Engineer Board shortly after the completion of the tests; and (c) visits to the Experiment Station by the technical personnel of the Engineer Board.

Personnel

76. The model study was accomplished in the Hydraulic Structures Section of the Hydrodynamics Division of the U. S. Waterways Experiment Station. Director of the Experiment Station is Mr. Gerard H. Matthes, Head Engineer, and Captain Joseph B. Tiffany, Jr., C. E., is Executive Assistant. Chief of the Hydrodynamics Division and Acting Chief of the Hydraulic Structures Section during the conduct of the studies was Mr. Fred R. Brown, Engineer. The Project Engineer in direct charge of the study and present Chief of the Hydraulic Structures Section was Mr. John W. Bolin, Jr., Associate Engineer. The following assisted in the conduct of the model study: Messrs. Americus M. Gill, Principal Engineering Aide, Edwin S. Melsheimer, Senior Engineering Aide, Joseph W. McGee, Senior Engineering Aide, Thomas J. Spinks, Senior Engineering Aide, John B. Clark, Engineering Aide, Edward L. Cratin, Assistant Engineering Aide, Frank A. McCrory, Under Engineering Aide, Mrs. Frances M. Betts, and Miss Sarah A. Morrison, Assistant Engineering Aides, and Miss Mary M. Robert, Junior Engineering Aide.

77. Lieutenant Colonels Clayton E. Mullins and George W. Howard visited the Experiment Station in an advisory capacity at intervals during the testing program. Other visitors included Colonels J. H. Stratton, F. S. Besson, Jr., J. Goodwin, P. P. Goerz, Lieutenant Colonel Hibbert Hill, Major New, and First Lieutenant W. C. Mitchell.

TABLES

TABLE 1

Model Study of Pontons and Pneumatic Floats

COMPARISON OF AVERAGE MINIMUM FREEBOARD
VELOCITY RELATIONSHIP

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Velocity Ft/Sec	American 25-Ton Ponton		Alternate American Ponton		German Ponton		British Ponton Mark V		Pneumatic Float Type M1	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side
1	18.6	14.0	22.8	13.9	13.9	22.6	13.7	13.9	25.9	14.0
2	17.8	14.0	22.4	13.8	13.8	22.5	13.4	13.9	25.6	14.0
3	17.0	14.0	21.8	13.7	13.8	22.4	12.9	13.8	24.8	13.9
4	16.1	13.8	21.0	13.6	13.7	22.2	12.2	13.7	24.4	13.8
5	14.9	13.6	19.8	13.3	13.5	21.8	11.2	13.6	21.5	13.6
6	13.3	12.9	18.2	12.8	13.2	21.3	9.7	13.1	19.2	13.1
7	11.1	11.9	16.3	12.1	12.5	20.3	7.8	12.2	16.3	12.4
8	8.1	10.7	13.9	11.1	11.6	18.9	5.3	11.0	13.9	11.1
9	3.8	9.4	11.3	9.8	10.4	17.1	2.3	9.4	9.1	8.6
10			8.3	8.3						
Ponton Loaded to 10-Inch Freeboard on Side in Still Water										
1	14.5	9.9	18.5	9.9	19.0	10.0	9.7	9.9	21.9	10.0
2	13.3	9.6	18.0	9.8	18.9	9.9	9.1	9.9	21.5	10.0
3	12.9	9.4	17.4	9.6	18.7	9.9	8.5	9.8	20.5	10.0
4	11.5	9.1	16.5	9.5	18.3	9.7	7.3	9.6	19.0	10.0
5	9.7	8.8	15.3	9.2	17.9	9.5	5.8	9.3	17.2	9.9
6	7.6	8.3	13.7	8.8	17.2	9.1	3.8	8.8	15.0	9.5
7	5.0	7.6	11.6	8.1	16.3	8.4	1.5	8.1	12.3	8.3
8	1.6	6.8	8.9	7.1	14.8	7.5			8.1	5.8
9					12.2	6.5				
Ponton Loaded to 6-Inch Freeboard on Side in Still Water										
1	10.7	5.9	14.7	5.9	14.8	5.8	5.6	6.0	17.9	6.0
2	10.1	5.7	14.0	5.8	14.6	5.7	5.1	5.9	17.3	6.0
3	9.1	5.6	12.9	5.7	14.2	5.6	4.3	5.8	16.2	6.0
4	7.5	5.3	11.4	5.7	13.6	5.6	3.2	5.7	14.7	5.8
5	5.2	4.7	9.5	5.5	12.7	5.5	1.5	5.5	12.8	5.4
6	2.1	3.7	7.3	5.2	11.5	5.2			10.1	4.2
7					9.6	4.7			5.6	1.2
8										
9										

TABLE 2

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

American 25-Ton Ponton			Alternate American Ponton			German Ponton			British Ponton Mark V			Pneumatic Float Type M1		
Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	14.96	14.00	1.13	10.40	13.90	1.13	12.00	13.92	1.13	6.40	13.82	1.13	8.00	14.00
3.00	14.96	14.00	2.88	10.40	13.61	3.00	13.60	13.82	2.77	6.40	13.82	3.00	8.00	13.92
5.06	14.96	13.63	5.06	12.00	13.42	5.20	10.40	13.63	5.01	8.00	13.54	5.06	8.00	13.54
7.18	7.60	11.62	7.18	12.80	11.88	7.35	12.40	12.10	7.27	12.40	11.90	7.40	10.00	12.00
9.95	15.20	8.26	8.71	19.20	10.25	9.36	18.00	9.98	8.94	16.80	9.50	8.48	11.20	10.08
			10.46	20.00	7.37							9.22	13.60	6.82
Ponton Loaded to 10-Inch Freeboard on Side in Still Water														
1.13	10.40	9.60	1.13	10.40	9.81	1.13	12.00	9.89	1.13	8.00	9.79	1.13	8.00	10.00
3.20	10.40	9.21	3.00	10.40	9.62	3.00	12.00	9.89	3.00	8.00	9.79	3.00	8.00	10.00
4.81	10.40	9.12	5.20	11.20	9.33	4.88	12.40	9.60	5.20	9.20	9.31	5.26	6.40	9.79
7.27	8.80	7.48	7.27	12.00	7.51	7.35	13.20	7.97	7.35	13.60	7.87	7.27	8.00	7.30
8.94	14.40	6.05	8.71	16.00	6.16	9.22	20.00	6.34				8.34	14.80	4.51
Ponton Loaded to 6-Inch Freeboard on Side in Still Water														
1.13	14.40	5.66	1.13	12.00	5.85	1.13	9.60	5.95	1.13	6.80	5.86	1.13	7.20	6.00
3.00	14.40	5.56	2.88	12.00	5.66	3.00	9.60	5.95	3.00	6.80	5.86	3.00	6.96	6.00
4.52	11.20	5.18	5.20	13.60	5.47	3.93	9.60	5.86	4.75	8.00	5.57	5.20	6.80	5.28
5.90	6.40	4.13	6.90	16.00	4.70	5.01	12.80	5.57	6.00	10.00	4.42	7.13	10.40	0.19
6.70	6.80	2.50				6.00	14.40	5.18						
						7.18	14.00	3.94						

TABLE 5

Model Study of Pontoon and Pneumatic Floats

COMPARISON OF AVERAGE MINIMUM FREEBOARD

VELOCITY RELATIONSHIP

Pontoon Loaded to 14-Inch Freeboard on Side in Still Water

Velocity ft/sec	Type 1		Type 2		Type 3		Type 4		Type 5		Type 6		Type 7		Type 8		Type 9		Type 10		Type 11		Type 12	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side
1	18.6	14.0	18.7	13.9	18.6	13.7	18.8	13.9	18.6	13.9	18.6	14.2	18.8	14.0	18.9	14.0	19.0	14.0	30.7	14.2	25.0	14.0	22.8	13.8
2	18.4	14.0	18.2	13.8	18.5	13.7	18.6	13.7	18.4	13.9	18.6	14.1	18.6	14.0	18.4	14.0	18.6	13.8	29.8	14.2	24.6	13.8	22.6	13.8
3	17.8	14.0	17.5	13.6	18.1	13.6	18.1	13.4	17.9	13.9	18.3	14.0	18.2	13.9	17.8	14.0	18.1	13.6	29.0	14.1	24.1	13.6	22.2	13.7
4	16.9	13.9	16.4	13.4	17.2	13.3	17.1	13.1	17.1	13.8	17.8	13.9	17.5	13.6	16.9	13.7	17.4	13.4	28.1	14.0	23.3	13.4	21.8	13.6
5	15.6	13.8	14.8	13.0	15.7	12.8	15.4	12.8	15.7	13.4	17.4	13.6	16.6	13.1	15.6	13.3	16.4	13.1	26.9	13.6	22.1	13.0	21.2	13.5
6	14.0	13.6	13.0	12.4	13.7	12.1	13.4	12.5	13.9	12.6	16.7	13.2	15.5	12.4	13.8	12.5	15.2	12.7	25.3	13.0	20.3	12.4	19.8	13.1
7	12.1	13.3	10.8	11.6	11.5	11.3	11.1	12.1	11.8	11.5	16.0	12.6	14.3	11.7	11.4	11.3	13.6	12.2	23.1	11.9	18.4	11.6	18.0	12.4
8	10.2	12.8	8.9	10.8	9.1	10.5	8.7	11.6	9.1	10.0	15.2	12.0	13.0	10.9	8.7	9.7	11.6	11.5	20.1	10.7	16.0	10.7	15.5	11.2
9	8.0	12.3	6.1	9.8	6.7	9.6	6.2	11.1	6.1	8.3	14.3	11.2	11.6	10.0	5.8	7.9	9.0	10.5	15.9	9.4	13.6	9.6	12.2	9.8
10	5.6	11.8					3.5	10.6	2.8	6.5	13.3	10.0					6.1	9.1	8.8	8.1	10.9	8.5	8.2	8.2
10.5																	4.5	8.2			9.6	7.9		

Pontoon Loaded to 10-Inch Freeboard on Side in Still Water

1	14.8	9.9	14.5	10.0	14.8	10.0	14.6	9.9	15.0	9.9	14.8	10.0	14.5	10.0	14.6	9.9	14.8	10.0	26.0	9.6	20.5	10.0	19.1	9.9
2	14.5	9.9	13.9	9.8	14.6	10.0	14.3	9.9	14.9	9.8	14.7	10.0	14.4	9.9	14.3	9.8	14.5	9.9	25.6	9.5	20.2	10.0	18.8	9.8
3	13.8	9.9	13.0	9.5	14.1	9.9	13.8	9.9	14.2	9.7	14.4	9.9	14.0	9.8	13.6	9.7	13.9	9.8	24.8	9.3	19.4	9.9	18.3	9.7
4	12.8	9.9	11.8	9.2	13.0	9.8	12.6	9.8	12.8	9.4	13.8	9.5	13.4	9.5	12.6	9.2	13.1	9.5	23.5	9.2	18.3	9.7	17.4	9.6
5	11.4	9.8	10.4	8.9	11.5	9.4	11.2	9.6	11.0	9.1	13.2	9.1	12.3	9.1	11.1	8.6	11.8	9.1	21.8	8.9	16.7	9.2	16.1	9.4
6	13.0	9.4	8.6	8.5	9.7	8.9	9.2	9.2	8.8	8.5	12.5	8.5	10.9	8.5	9.4	8.0	9.9	8.6	19.7	8.4	14.7	8.6	14.4	8.9
7	8.1	8.6	6.7	7.9	7.7	8.2	6.8	8.4	6.1	7.7	11.4	8.0	9.3	7.9	7.6	7.3	7.5	7.8	17.3	7.7	12.5	7.6	12.4	8.2
8	6.0	7.7	4.4	7.2	5.5	7.5	4.4	7.4	3.3	6.3	10.1	7.3	7.6	7.2	5.6	6.5	4.7	6.8	13.8	6.8	10.2	6.4	10.2	7.5
9	3.1	6.8	1.8	6.5	2.9	6.9	1.8	6.2			7.9	6.6	5.7	6.5	3.5	5.6	1.7	5.2			7.9	5.1	7.9	6.7

Pontoon Loaded to 6-Inch Freeboard on Side in Still Water

1	10.7	5.9	10.7	5.8	10.8	6.0	10.8	5.9	11.0	5.9	10.8	5.9	10.6	6.0	10.6	6.0	10.5	10.7	22.4	5.6	16.7	6.0	14.9	5.9
2	10.3	5.9	10.0	5.7	10.6	6.0	10.5	5.9	10.6	5.9	10.8	5.9	10.3	6.0	10.1	5.9	10.4	6.0	22.1	5.6	16.4	6.0	14.6	5.8
3	9.5	5.9	9.2	5.5	9.8	5.9	9.4	5.8	9.9	5.9	10.6	5.9	9.8	5.8	9.3	5.8	9.8	5.9	21.1	5.6	15.7	5.9	13.9	5.7
4	8.2	5.8	8.0	5.1	8.8	5.8	7.8	5.6	8.7	5.7	10.0	5.8	9.0	5.3	8.1	5.6	8.9	5.8	19.6	5.4	14.7	5.7	12.8	5.6
5	6.8	5.6	6.4	4.6	7.5	5.6	5.8	5.4	6.9	5.3	9.1	5.7	7.9	4.8	6.5	5.4	7.3	5.4	17.4	4.9	13.0	5.1	11.5	5.2
6	5.2	5.1	4.2	5.8	6.0	5.3	3.5	4.6	4.5	4.5	7.6	5.5	6.4	4.4	4.4	4.9	5.3	4.7	14.5	3.8	10.8	4.1	9.9	4.6
6.5	4.4	4.8																						
7	3.2	4.1	1.6	2.6	4.3	4.9	1.2	3.8			5.9	4.7	4.6	3.6	2.1	4.1	3.2	3.5			8.3	2.3	7.8	3.4
8																								

TABLE 4

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Type 1 Attachment			Type 2 Attachment			Type 3 Attachment		
Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	10.00	14.02	1.13	8.32	13.92	1.13	8.96	13.73
3.00	11.20	14.02	3.00	8.32	13.63	3.00	10.40	13.72
5.00	15.60	13.85	5.06	6.88	13.05	5.06	10.40	12.80
7.35	17.6	13.20	7.08	10.32	11.52	7.27	10.40	11.04
8.85	21.60	12.38	9.13	16.16	9.70	9.70	16.00	9.02
9.80	13.60	11.90						
Ponton Loaded to 10-Inch Freeboard on Side in Still Water								
1.13	9.60	9.95	1.13	8.32	9.90	1.13	8.88	10.00
2.88	9.60	9.95	3.00	8.32	9.55	3.00	8.88	9.89
5.00	9.60	10.30	5.01	0.60	8.70	5.01	6.72	9.31
7.27	12.24	8.20	7.35	11.60	7.70	7.35	12.48	8.06
9.08	16.64	6.70	9.81	17.60	5.86	8.57	12.40	7.05
10.01	15.60	5.47				9.10	12.80	6.80
Ponton Loaded to 6-Inch Freeboard on Side in Still Water								
1.13	10.32	5.90	1.13	14.96	5.80	1.13	10.16	6.00
3.00	10.32	5.70	3.00	8.48	5.40	3.14	10.16	5.85
4.81	6.56	5.85	5.20	8.56	4.45	5.13	6.64	5.47
6.70	8.64	4.60	7.35	8.40	2.00	7.27	11.76	4.70
7.52	9.60	3.07						

TABLE 4 (Continued)

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 1¼-Inch Freeboard on Side in Still Water

Type 4 Attachment			Type 5 Attachment			Type 6 Attachment		
Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	12.40	13.92	1.13	9.60	13.92	1.13	11.60	14.21
3.00	11.20	13.40	3.00	12.80	13.92	3.00	11.36	14.02
5.06	8.80	13.25	5.01	12.80	13.44	5.01	14.80	14.02
7.44	12.24	10.94	6.31	10.40	12.19	7.27	11.60	12.00
10.00	18.40	10.60	7.35	11.20	10.94	10.58	22.00	9.12
			8.48	16.00	9.31			
			10.21	18.40	6.91			
Ponton Loaded to 10-Inch Freeboard on Side in Still Water								
1.13	8.88	9.89	1.13	11.60	9.79	1.13	9.28	10.00
3.14	8.88	9.80	3.00	11.60	9.65	3.00	9.60	9.85
5.01	8.72	9.40	5.01	15.2	9.21	5.43	8.72	8.90
5.20	8.88	9.89	7.27	13.20	7.30	6.31	11.44	8.25
7.18	9.12	8.20	8.09	14.80	6.20	7.27	11.60	7.87
8.41	12.40	6.00				9.13	16.40	6.50
9.10	12.80	6.14						
Ponton Loaded to 6-Inch Freeboard on Side in Still Water								
1.13	9.20	5.86	1.13	11.60	5.76	1.13	9.44	5.86
3.00	9.20	5.76	3.00	11.60	5.66	3.00	9.44	5.86
5.06	9.20	5.25	5.01	8.48	5.37	5.56	8.88	5.18
7.44	11.28	1.92	6.22	8.40	4.30	6.00	8.80	5.66
						7.40	12.00	4.22

TABLE 4 (Continued)

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Type 7 Attachment			Type 8 Attachment			Type 9 Attachment		
Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	9.84	14.02	1.13	7.84	14.02	1.13	9.28	14.01
3.14	8.72	13.92	3.14	7.84	14.01	3.00	9.28	13.63
5.43	7.84	12.86	5.43	6.00	12.48	5.20	9.28	13.54
7.35	9.20	11.34	7.35	9.60	11.04	7.35	12.40	11.52
9.76	20.00	9.41	9.49	20.00	6.91	9.08	15.60	10.46
						10.52	19.84	8.16
Ponton Loaded to 10-Inch Freeboard on Side in Still Water								
1.13	10.24	10.00	1.13	8.64	9.89	1.13	9.60	9.69
3.00	10.24	9.80	3.00	8.64	9.70	3.00	9.36	9.79
5.67	8.16	8.73	5.67	8.16	7.78	5.06	8.80	9.12
7.27	10.40	7.68	7.27	9.28	7.10	7.35	10.00	7.49
9.08	14.72	6.40	9.08	14.16	6.05	8.94	16.40	5.38
Ponton Loaded to 6-Inch Freeboard on Side in Still Water								
1.13	9.76	5.95	1.13	8.64	5.95	1.13	12.00	5.95
3.00	9.76	5.86	3.00	8.72	5.75	3.20	12.00	5.86
6.00	8.80	4.42	5.20	6.40	5.40	5.01	13.36	5.47
7.40	12.00	3.40	7.52	11.20	3.36	7.35	10.16	3.36

TABLE 4 (Continued)

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Type 10 Attachment			Type 11 Attachment			Type 12 Attachment		
Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity ft/sec	Distance From Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	14.96	14.01	1.13	8.64	13.92	1.13	13.04	13.82
3.00	14.96	14.11	3.00	8.64	13.63	3.00	13.04	13.72
5.06	14.96	13.63	5.20	8.64	13.25	5.01	12.40	13.63
7.18	7.60	11.62	7.35	10.96	11.04	7.39	12.96	11.42
9.95	15.20	8.26	9.08	15.60	9.50	8.48	18.64	11.04
			10.52	16.40	7.87	10.41	20.00	7.49
Ponton Loaded to 10-Inch Freeboard on Side in Still Water								
1.13	10.40	9.60	1.13	9.60	9.88	1.13	13.04	9.89
3.20	10.40	9.21	3.00	9.36	9.88	3.00	13.04	9.80
4.81	10.40	9.12	5.06	8.80	9.30	4.95	13.84	9.41
7.27	8.80	7.48	7.35	10.80	7.10	6.31	17.60	9.12
8.94	14.40	6.05	8.94	14.40	5.20	7.44	12.96	7.68
						9.42	20.56	6.24
Ponton Loaded to 6-Inch Freeboard on Side in Still Water								
1.13	14.40	5.66	1.13	8.80	5.86	1.13	12.80	5.86
3.00	14.40	5.56	3.20	9.20	5.86	3.00	12.00	5.76
4.52	11.20	5.18	4.02	14.56	5.66	4.10	12.80	5.56
5.90	6.40	4.13	5.00	13.20	5.38	5.13	14.00	5.28
6.70	6.80	2.50	5.95	7.20	3.74	6.17	10.40	4.32
			7.35	9.60	1.44	7.04	13.44	3.36

TABLE 5

MODEL STUDY OF PONTON AND PNEUMATIC FLOATS
COMPARISON OF MINIMUM FREEBOARD
VELOCITY RELATIONSHIPS

Ponton Loaded to 10-Inch Freeboard on Side in Still Water

Velocity ft per sec	Type 1 Attachment		Type 2 Attachment		Type 3 Attachment		Type 4 Attachment		Type 5 Attachment		Type 6 Attachment	
	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side
1.0	14.9	9.6	14.3	9.8	14.7	9.8	14.5	9.6	14.9	9.7	14.8	9.9
2.0	14.3	9.6	13.4	9.4	14.0	9.7	14.0	9.6	14.7	9.7	14.7	9.8
3.0	13.2	9.6	12.0	9.0	12.7	9.5	12.8	9.6	13.7	9.5	14.1	9.5
4.0	11.8	9.5	10.1	8.4	10.8	9.0	11.0	9.0	11.7	9.1	13.3	8.7
5.0	9.2	9.2	7.6	7.6	8.9	7.9	8.8	8.2	9.2	8.5	12.3	7.8
6.0	7.0	7.9	5.2	6.7	6.4	6.7	6.4	6.8	6.1	7.5	10.7	6.9
7.0	4.0	6.0	2.4	5.0	4.0	5.3	3.0	5.1	2.7	5.8	8.6	5.8
8.0	1.4	3.5			0.8	3.4	-0.8	2.5	-2.2	0.8	4.8	4.4
9.0	-3.1	0.4									-4.0	1.5

Velocity ft per sec	Type 7 Attachment		Type 8 Attachment		Type 9 Attachment		Type 10 Attachment		Type 11 Attachment		Type 12 Attachment	
	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side	Minimum Freeboard in Inches on Bow	Minimum Freeboard in Inches on Side
1.0	14.4	9.9	14.5	9.7	14.6	9.6	25.9	9.8	20.4	9.8	18.8	9.7
2.0	14.2	9.7	14.2	9.7	14.2	9.6	25.3	9.6	19.9	9.8	18.6	9.7
3.0	13.7	9.4	13.2	9.4	13.4	9.6	24.5	9.3	18.6	9.6	17.8	9.6
4.0	12.8	8.8	11.1	8.5	11.7	9.2	22.5	9.0	16.5	8.9	16.4	9.2
5.0	10.9	8.0	8.9	7.3	9.2	8.5	19.6	8.5	14.1	7.8	14.6	8.4
6.0	8.5	7.0	6.6	5.9	6.2	7.3	15.9	7.1	11.4	6.6	11.8	7.2
7.0	6.2	5.6	3.3	4.5	2.1	5.7	11.6	5.3	8.7	5.0	8.1	5.6
8.0	3.6	3.0	-0.7	2.4	-0.3	3.6	6.6	3.2	5.8	2.8	6.0	3.5
9.0	-1.0	0.6	-5.6	-0.1	-4.8	0.2	-0.2	-0.2	2.4	-0.7	-0.7	0.6

TABLE 6

Model Study of Pontons and Pneumatic Floats

COMPARISON OF AVERAGE MINIMUM FREEBOARD
VELOCITY RELATIONSHIP

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Velocity Ft/Sec	Type A		Type B		Type C		Type D		Type E		Type F		Type G		Type H		Type I		Type J		Type K		Type L	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side
1	13.4	13.8	13.6	13.9	13.6	13.9	13.8	14.0	13.8	14.0	13.6	13.9	13.7	14.0	13.7	13.9	13.8	13.9	13.8	14.0	13.8	14.0	13.8	14.0
2	12.6	13.7	12.9	13.8	13.2	13.8	13.5	14.0	13.2	13.8	13.0	13.8	13.1	13.8	13.3	13.7	13.2	13.8	12.9	13.9	13.2	13.8	13.4	13.8
3	11.3	13.3	11.8	13.6	12.4	13.5	13.1	13.9	12.2	13.7	12.0	13.4	12.3	13.6	12.8	13.5	12.2	13.5	11.7	13.7	12.1	13.6	12.8	13.6
4	9.5	12.8	10.1	13.2	11.2	13.1	12.5	13.6	10.7	13.3	10.6	13.0	10.9	13.5	12.1	13.2	10.6	13.1	10.1	13.3	10.6	13.2	11.8	13.2
5	6.7	12.2	7.8	12.7	9.5	12.5	11.6	13.1	8.6	12.6	8.6	12.3	9.1	12.7	11.2	12.8	8.4	12.5	8.0	12.6	8.7	12.4	10.6	12.6
6	2.9	11.2	5.0	11.8	7.4	11.5	10.4	12.3	5.6	11.4	6.0	11.3	7.1	11.9	9.9	12.2	5.8	11.6	5.7	11.2	6.5	11.4	9.1	11.7
7			1.4	10.1	4.8	10.2	9.0	11.3	1.8	9.7	3.0	9.8	4.8	10.9	8.3	11.4	2.9	10.4	3.1	9.5	3.8	10.3	7.4	10.7
8					1.7	8.6	6.9	10.1					2.2	9.6	6.2	10.6			0.2	7.3	0.8	8.9	5.6	9.5
9							3.9	8.7							3.7	9.6							3.2	8.3
10															0.8	8.6							0.4	6.8

Ponton Loaded to 10-Inch Freeboard on Side in Still Water

1	9.3	9.8	9.7	9.9	9.5	9.9	9.8	10.0	9.5	9.9	9.4	9.9	9.6	10.0	9.8	9.9	9.7	9.9	9.8	10.0	9.8	9.9	9.9	9.9
2	8.4	9.6	9.1	9.8	8.6	9.8	9.4	9.8	8.6	9.8	8.7	9.7	9.0	9.8	9.5	9.8	8.6	9.7	9.3	9.9	9.3	9.8	9.6	9.8
3	7.1	9.3	8.1	9.7	7.5	9.4	8.8	9.7	7.3	9.5	7.6	9.4	8.0	9.6	9.0	9.6	7.1	9.4	8.3	9.7	8.3	9.6	9.0	9.6
4	5.3	8.9	6.6	9.6	6.1	8.8	7.9	9.4	5.6	9.1	5.8	8.9	6.8	9.3	8.1	9.2	5.3	8.9	6.8	9.3	6.8	9.5	7.8	9.1
5	2.9	8.3	4.5	9.3	4.6	7.8	6.6	9.1	3.2	8.5	3.7	8.1	5.1	8.8	6.9	8.6	3.2	8.1	4.9	8.7	4.9	9.1	6.4	8.4
6			1.8	8.7	2.7	6.7	4.9	8.5	0.0	7.5	1.2	7.1	3.1	7.8	5.3	7.8	0.6	6.7	2.6	7.7	2.9	8.0	4.3	7.5
7					0.6	5.2	2.8	7.8					0.6	6.3	3.1	6.8			0.1	5.8	0.4	6.3	1.3	6.3
8							0.3	6.8							0.4	5.3								

Ponton Loaded to 6-Inch Freeboard on Side in Still Water

1	5.3	5.9	5.5	5.9	5.8	6.0	5.8	6.0	5.8	6.0	5.9	6.0	5.8	6.0	5.9	6.0	5.7	6.0	5.9	5.9	5.8	6.0	6.0	6.0
2	4.3	5.7	4.8	5.8	5.2	5.9	5.3	5.9	5.2	5.8	5.3	5.9	5.2	5.9	5.5	5.9	5.0	5.9	5.3	5.8	5.3	5.9	5.6	5.9
3	2.9	5.4	3.7	5.7	4.3	5.7	4.3	5.8	4.2	5.7	4.2	5.8	4.3	5.8	4.6	5.8	3.8	5.7	4.3	5.7	4.2	5.8	4.8	5.8
4	1.1	4.9	2.3	5.5	2.8	5.2	2.9	5.7	2.5	5.4	2.4	5.5	2.8	5.7	3.3	5.7	2.3	5.5	3.1	5.6	2.7	5.4	3.3	5.7
5			0.4	5.0	0.7	4.4	1.1	5.6	0.2	5.1	0.1	5.1	0.9	5.1	1.8	5.3	0.6	5.1	1.1	5.2	0.8	4.7	1.4	5.3
6															0.0	4.3								

TABLE 7

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Pontons Loaded to 14-Inch Freeboard on Side in Still Water

Type A Design			Type B Design			Type C Design			Type D Design		
Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	5.60	13.73	1.13	4.00	13.82	1.13	5.60	13.92	1.13	8.00	14.00
3.00	6.40	13.34	3.00	5.60	13.63	3.00	5.60	13.63	3.14	8.00	13.92
3.85	6.40	12.77	4.81	6.40	12.86	5.43	6.40	12.10	5.06	8.80	13.14
5.06	8.80	12.10	6.00	8.40	11.81	7.35	10.00	9.70	7.14	14.40	10.66
6.00	10.00	11.14	7.35	9.60	9.31	8.80	13.60	7.30	9.22	20.80	8.54
7.35	11.20	9.70	7.86	11.60	7.87						
8.02	12.00	8.26									
Pontons Loaded to 10-Inch Freeboard on Side in Still Water											
1.13	4.80	9.79	1.13	4.00	9.79	1.13	5.60	9.89	1.13	8.00	9.70
3.00	6.00	9.31	3.20	5.60	9.70	3.00	6.40	9.60	3.20	8.00	9.31
4.10	8.40	8.83	4.88	5.60	9.50	5.32	6.00	7.30	5.01	7.20	9.12
5.20	8.40	8.16	7.35	11.20	6.72	7.35	10.00	4.90	7.35	12.40	7.20
6.22	11.60	7.68				7.61	10.40	4.42	8.02	14.40	7.20
7.35	12.80	6.24									
Pontons Loaded to 6-Inch Freeboard on Side in Still Water											
1.13	4.00	5.95	1.13	5.60	5.76	1.13	4.80	5.95	1.13	8.00	6.00
2.88	6.00	5.47	3.00	5.60	5.66	2.88	6.40	5.76	3.00	8.00	5.86
3.85	8.00	4.90	4.52	9.60	5.28	3.93	4.00	5.28	3.85	8.00	5.76
4.81	8.80	4.32	5.01	7.20	4.99	5.06	6.40	4.32	5.06	11.20	5.57
5.67	11.20	3.74	6.42	9.60	3.84	5.56	6.80	3.84	5.78	9.60	5.18

TABLE 7 (Continued)

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Type E Design			Type F Design			Type G Design			Type H Design		
Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	6.40	13.92	1.13	5.60	13.73	1.13	6.40	13.73	1.13	8.00	13.82
3.20	6.40	13.63	3.00	5.60	13.44	3.14	6.40	13.63	3.14	4.40	13.54
5.32	6.40	12.38	5.06	6.40	12.29	4.81	7.20	12.86	5.06	8.00	12.77
7.18	8.80	8.92	7.35	11.20	9.22	7.27	10.80	10.66	7.27	12.00	11.04
8.80	12.00	5.57	8.09	12.00	7.30	8.54	13.20	8.26	9.62	18.40	9.12
Ponton Loaded to 10-Inch Freeboard on Side in Still Water											
1.13	6.40	9.79	1.13	6.40	9.60	1.13	8.00	9.89	1.13	8.00	9.88
3.00	6.40	9.70	3.00	6.40	9.41	3.00	6.00	9.60	3.14	10.40	9.41
5.01	7.60	8.35	5.06	8.40	8.06	4.67	6.40	9.22	5.06	8.00	8.83
6.70	9.60	6.72	6.70	8.80	6.34	7.27	11.20	5.66	7.35	12.80	6.33
									7.52	4.80	6.14
Ponton Loaded to 6-Inch Freeboard on Side in Still Water											
1.13	6.40	5.86	1.13	8.00	5.95	1.13	8.00	5.95	1.13	8.00	5.95
3.14	6.40	5.66	3.20	8.00	5.86	3.00	8.00	5.86	3.20	8.00	5.86
4.95	7.20	5.09	4.02	6.40	5.47	4.10	6.40	5.66	4.81	11.20	5.66
6.00	9.60	4.42	5.06	7.20	5.18	5.78	7.20	4.42	6.00	8.80	4.32
			5.90	8.00	4.61						

TABLE 7 (Continued)

Model Study of Pontons and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Type I Design			Type J Design			Type K Design			Type L Design		
Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	8.00	13.92	1.13	8.00	13.92	1.13	9.20	13.63	1.13	8.80	13.82
3.00	8.00	13.44	3.39	8.80	13.63	3.00	8.80	13.63	3.00	8.80	13.82
5.20	8.00	12.67	5.06	9.60	12.58	5.26	8.40	12.00	4.95	8.80	12.67
7.35	10.40	10.08	7.35	10.40	8.54	7.35	12.40	9.89	7.52	12.80	9.89
9.08	17.60	7.39	8.94	11.40	5.18	8.71	14.40	8.15	9.08	16.40	8.54
Ponton Loaded to 10-Inch Freeboard on Side in Still Water											
1.13	8.00	9.89	1.13	8.00	9.89	1.13	9.60	9.70	1.13	8.00	9.89
3.14	8.00	9.41	3.20	8.80	9.70	3.00	9.60	9.70	2.88	8.00	9.60
5.20	8.00	8.16	5.67	9.60	8.26	4.95	9.60	9.31	5.01	8.80	8.64
7.35	12.00	3.55	7.27	12.00	4.99	7.35	11.20	5.76	7.35	12.00	5.86
									7.52	12.00	5.66
Ponton Loaded to 6-Inch Freeboard on Side in Still Water											
1.13	8.00	5.95	1.13	8.00	5.95	1.13	8.00	5.95	1.13	8.00	5.95
3.00	8.00	5.76	2.88	8.00	5.76	3.14	8.80	5.76	2.88	8.00	5.86
4.38	8.00	5.38	4.33	10.80	5.47	4.16	9.60	5.38	4.33	8.00	5.66
6.00	10.40	4.70	5.67	9.60	4.99	6.00	10.40	3.94	6.00	10.40	4.90

TABLE 8

Model Study of Pontons and Pneumatic Floats

COMPARISON OF AVERAGE MINIMUM FREEBOARD
VELOCITY RELATIONSHIP

Ponton Loaded to 14-Inch Freeboard on Side in Still Water

Velocity Ft/Sec	Type 1 Design		Type 2 Design		Type 3 Design		Type 4 Design	
	Average Minimum Freeboard in Inches		Average Minimum Freeboard in Inches		Average Minimum Freeboard in Inches		Average Minimum Freeboard in Inches	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side
1.0	19.1	14.0	18.9	13.8	19.5	13.8	13.9	14.0
2.0	18.8	13.9	18.8	13.7	18.9	13.7	13.6	13.9
3.0	18.4	13.8	18.5	13.6	18.1	13.6	13.2	13.8
4.0	17.5	13.6	18.1	13.5	17.1	13.5	12.3	13.6
5.0	16.0	13.4	17.3	13.2	15.7	13.3	11.0	13.3
6.0	14.2	13.0	16.5	12.9	13.8	13.0	9.3	12.8
7.0	12.2	12.5	15.3	12.5	11.5	12.5	7.4	12.1
8.0	10.2	11.6	14.0	11.8	8.8	11.7	5.4	11.1
9.0	8.0	10.3	12.1	10.6	5.6	10.3		
10.0	5.9	8.5			1.4	7.9		

Ponton Loaded to 10-Inch Freeboard on Side in Still Water

1.0	14.6	9.9	14.7	9.7	15.5	10.0	9.7	10.0
2.0	14.1	9.8	14.4	9.6	15.0	10.0	9.3	10.0
3.0	13.5	9.7	14.0	9.5	14.1	9.9	8.6	9.9
4.0	12.6	9.6	13.3	9.4	13.0	9.8	7.6	9.8
5.0	11.2	9.4	12.3	9.3	11.6	9.6	6.2	9.5
6.0	9.4	8.9	10.7	9.2	9.7	9.2	4.5	9.0
7.0	7.3	8.3	8.6	8.9	7.2	8.8	2.5	8.3
8.0	4.9	7.2	6.4	8.5	3.9	8.2		
9.0			4.1	7.3				

Ponton Loaded to 6-Inch Freeboard on Side in Still Water

1.0	10.8	5.9	10.7	6.0	11.6	6.0	5.8	6.0
2.0	10.3	5.8	10.4	6.0	10.9	5.9	5.4	6.0
3.0	9.5	5.7	9.8	6.0	9.9	5.8	4.7	5.9
4.0	8.1	5.6	8.9	5.9	8.6	5.6	3.4	5.8
5.0	6.3	5.3	7.6	5.8	6.9	5.4	1.2	5.6
6.0	4.2	4.4	5.7	5.4	4.6	5.1		
7.0			3.2	4.4	1.8	4.3		

TABLE 9

Model Study of Pontoon and Pneumatic Floats

AVERAGE MINIMUM FREEBOARD ON SIDE

Pontoon Loaded to 14-Inch Freeboard on Side in Still Water

Type 1 Design			Type 2 Design			Type 3 Design			Type 4 Design		
Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches	Velocity Ft/Sec	Distance from Bow on Side in Feet	Observed Average Freeboard in Inches
1.13	8.64	13.82	1.13	10.88	13.82	1.13	9.20	13.82	1.13	9.20	13.92
3.20	8.64	13.82	3.00	10.88	13.54	3.00	8.80	13.63	3.00	9.20	13.82
5.06	8.00	13.25	4.95	13.04	13.25	5.26	15.60	13.25	5.01	11.20	13.15
7.35	11.52	12.67	7.27	13.04	11.71	7.35	12.96	12.29	7.35	14.40	11.90
8.57	13.76	10.46	7.95	14.56	11.14	8.80	16.80	10.66	8.65	16.00	10.18
10.01	17.76	8.50	9.90	17.20	8.50	10.21	17.20	7.10	10.46	20.80	6.62

Pontoon Loaded to 10-Inch Freeboard on Side in Still Water

1.13	10.40	9.79	1.13	10.00	9.50	1.13	8.80	9.98	1.13	8.80	10.08
3.00	10.40	9.79	2.88	10.00	9.70	3.00	9.60	9.89	3.00	12.80	9.79
4.95	13.28	9.41	4.75	15.76	9.31	5.32	15.60	9.50	5.01	14.00	9.50
7.35	12.96	7.97	7.08	12.16	8.83	7.35	11.60	8.74	7.39	14.40	8.06
8.94	21.20	5.28	8.99	18.72	7.20	8.45	16.00	7.39	9.13	20.00	4.51
						9.25	16.80	5.18			

Pontoon Loaded to 6-Inch Freeboard on Side in Still Water

1.13	11.36	5.86	1.13	10.40	6.05	1.13	8.00	5.95	1.13	8.80	6.00
3.00	12.08	5.76	3.00	9.76	5.95	3.00	16.00	5.66	3.00	11.20	6.05
4.95	13.60	5.57	4.95	9.76	5.95	4.02	13.60	5.66	3.93	14.40	5.86
6.70	9.28	2.98	7.35	13.20	3.65	5.06	16.16	5.57	5.01	22.40	5.66
						6.11	13.20	5.09	5.90	11.60	5.38
						7.35	13.20	3.94	7.27	12.96	3.84
						8.02	15.60	2.98			

TABLE 10

Model Study of Pontons and Pneumatic Floats

COMPARISON OF MINIMUM FREEBOARD
VELOCITY RELATIONSHIP

Ponton Loaded to 10-Inch Freeboard on Side in Still Water

Velocity Ft/Sec	American 25-Ton Ponton		Type 1 Design		Type 2 Design		Type 3 Design		Type 4 Design	
	Minimum Freeboard in Inches		Minimum Freeboard in Inches		Minimum Freeboard in Inches		Minimum Freeboard in Inches		Minimum Freeboard in Inches	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side
1.0	13.9	9.8	14.3	9.7	14.5	9.5	15.4	9.9	9.6	10.0
2.0	13.5	9.6	13.8	9.7	14.3	9.5	14.6	9.8	8.8	9.8
3.0	12.5	9.3	13.0	9.4	13.7	9.4	13.5	9.6	7.7	9.5
4.0	10.5	9.0	11.4	9.0	12.3	9.0	11.6	9.3	6.4	9.0
5.0	7.6	8.5	9.6	8.4	10.4	8.3	9.1	8.6	4.0	8.5
6.0	3.9	7.1	7.2	7.0	7.8	7.4	6.1	7.6	1.0	7.8
7.0	-0.4	5.3	4.2	5.3	4.4	6.1	2.4	6.2	-2.5	6.7
8.0	-5.4	3.2	0.6	3.0	-1.4	3.8	-1.7	4.2	-6.4	4.9
9.0	-12.2	-0.2	-4.0	-0.7	-9.8	-0.7	-6.0	1.2	-10.9	0.6

TABLE 11

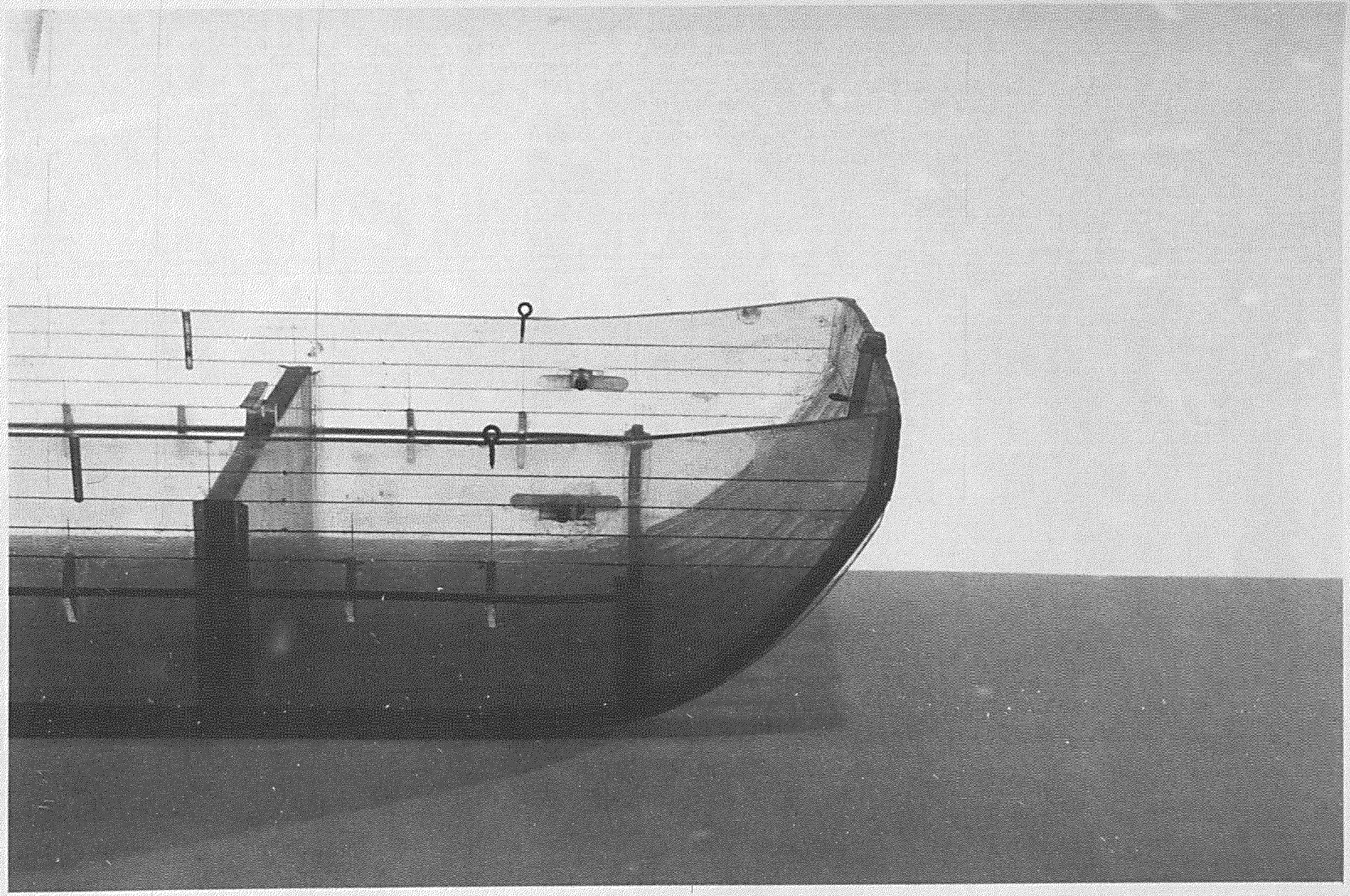
Model Study of Pontons and Pneumatic Floats

COMPARISON OF AVERAGE MINIMUM FREEBOARD

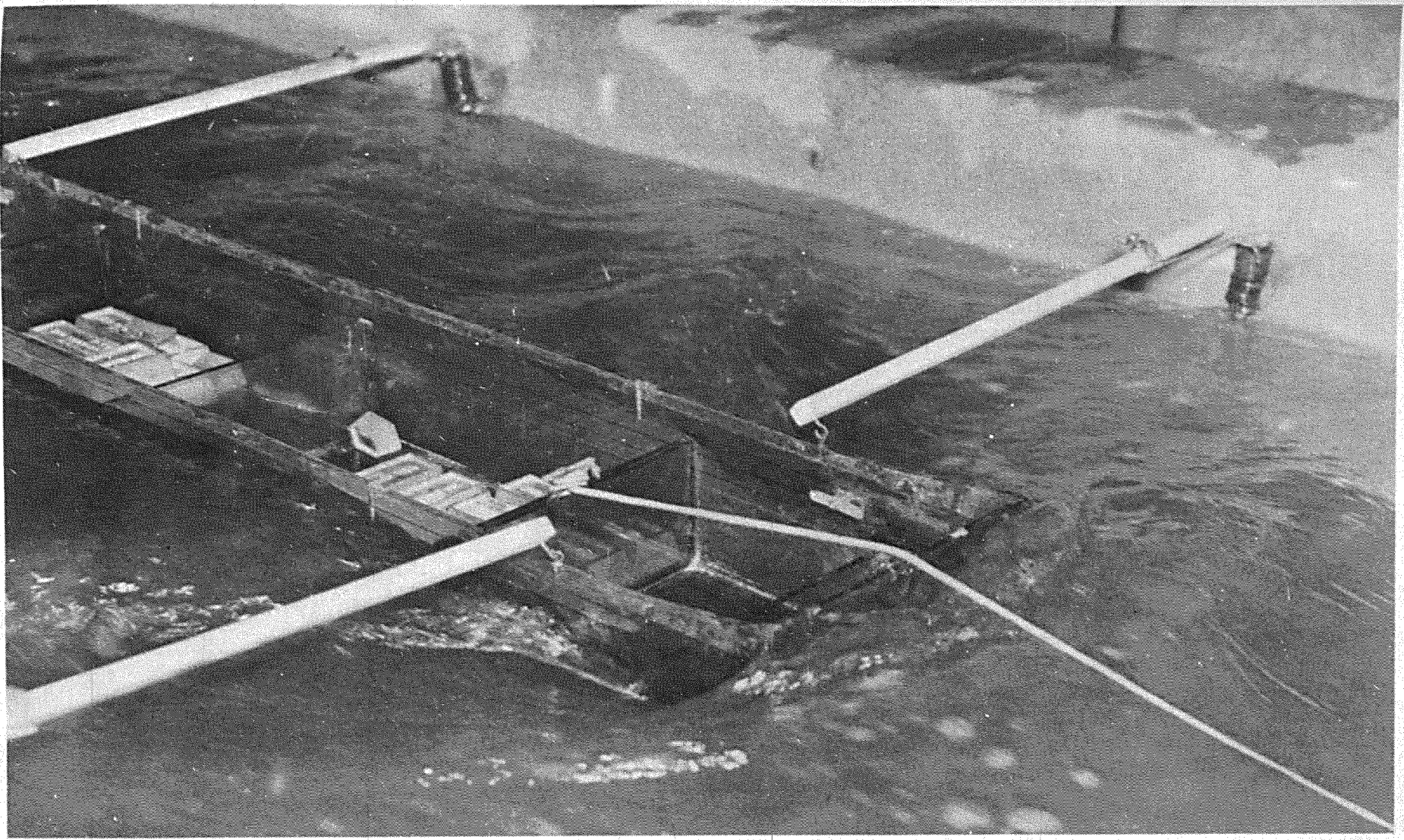
VELOCITY RELATIONSHIP

Velocity Ft/Sec	American 25-Ton Ponton Length of Ponton=32.75 ft		Type 1 Design Length of Ponton=35.92 ft		Type 1 Design Length of Ponton=32.75 ft		Type 2 Design Length of Ponton=35.68 ft		Type 2 Design Length of Ponton=32.75 ft	
	Observed Average Freeboard in Inches		Observed Average Freeboard in Inches		Observed Average Freeboard in Inches		Observed Average Freeboard in Inches		Observed Average Freeboard in Inches	
	Bow	Side	Bow	Side	Bow	Side	Bow	Side	Bow	Side
0	15.0	10.0	14.9	9.9	11.5	6.5	13.2	8.2	9.6	4.6
1	14.5	9.8	14.6	9.8	11.3	6.5	13.1	8.1	9.6	4.6
2	13.8	9.6	14.1	9.8	11.0	6.5	12.9	8.1	9.2	4.5
3	12.8	9.4	13.4	9.6	10.1	6.5	12.4	8.1	8.3	4.4
4	11.5	9.1	12.4	9.4	8.7	6.4	11.5	8.0	7.1	4.3
5	9.7	8.8	10.8	9.1	7.0	5.8	10.2	7.8	5.3	4.0
6	7.6	8.3	8.9	8.6	4.7	4.8	8.5	7.6	2.6	2.8
7	5.0	7.6	6.7	7.8			6.6	7.2		
8	1.6	6.8	4.3	6.9			4.2	6.7		
9			1.4	5.8			1.2	5.8		

Note: Tests were conducted using the same amount of weight necessary to load the American 25-ton ponton to a freeboard of 10-inches on the side in still water.

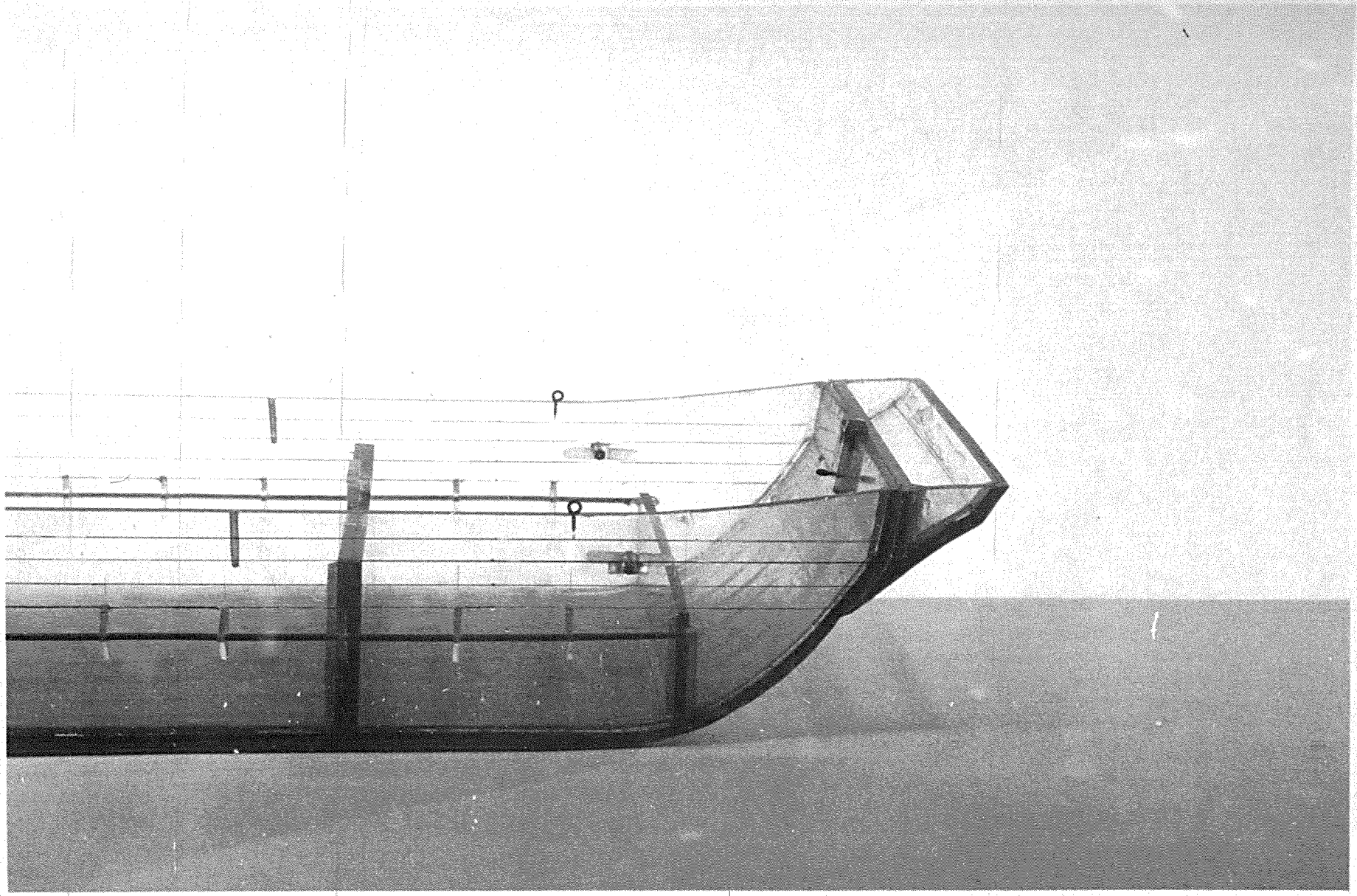


Photograph 1. Details of American 25-ton ponton.

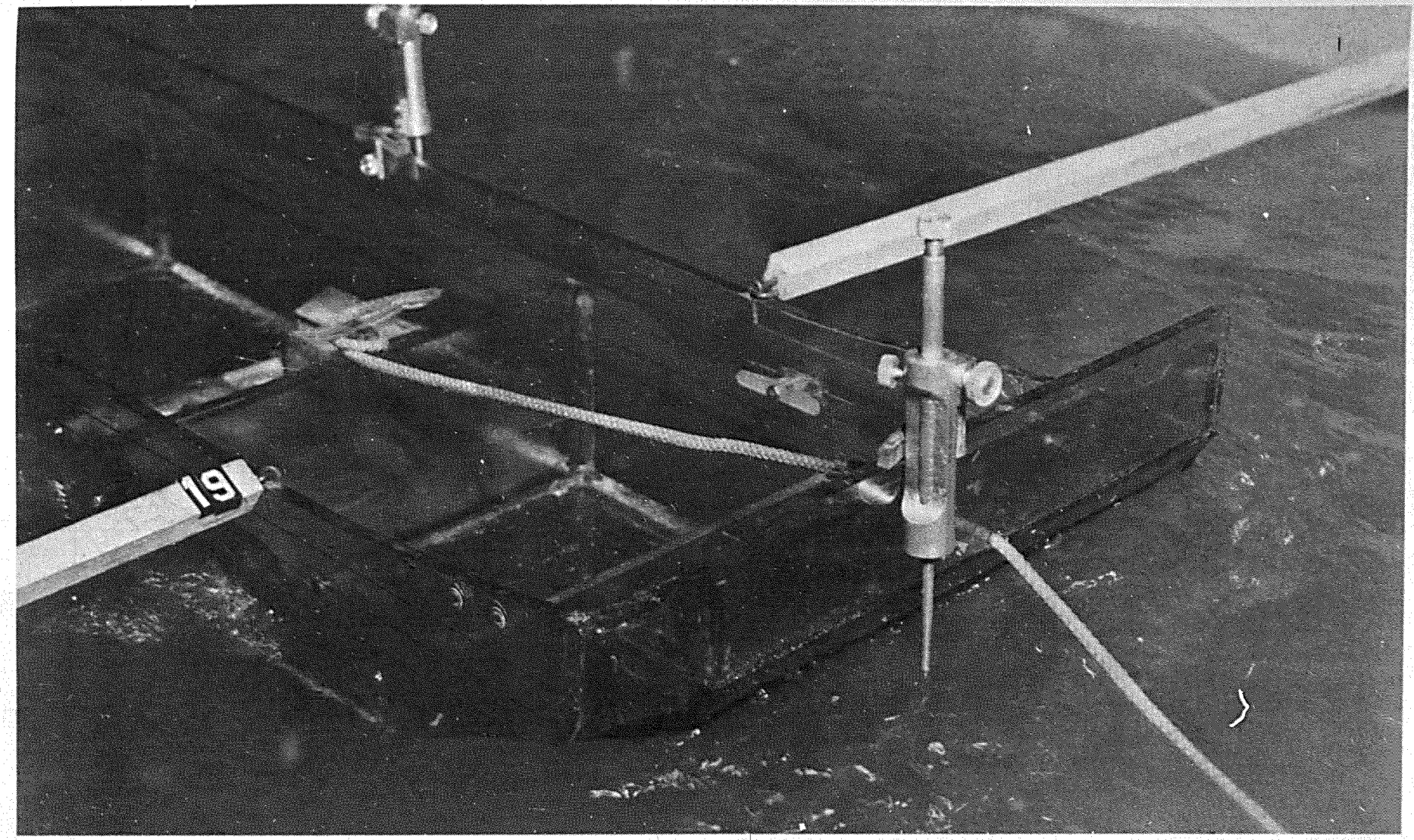


Photograph 2. Flow conditions for American 25-ton ponton. Average freeboards for velocity of 7.3 ft per sec and 10-inch loading.

Bow	4.25 inches
Side	7.50 inches

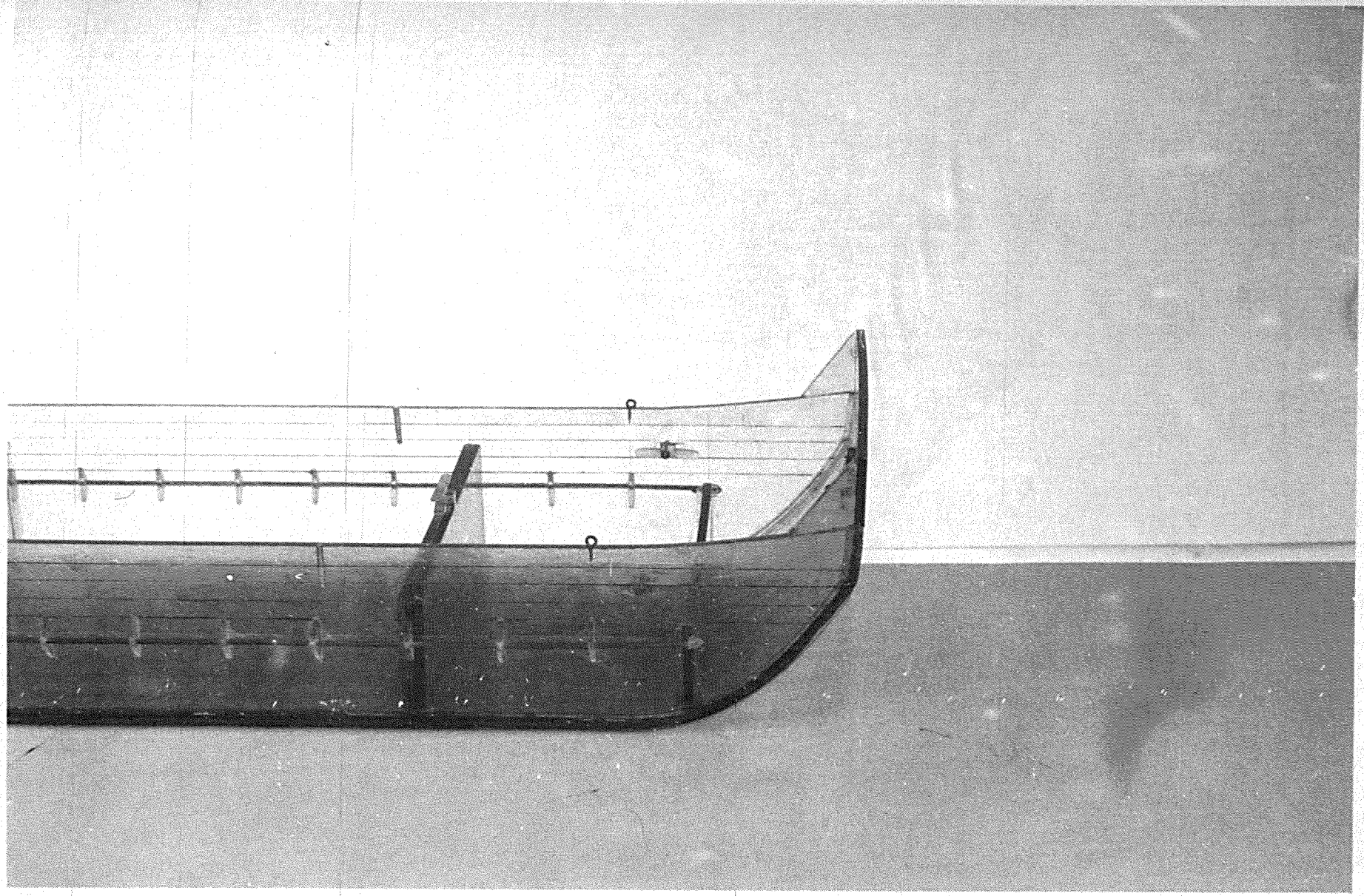


Photograph 3. · Details of type 3 attachment.

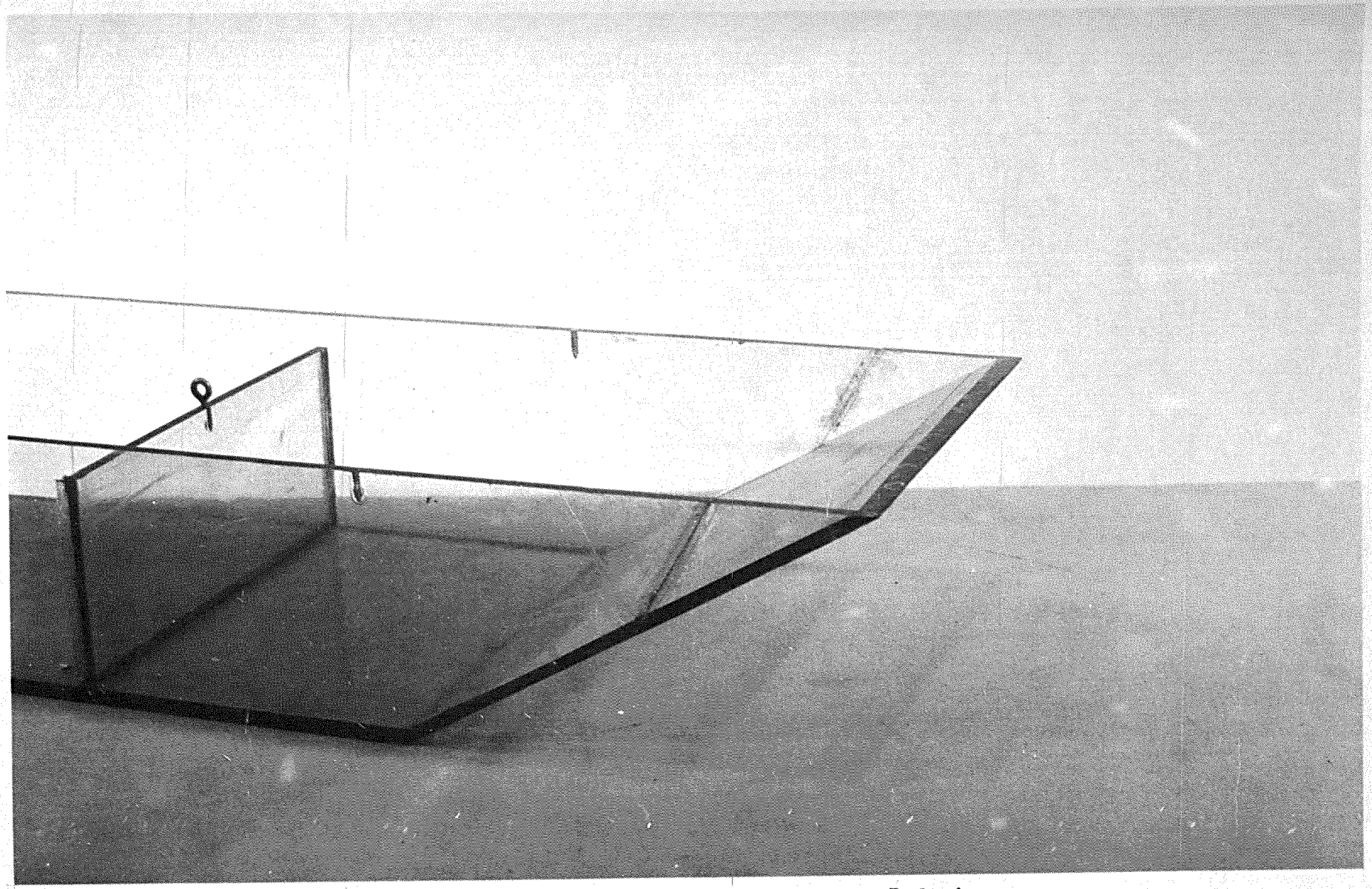


Photograph 4. Flow conditions for type 3 attachment. Freeboards for velocity of 7.4 ft per sec and 10-inch loading.

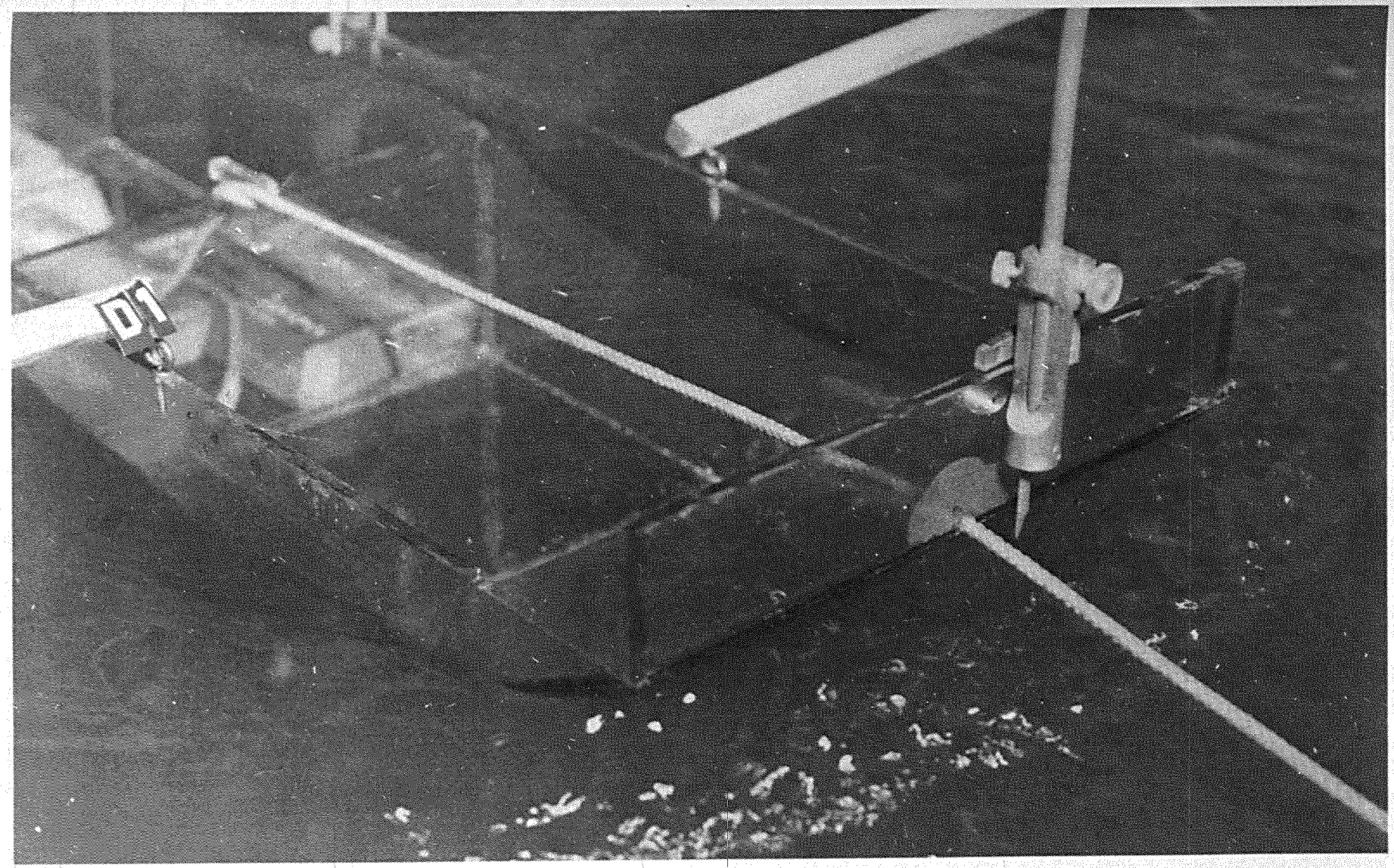
Bow 7.40 inches
Side 8.10 inches



Photograph 5. Details of type 10 attachment.

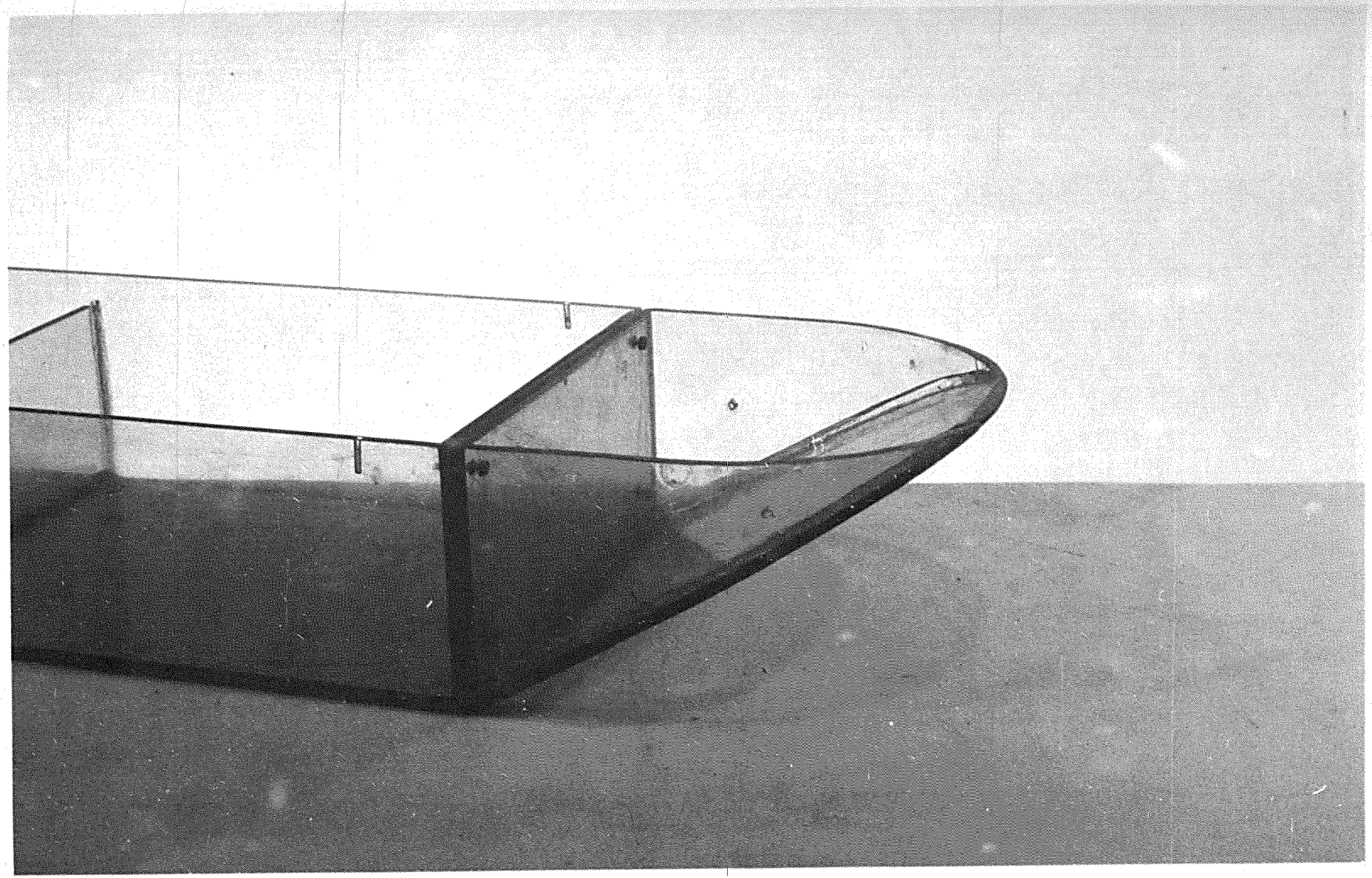


Photograph 6. Details of new ponton -- type D design.

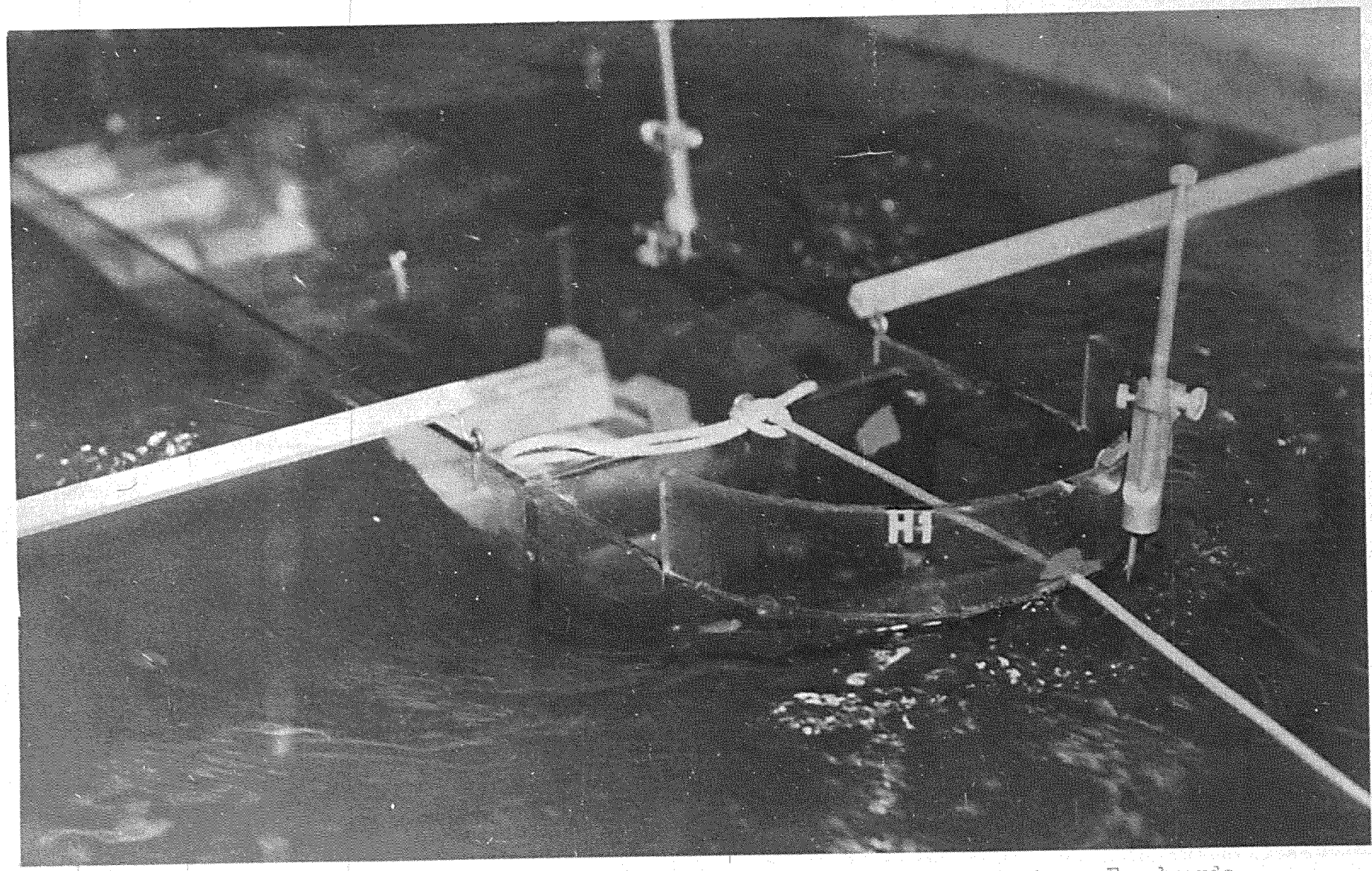


Photograph 7. Flow conditions for new ponton -- type D design. Freeboards for velocity of 7.35 ft per sec and 10-inch loading.

Bow	2.02 inches
Side	7.20 inches

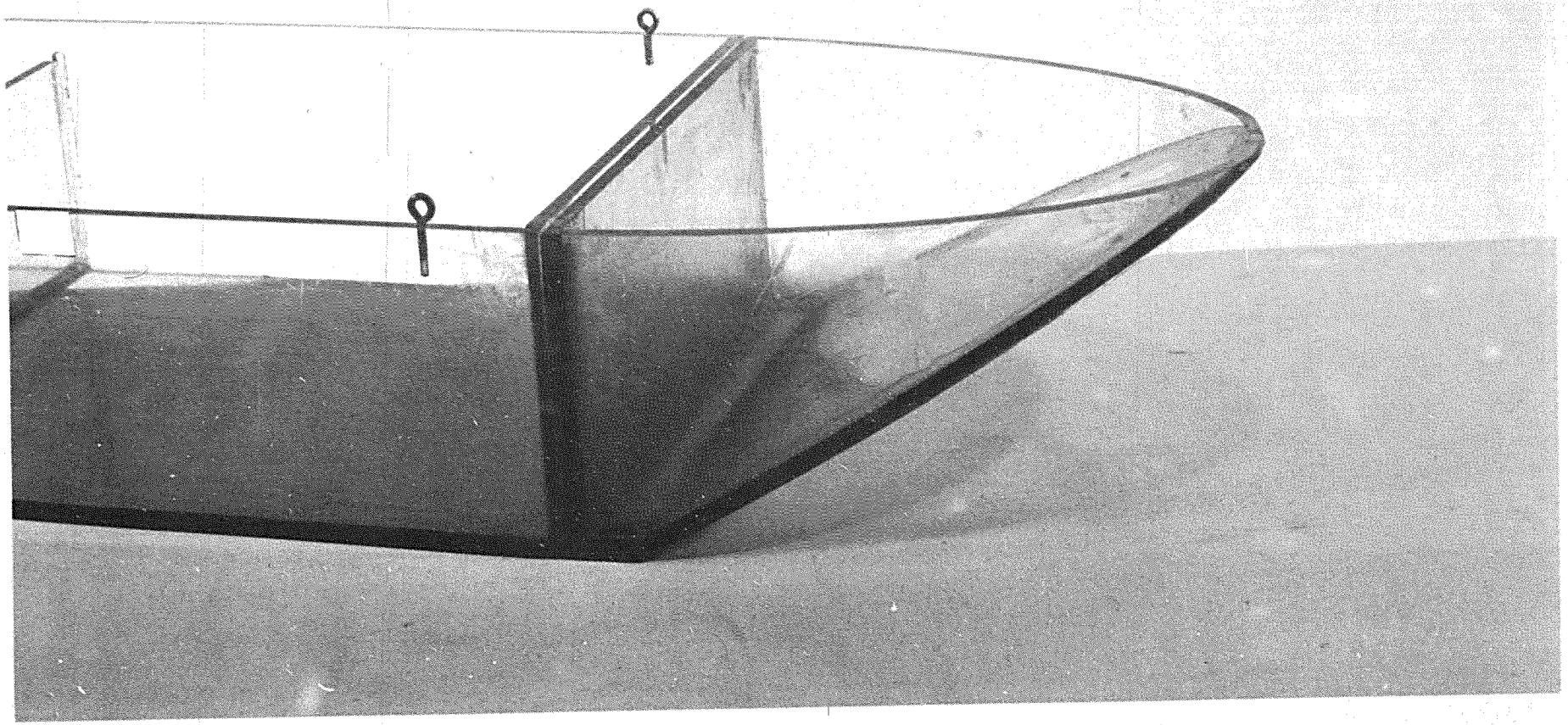


Photograph 8. Details of new ponton -- type H design.



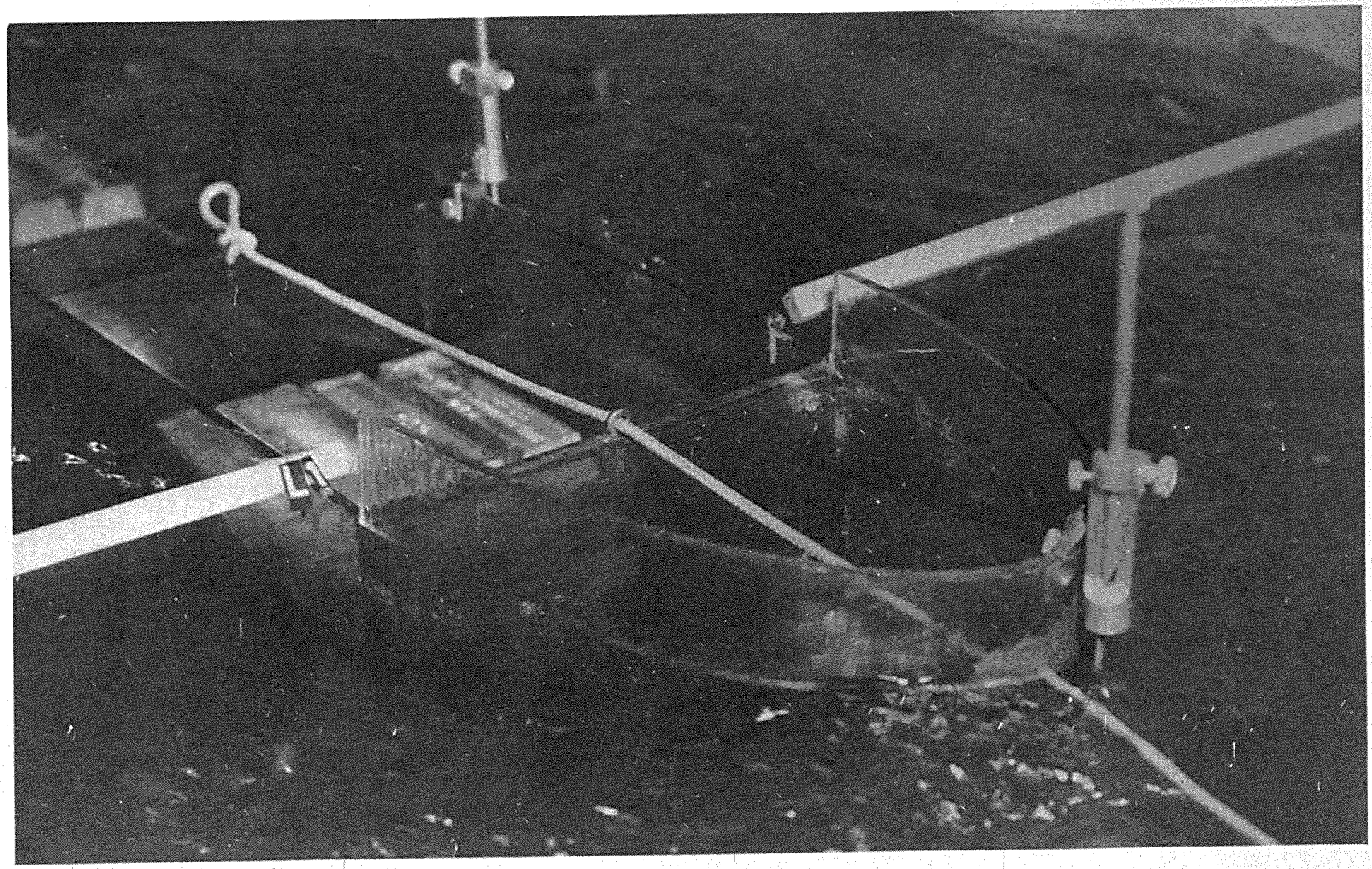
Photograph 9. Flow conditions for new ponton -- type H design. Freeboards for velocity of 7.35 ft per sec and 10-inch loading.

Bow	2.11 inches
Side	6.33 inches



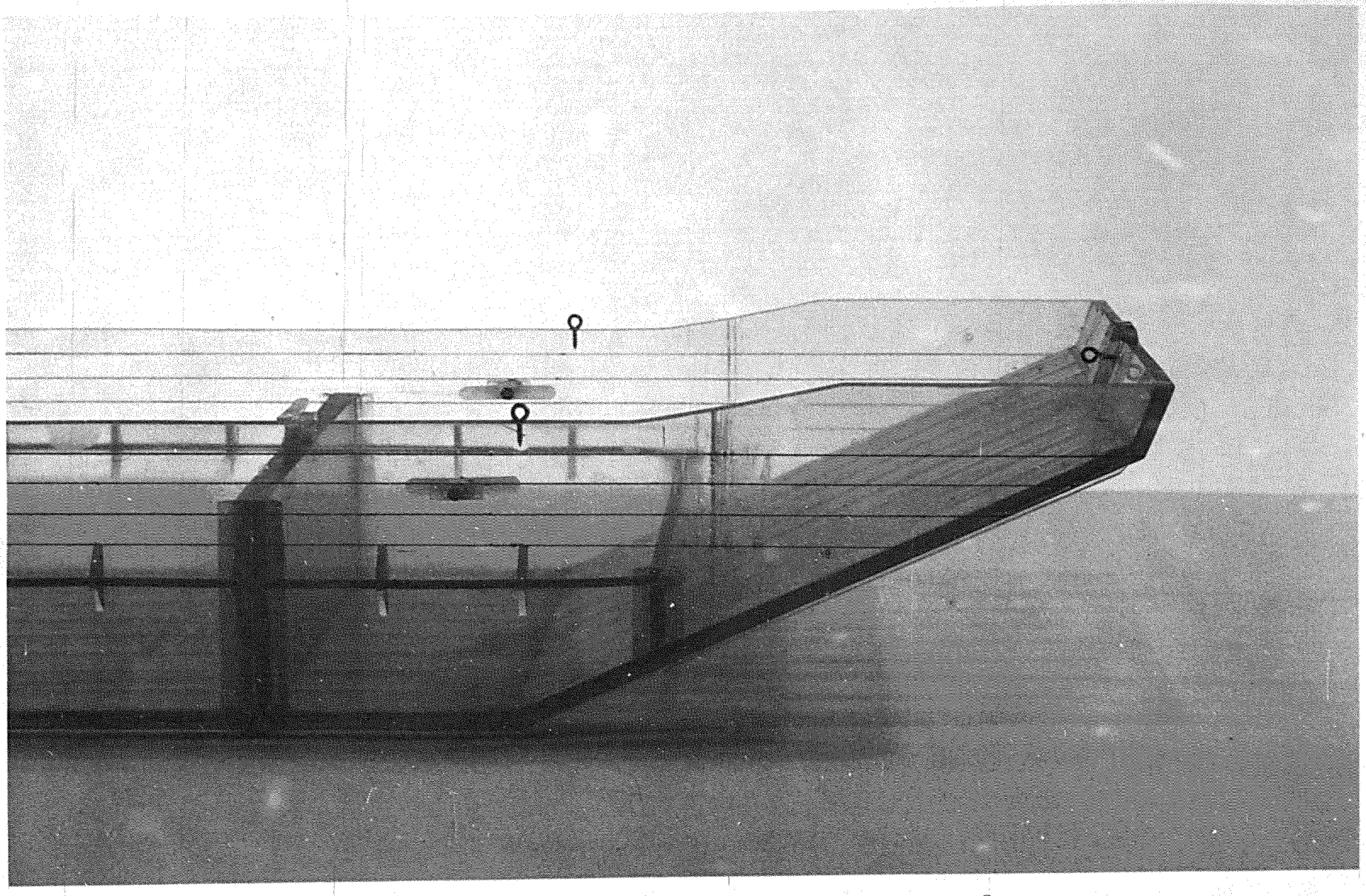
Photograph 10. Details of new ponton -- type L design.

Side 9.00 inches

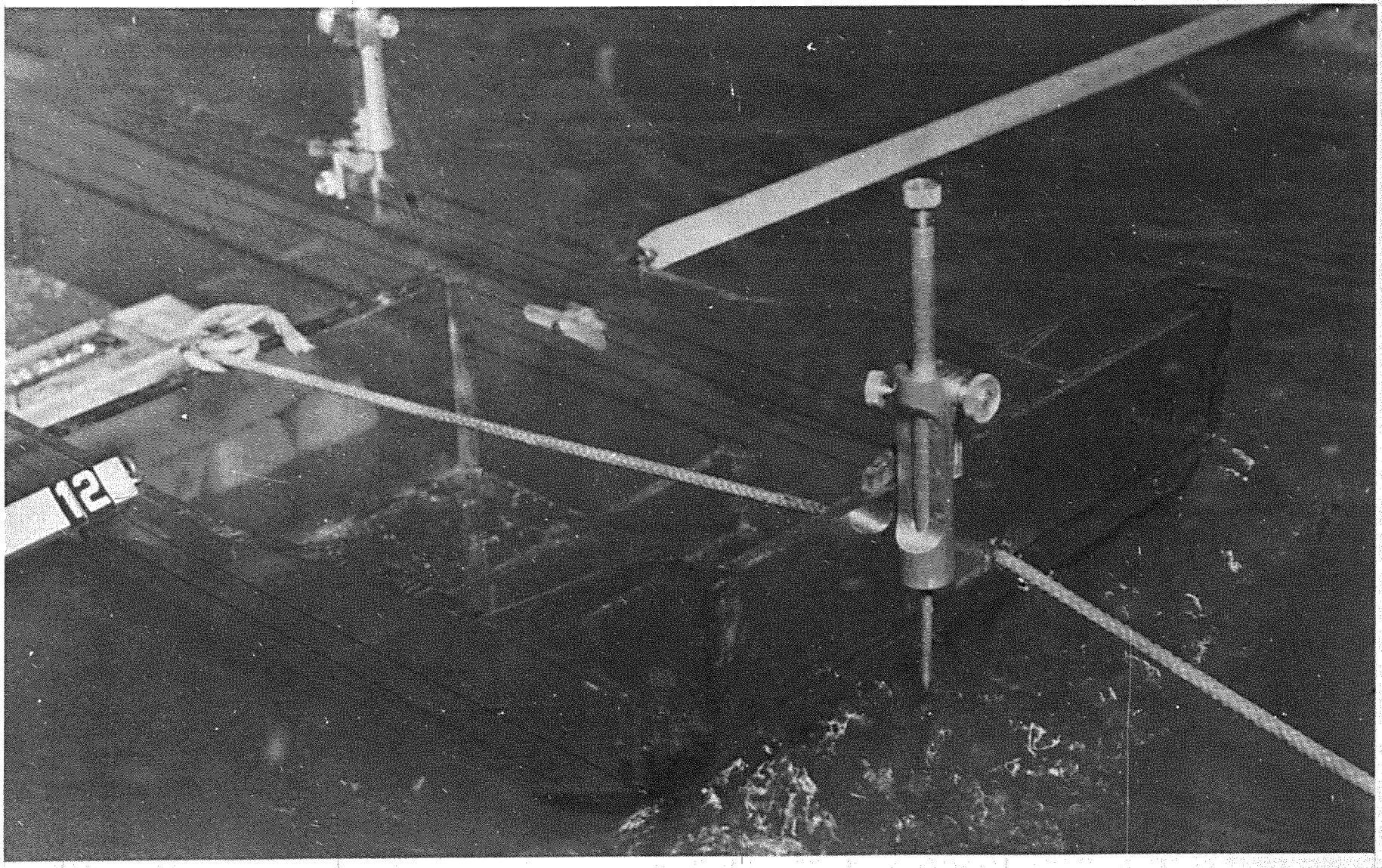


Photograph 11. Flow conditions for new ponton -- type L design. Freeboards for velocity of 7.35 ft per sec and 10-inch loading.

Bow	0.00 inches
Side	5.86 inches

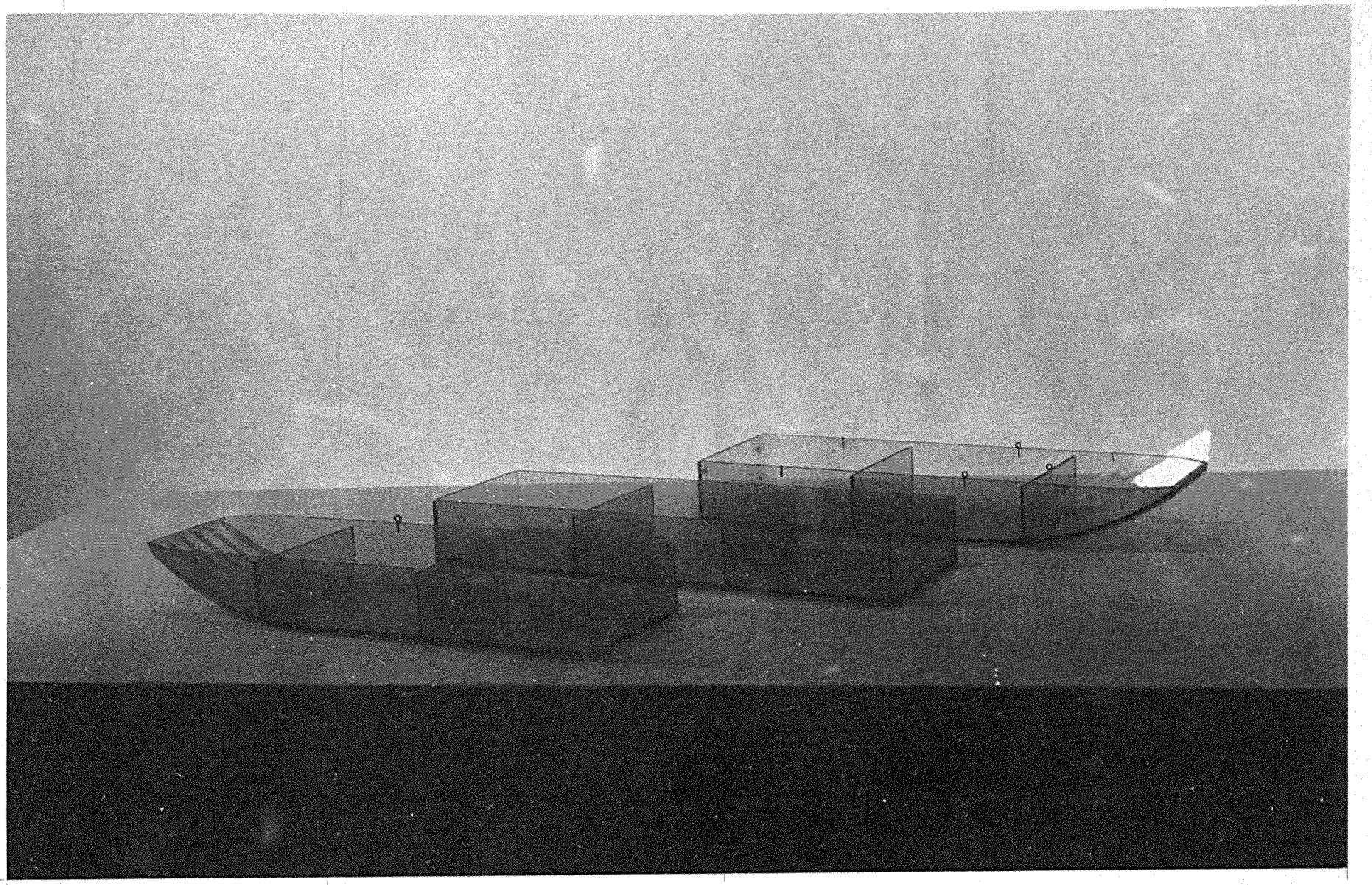


Photograph 12. Details of new ponton -- type 2.

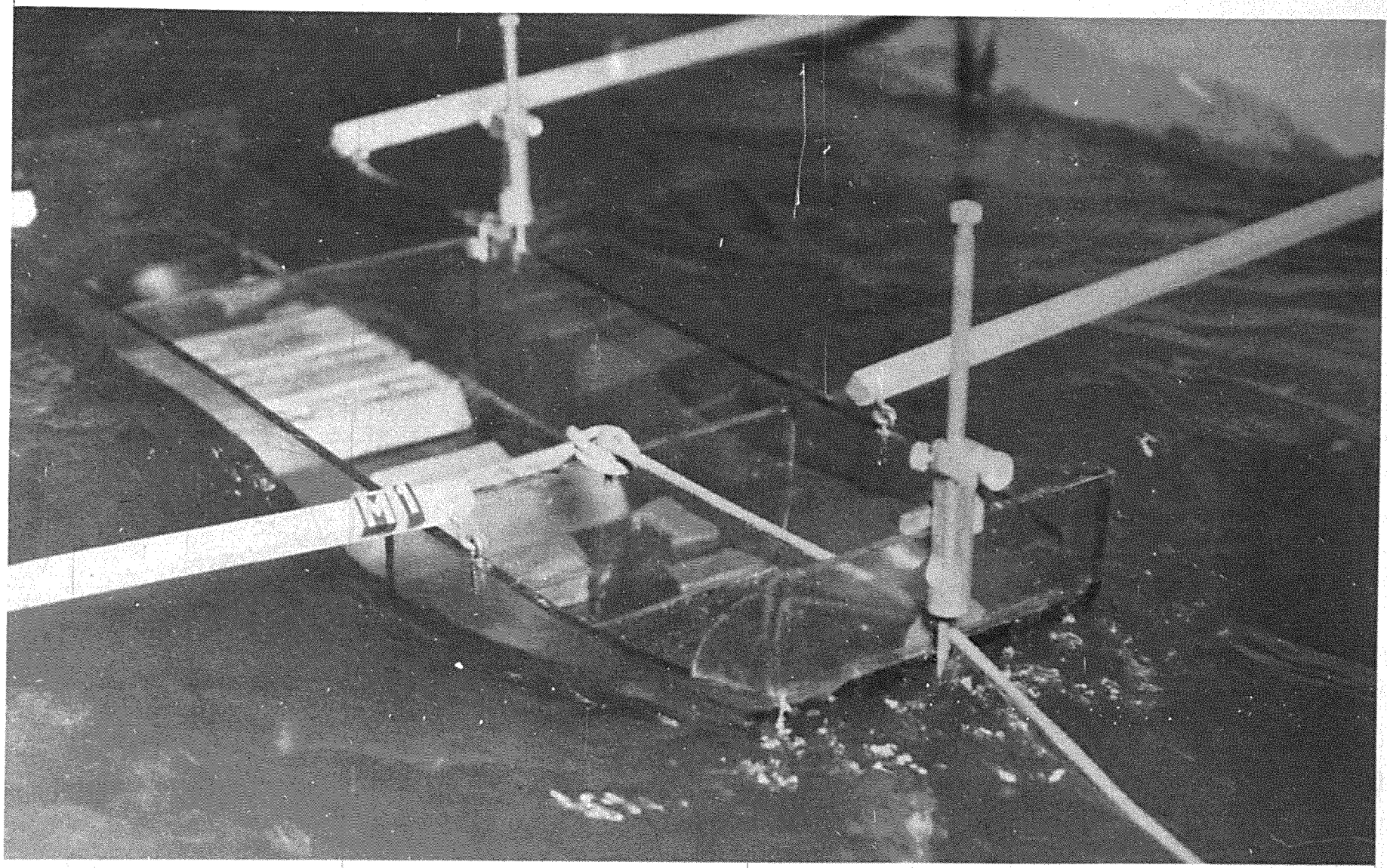


Photograph 13. Flow conditions for new ponton -- type 2. Freeboards for velocity of 7.08 ft per sec and 10-inch loading.

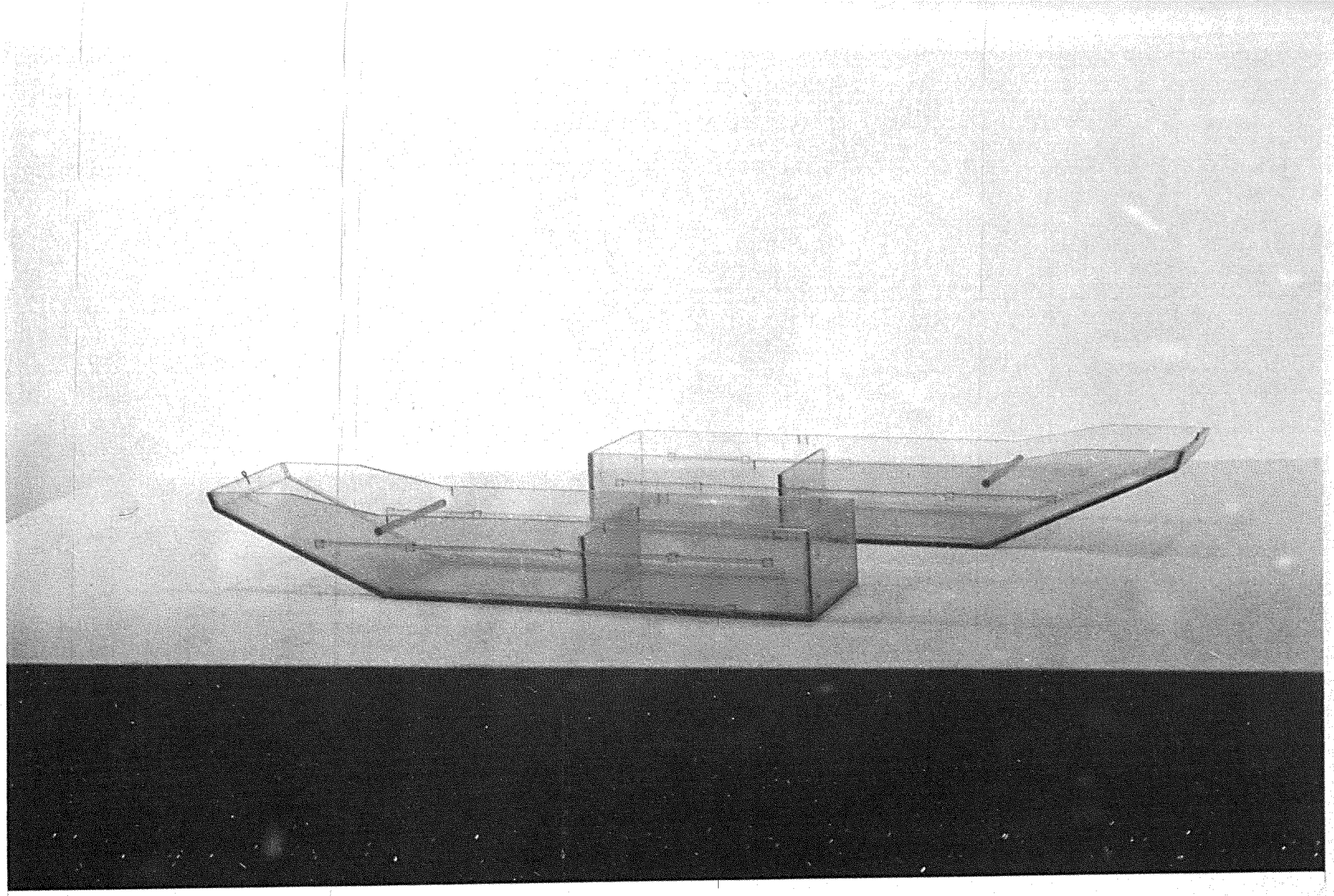
Bow 8.06 inches
Side 8.83 inches



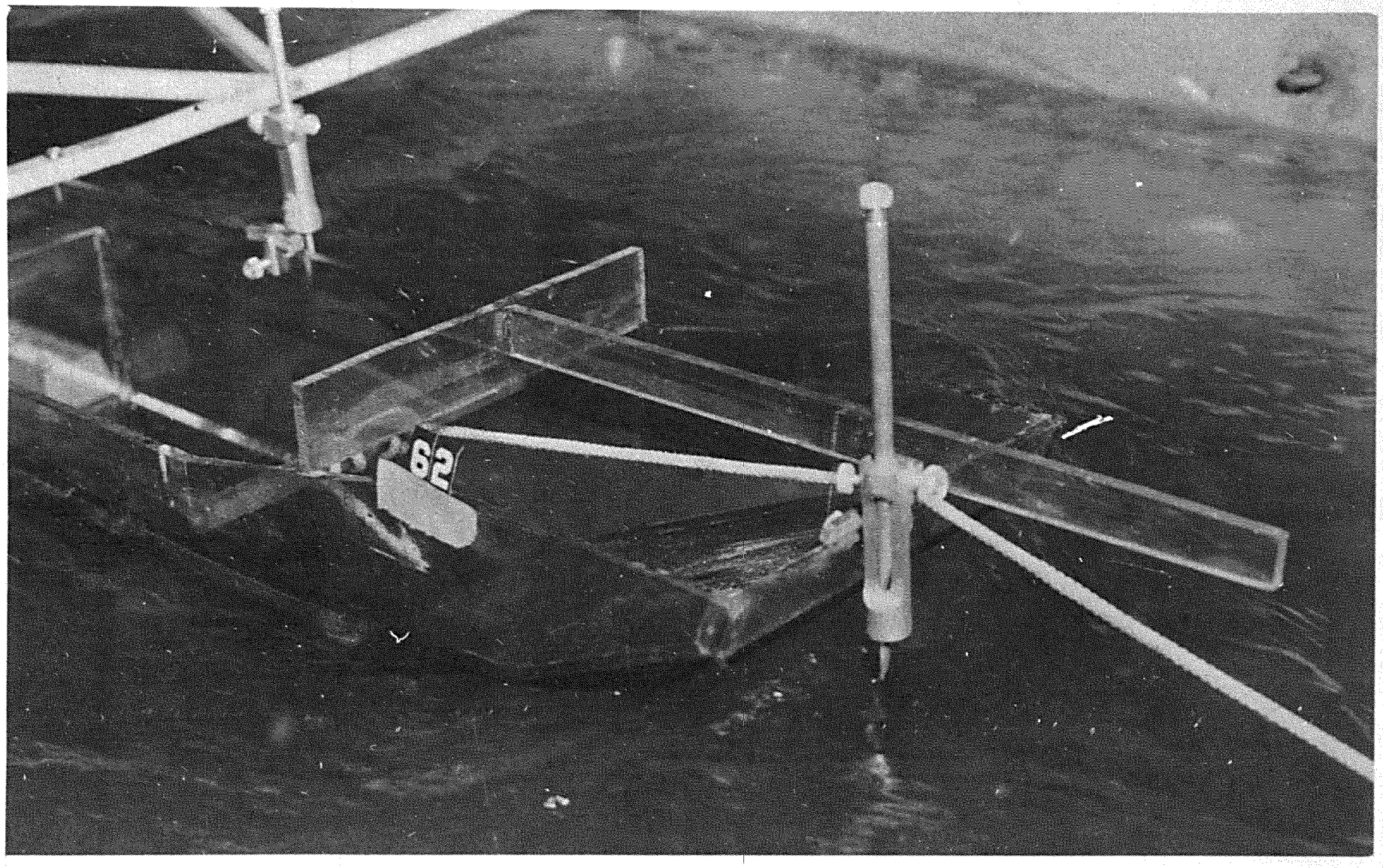
Photograph 14. Details of British ponton Mark V in its entirety.



Photograph 15. Flow conditions for British ponton Mark V. Freeboards for velocity of 7.35 ft per sec and 10-inch loading.
Bow 0.77 inches
Side 7.87 inches

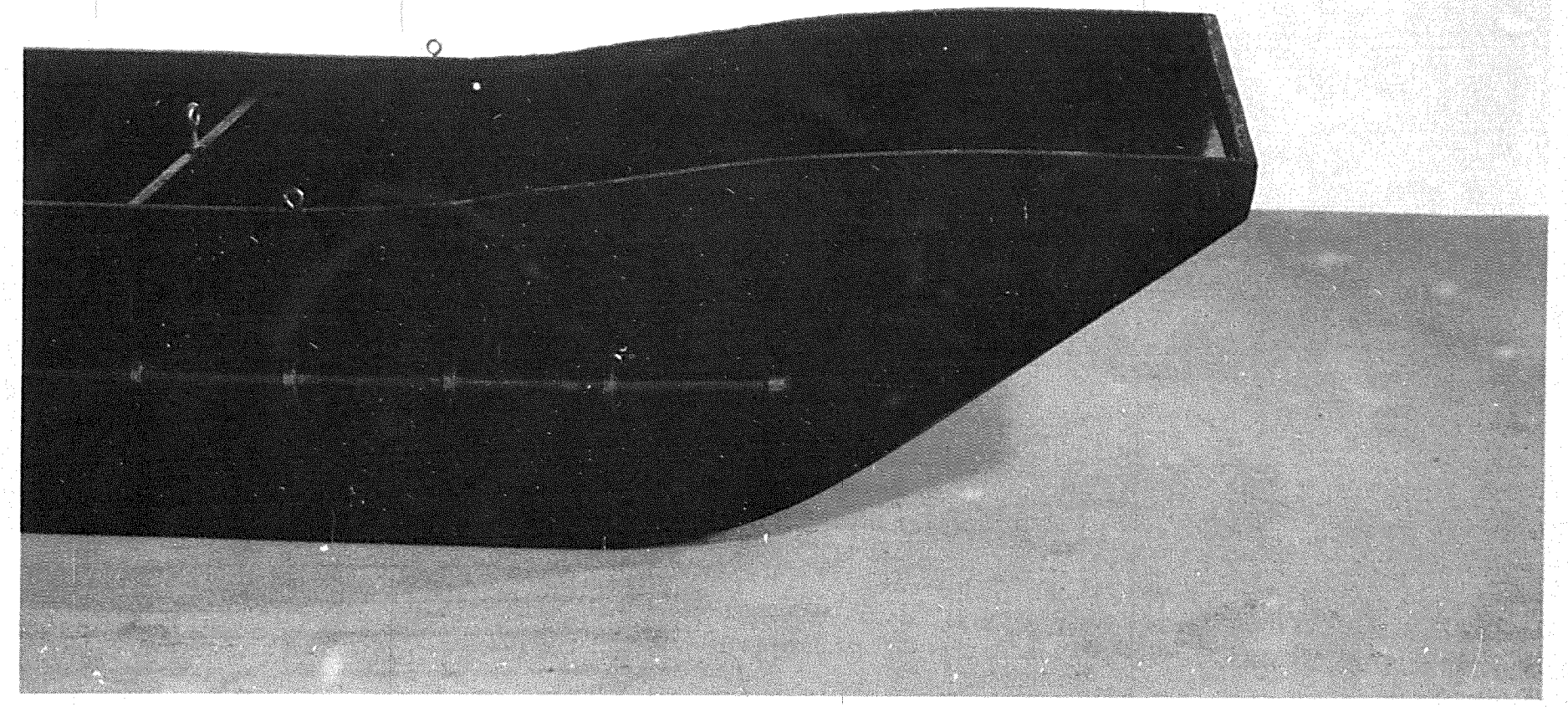


Photograph 16. Details of German ponton in its entirety.

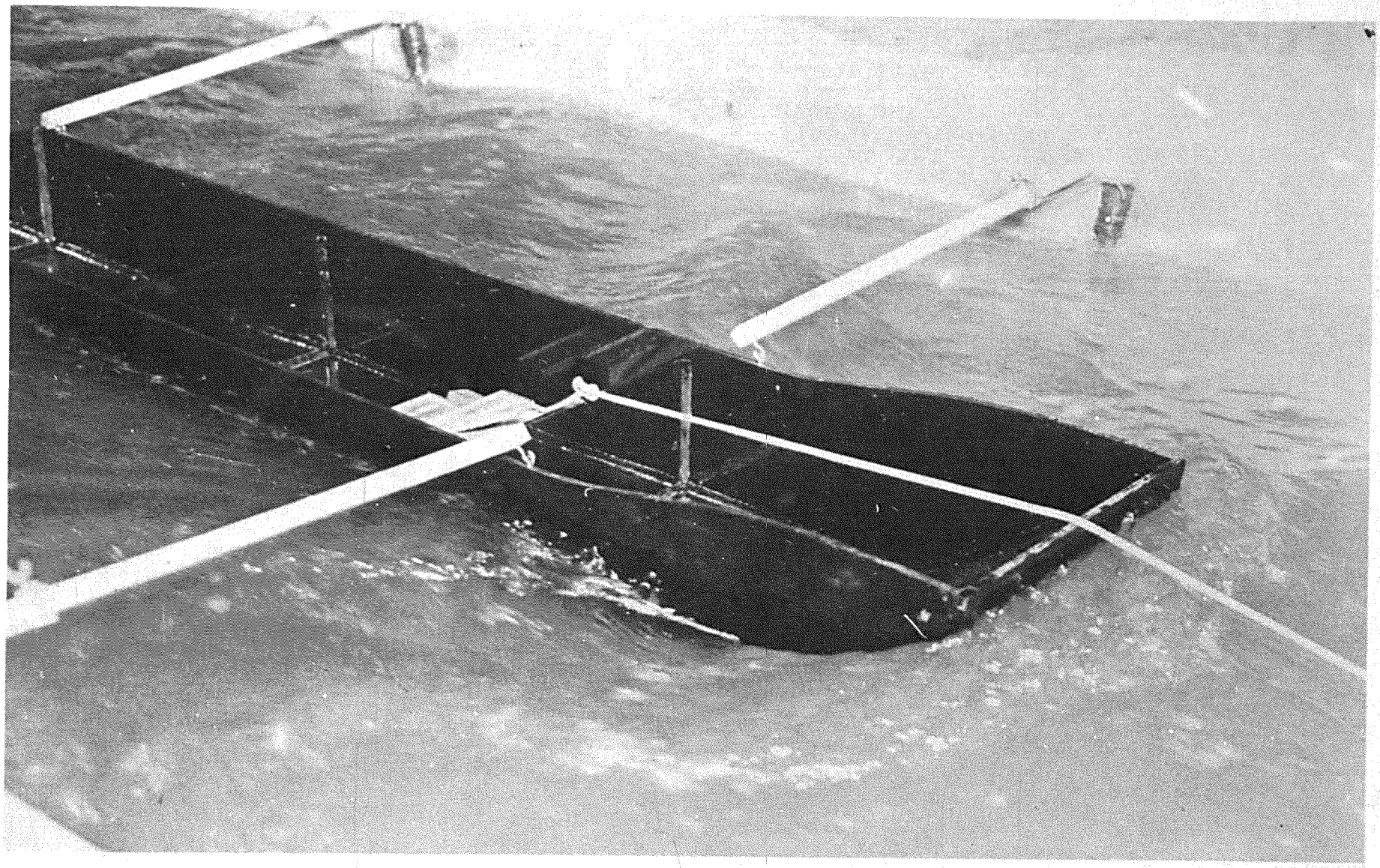


Photograph 17. Flow conditions for German ponton. Freeboards for velocity of 7.35 ft per sec and 10-inch loading.

Bow	15.90 inches
Side	8.00 inches

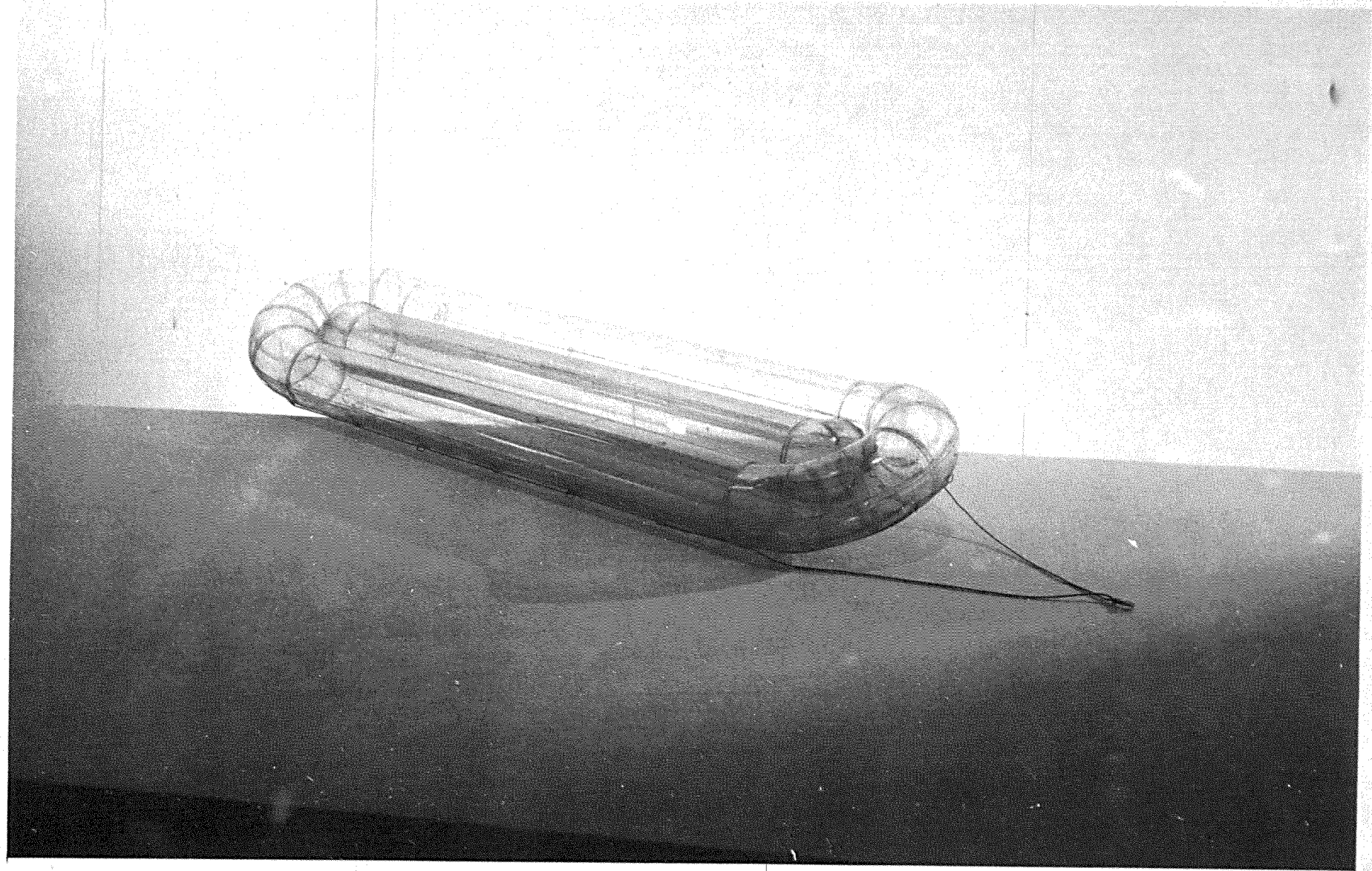


Photograph 18. Details of the alternate design ponton.

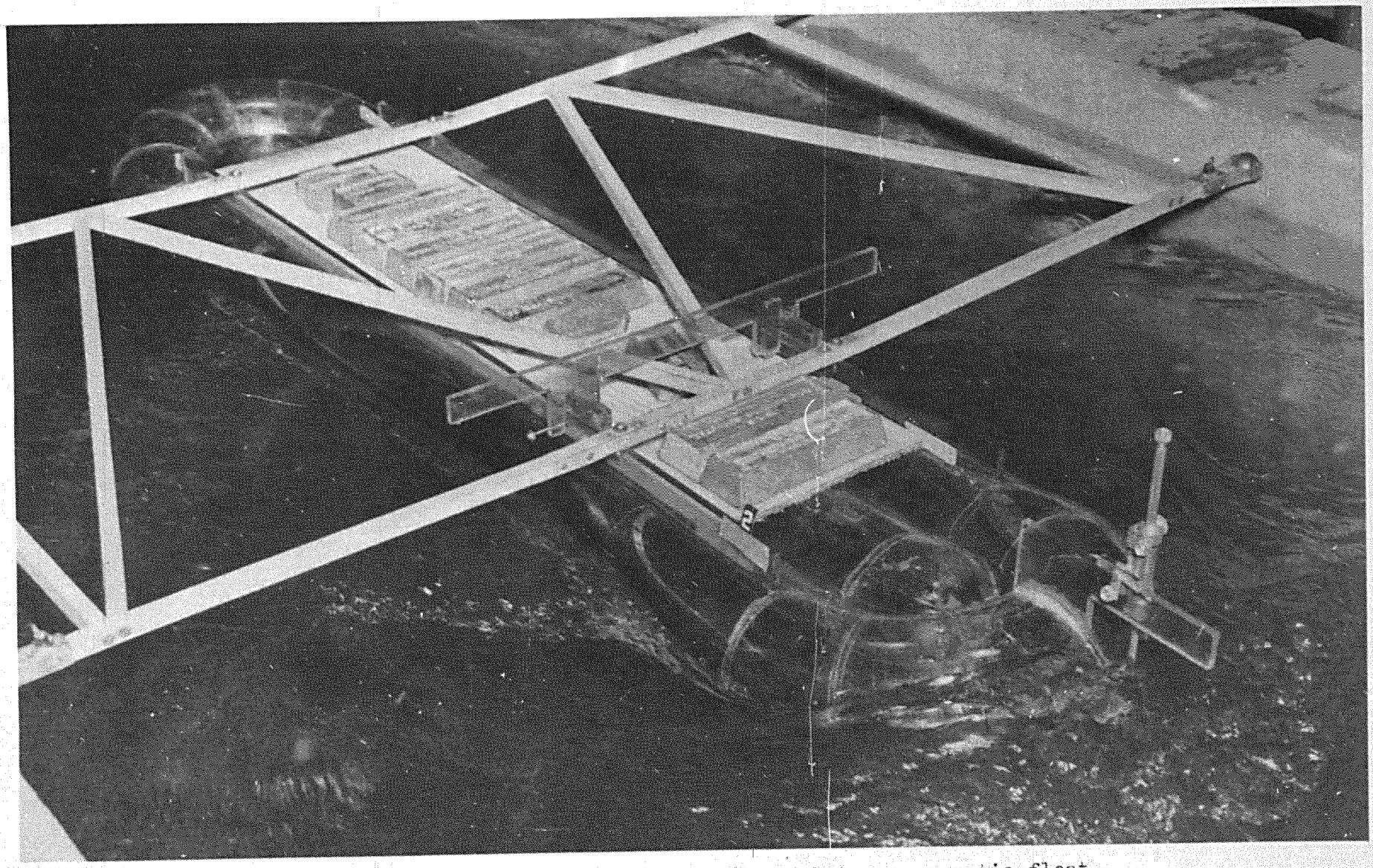


Photograph 19. Flow conditions for alternate design ponton. Average freeboards for velocity of 7.3 ft per sec and 10.75-inch loading.

Bow	12.10 inches
Side	8.26 inches



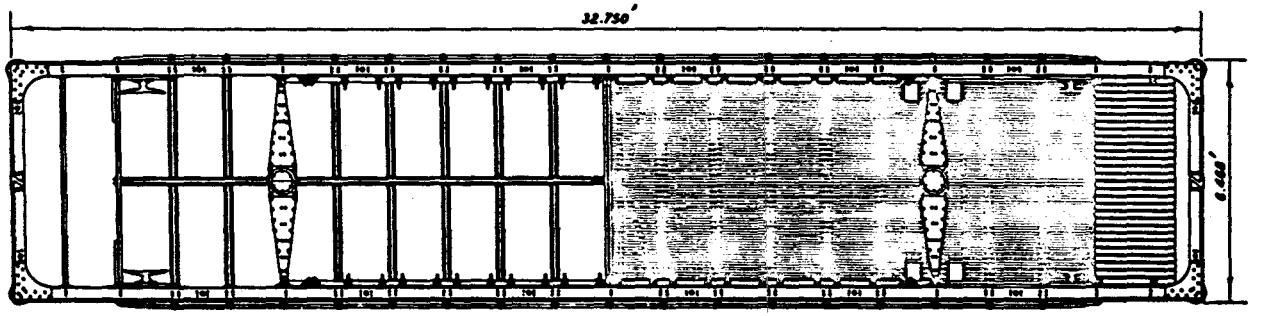
Photograph 20. Details of American M-1 type pneumatic float.



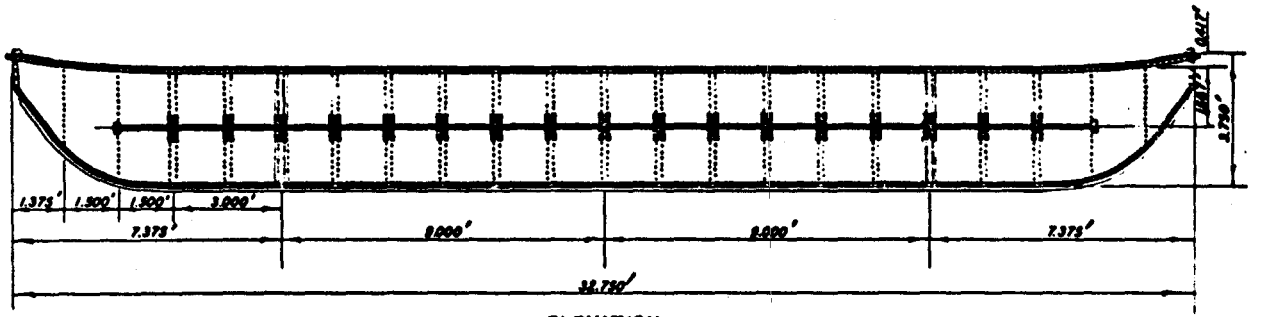
Photograph 21. Flow conditions for American M-1 type pneumatic float.
Freeboards for velocity of 7.27 ft per sec and 10-inch loading.

Bow	11.70 inches
Side	7.70 inches

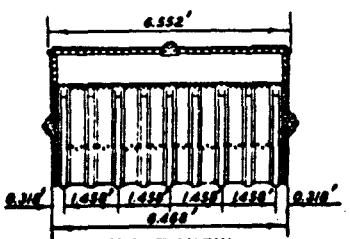
PLATES



PLAN



ELEVATION



FRONT VIEW

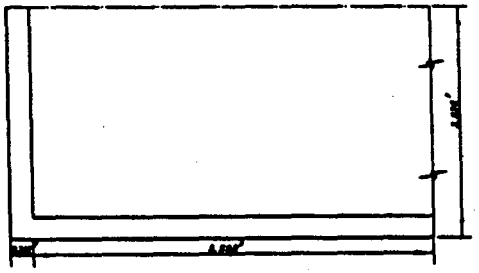
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

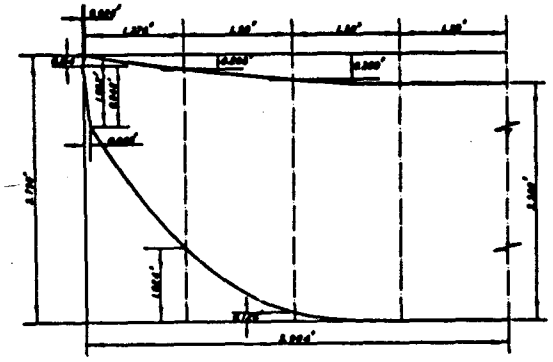
DETAILS OF AMERICAN 25-TON PONTON

SCALE

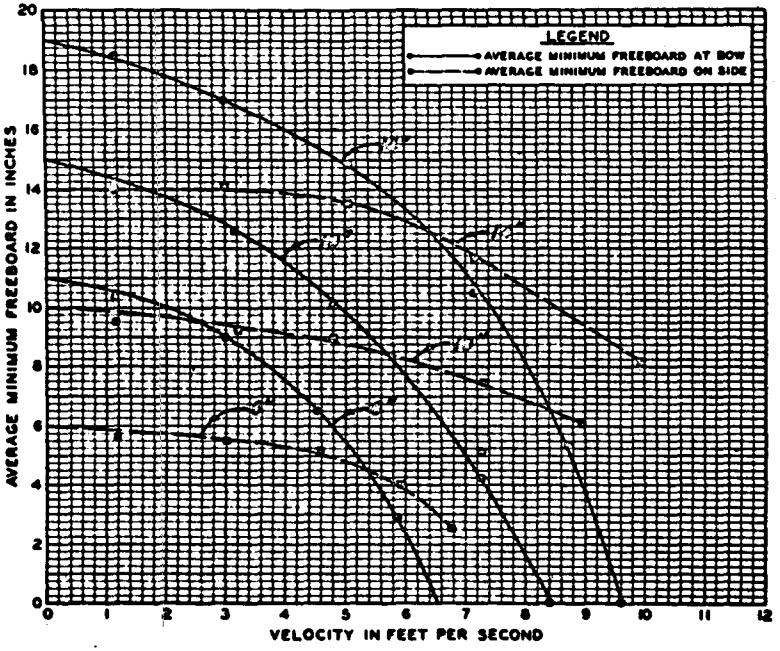
PLATE I



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

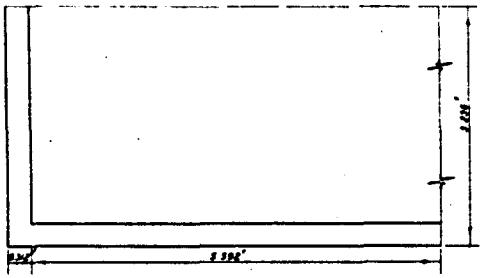
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON

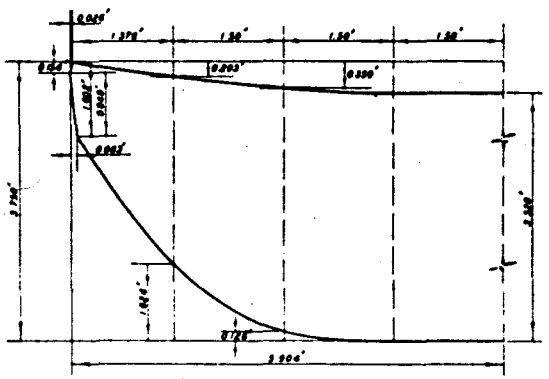
SCALE

1 0 1 2 3 4 5 FEET

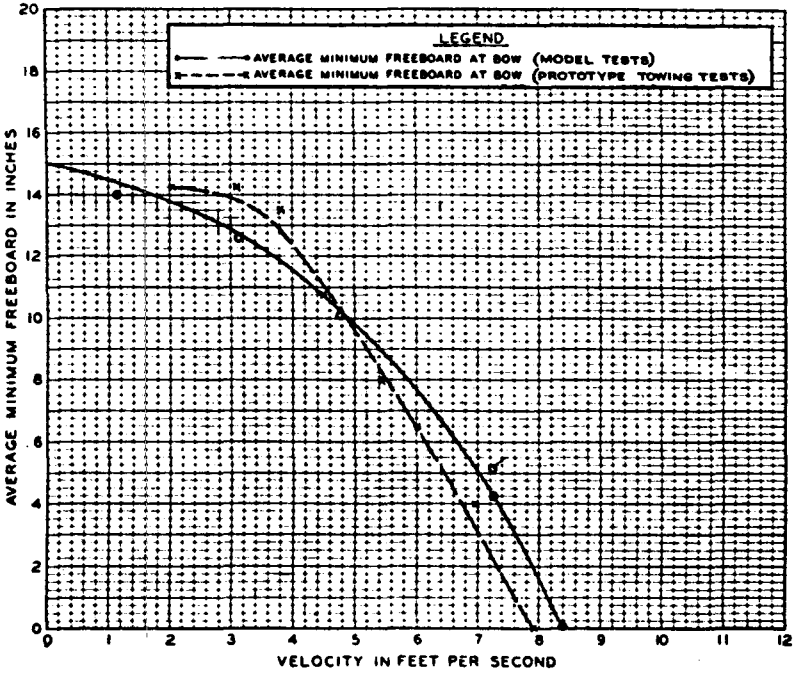
PLATE 2



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 10 INCHES ON THE SIDE AT START OF TESTS.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

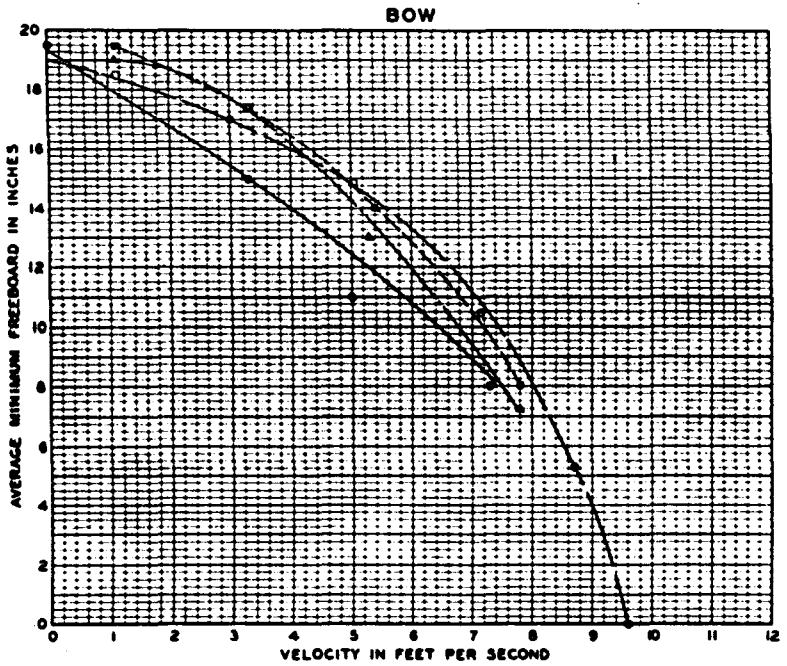
COMPARISON OF MODEL AND TOWING TESTS

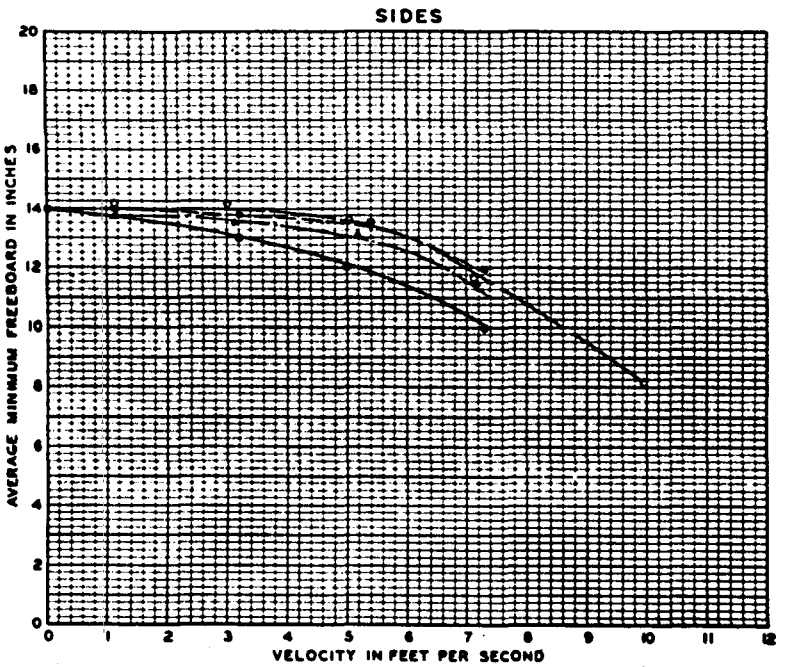
AMERICAN 25-TON PONTON

SCALE

1 0 1 2 3 4 5 FEET

PLATE 3





LEGEND

- PROTOTYPE
- MODEL, SINGLE PONTON
- MODEL, LEFT PONTON
- MODEL, RIGHT PONTON

TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14 INCHES ON THE SIDE AT START OF TEST.

ALL CURVES WERE DEVELOPED WITH PONTONS SPACED AT 15 FOOT CENTERS EXCEPT THAT INDICATED BY OPEN CIRCLES AND DASHED LINES ABOVE.

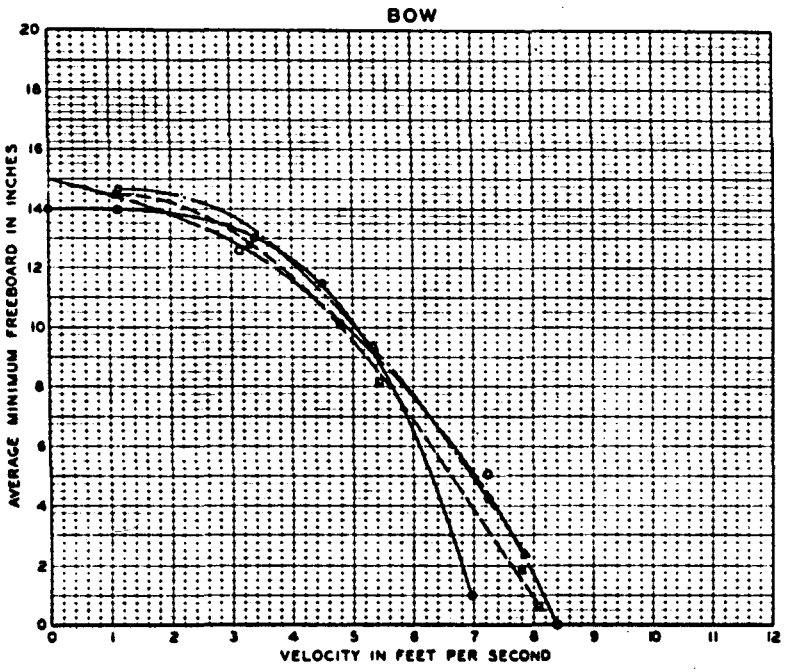
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

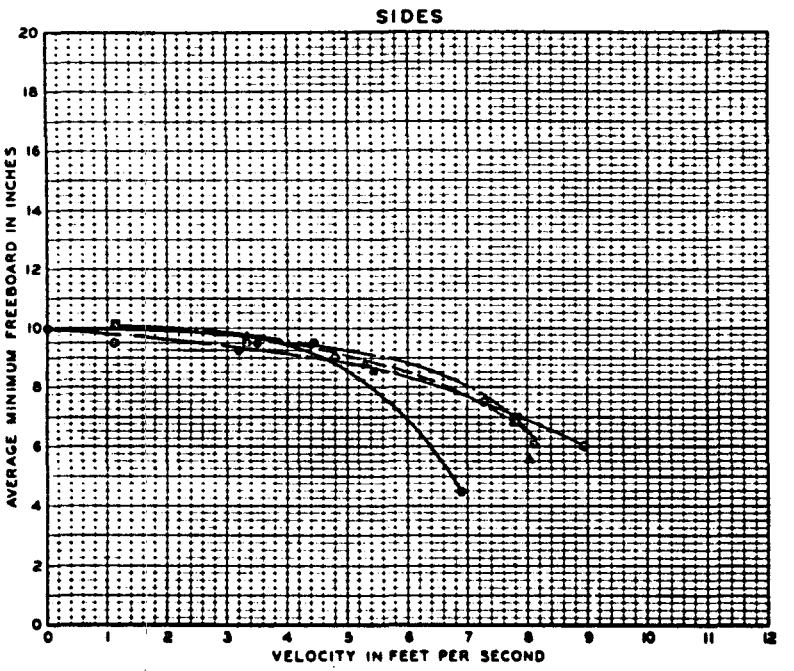
COMPARISON OF MODEL AND PROTOTYPE FREEBOARD–VELOCITY CURVES

AMERICAN 25-TON PONTON

SCALES AS SHOWN

PLATE 4





LEGEND

- PROTOTYPE
- MODEL, SINGLE PONTON
- MODEL, LEFT PONTON
- MODEL, RIGHT PONTON

TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 10 INCHES ON THE SIDE AT START OF TEST.

ALL CURVES WERE DEVELOPED WITH PONTONS SPACED AT 15 FOOT CENTERS EXCEPT THAT INDICATED BY OPEN CIRCLES AND DASHED LINES ABOVE.

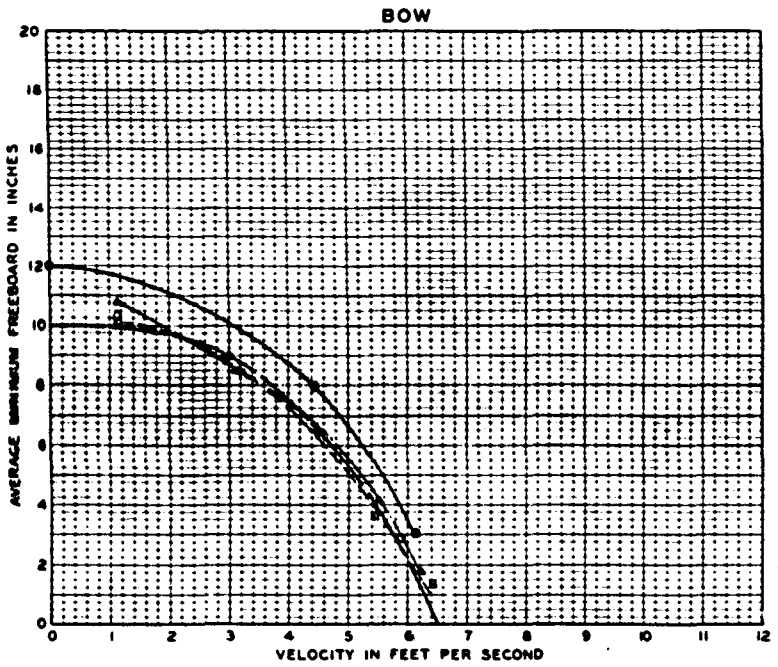
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

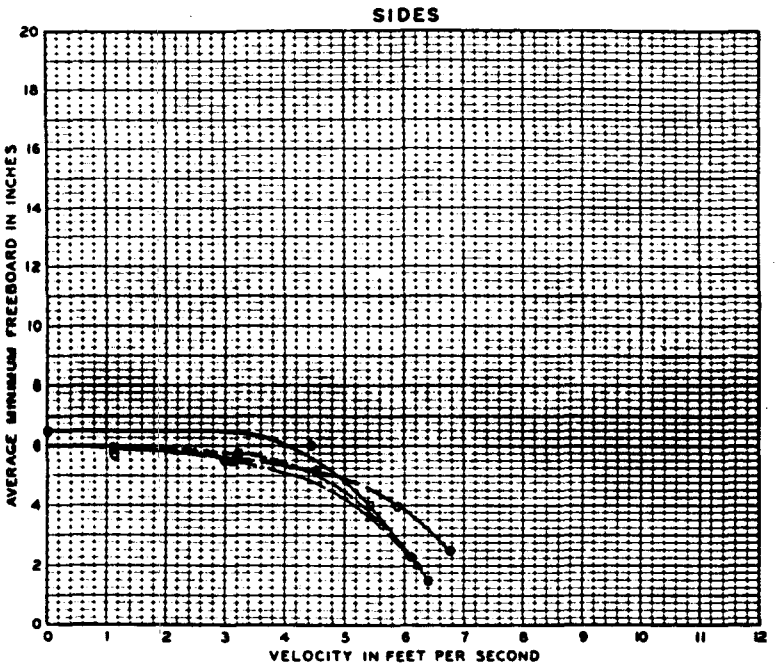
COMPARISON OF MODEL AND PROTOTYPE FREEBOARD–VELOCITY CURVES

AMERICAN 25-TON PONTON

SCALES AS SHOWN

PLATE 5





LEGEND

- PROTOTYPE
- MODEL, SINGLE PONTON
- MODEL, LEFT PONTON
- MODEL, RIGHT PONTON

TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 6 INCHES ON THE SIDE AT START OF TEST.

ALL CURVES WERE DEVELOPED WITH PONTONS SPACED AT 15 FOOT CENTERS EXCEPT THAT INDICATED BY OPEN CIRCLES AND DASHED LINES ABOVE.

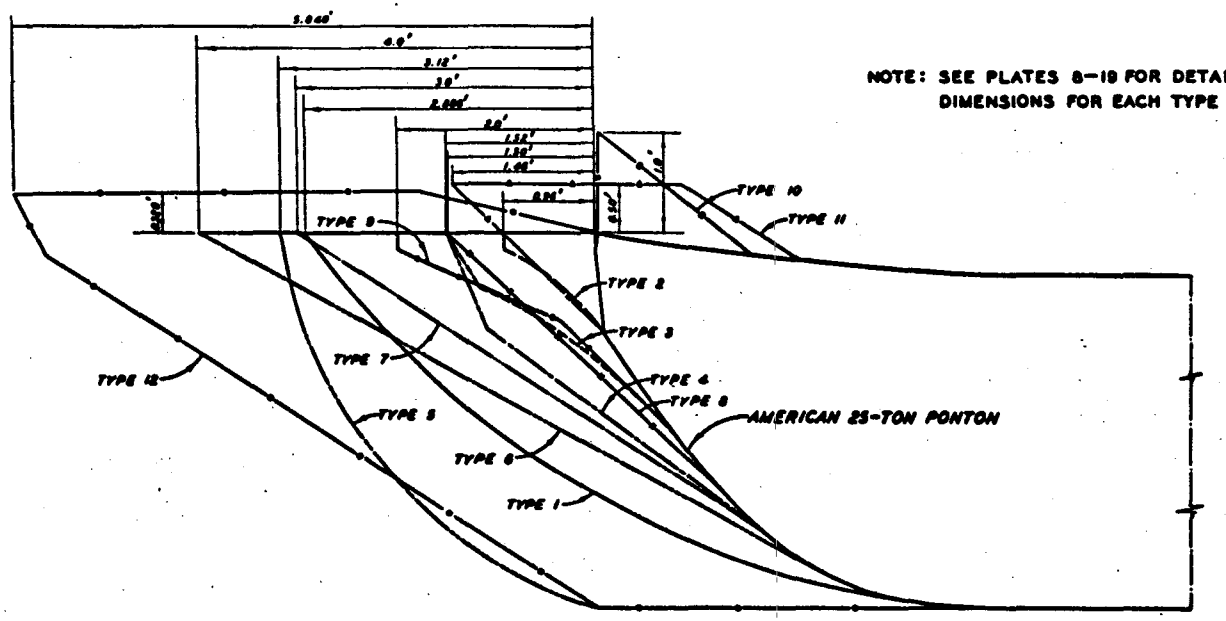
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

COMPARISON OF MODEL AND PROTOTYPE FREEBOARD–VELOCITY CURVES

AMERICAN 25-TON PONTON

SCALES AS SHOWN

PLATE 6



NOTE: SEE PLATES 8–18 FOR DETAILED DIMENSIONS FOR EACH TYPE ATTACHMENT.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

COMPARATIVE ALIGNMENT OF ATTACHMENTS

SCALE

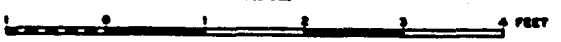
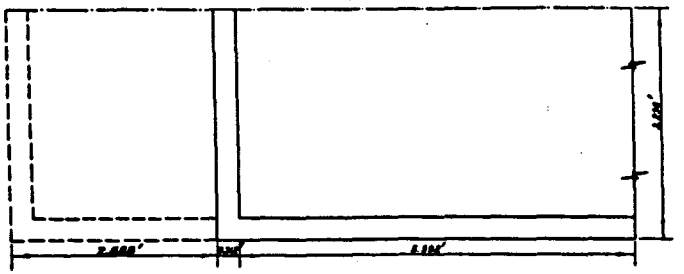
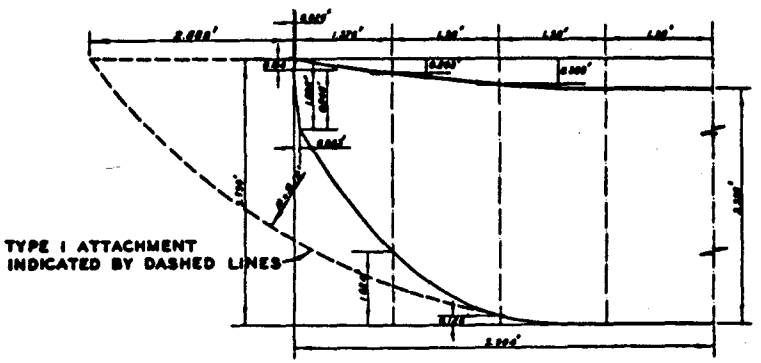


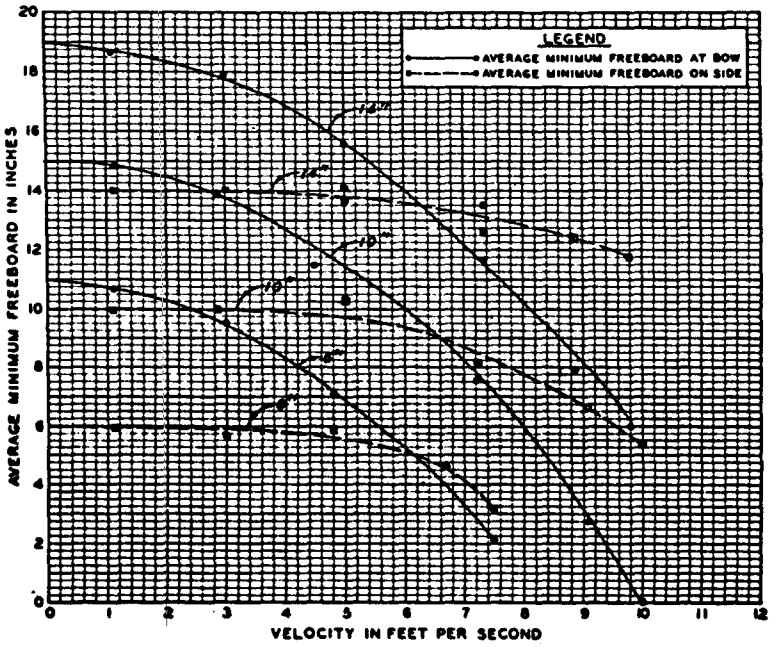
PLATE 7



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

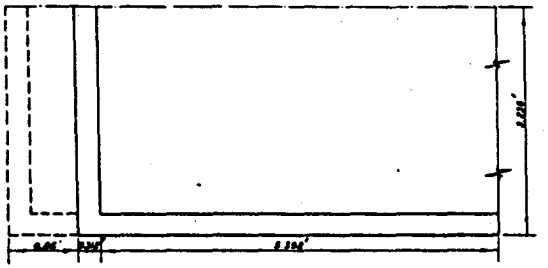
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

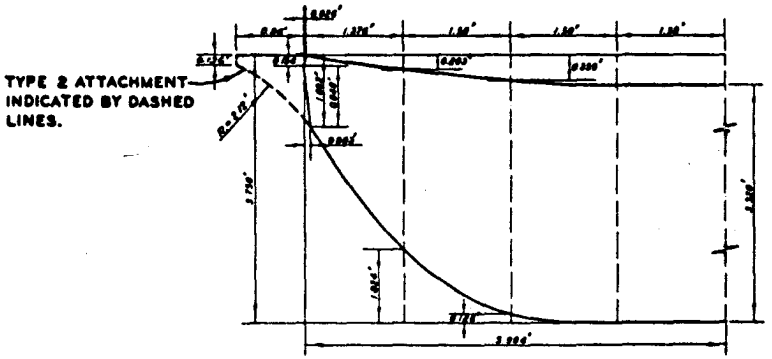
AMERICAN 25-TON PONTON—TYPE I ATTACHMENT

SCALE

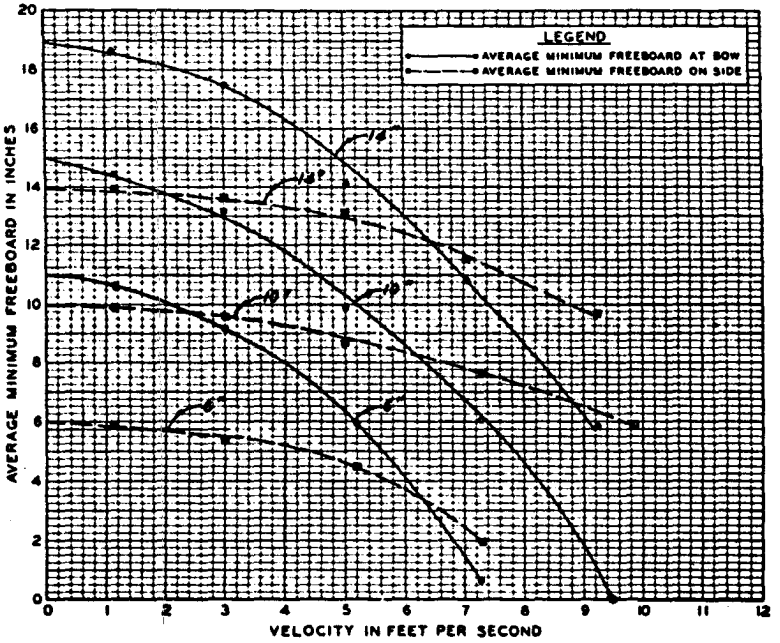
PLATE 8



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

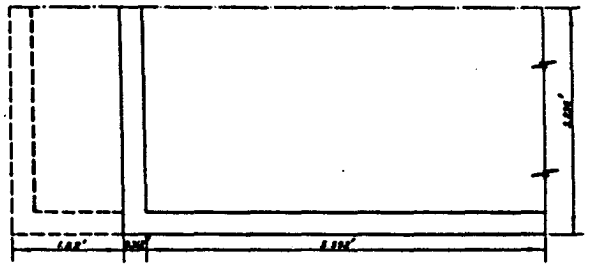
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 2 ATTACHMENT

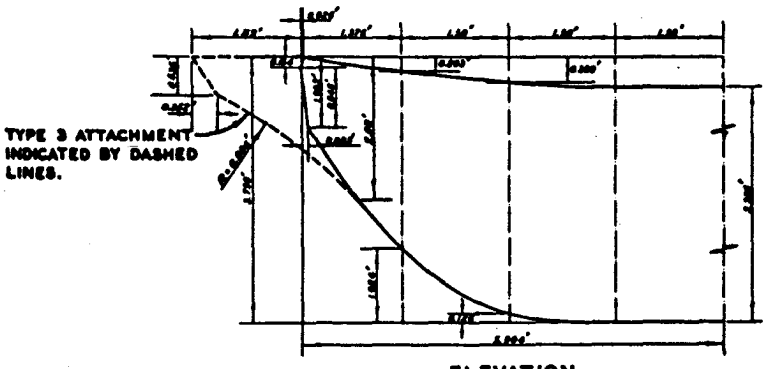
SCALE

1 0 1 2 3 4 5 FEET

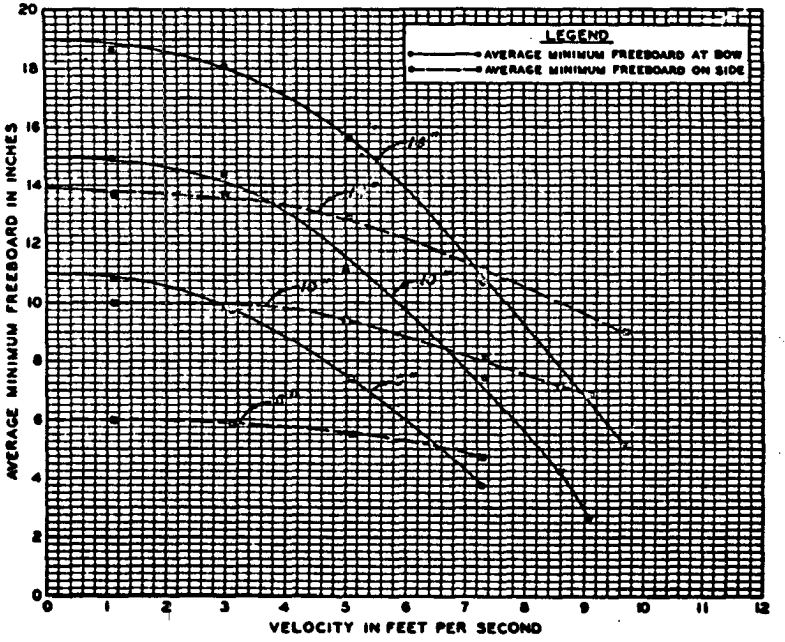
PLATE 9



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 3 ATTACHMENT

SCALE

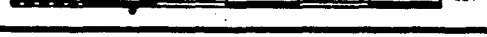
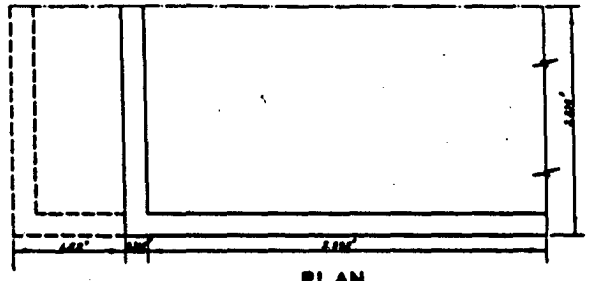
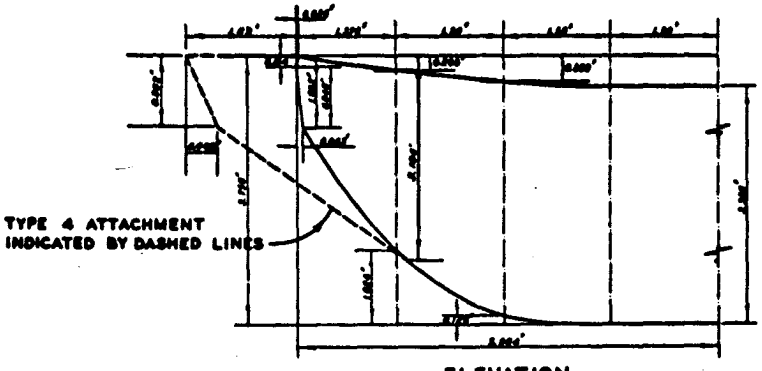


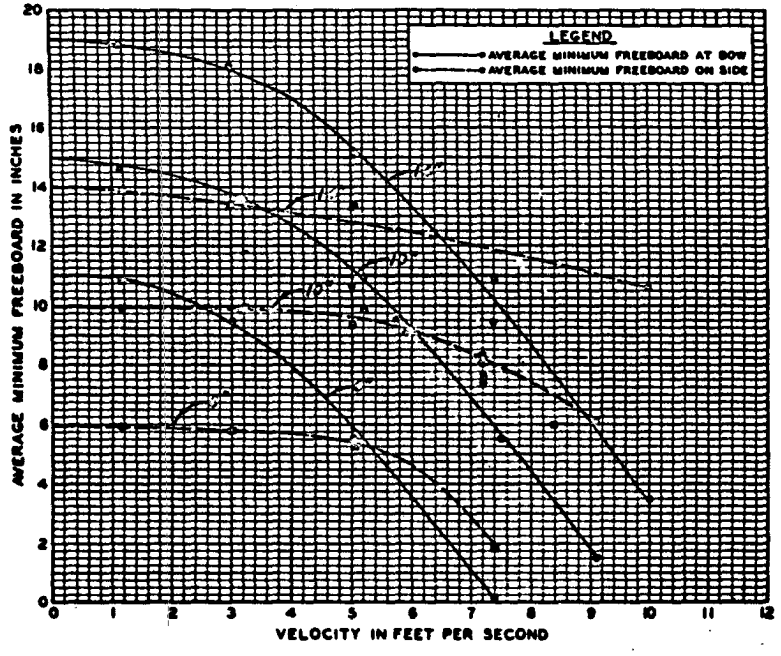
PLATE 10



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 8 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 4 ATTACHMENT

SCALE

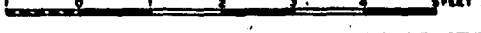
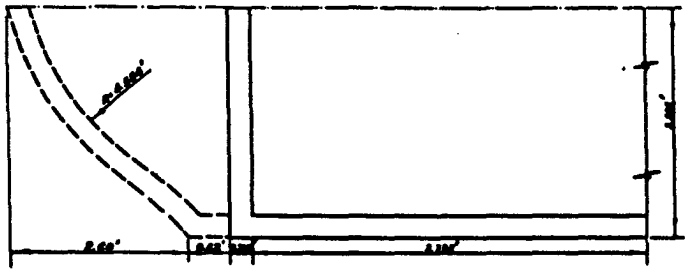
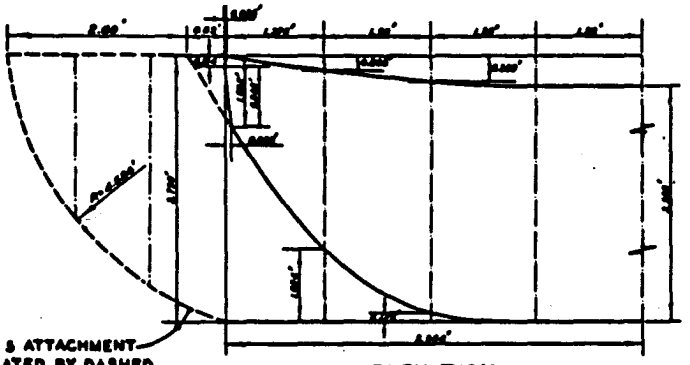


PLATE II

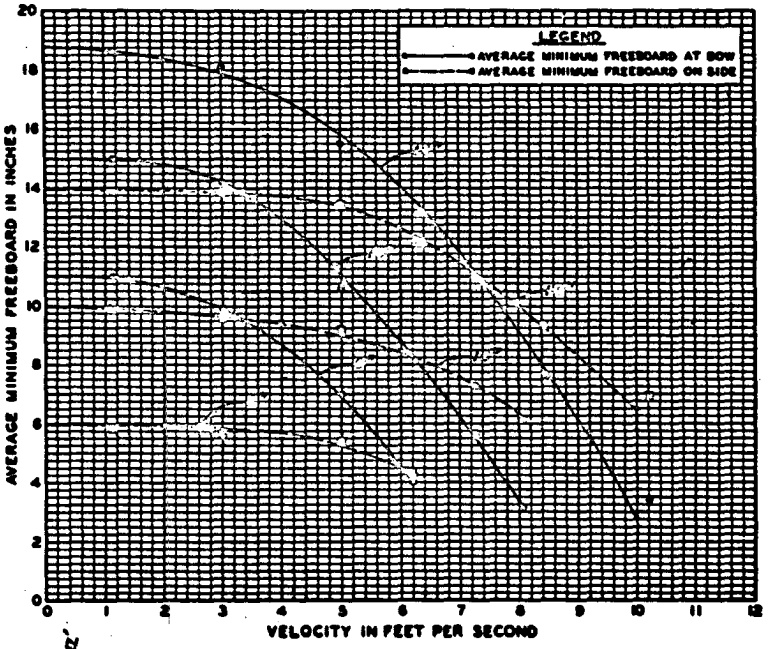


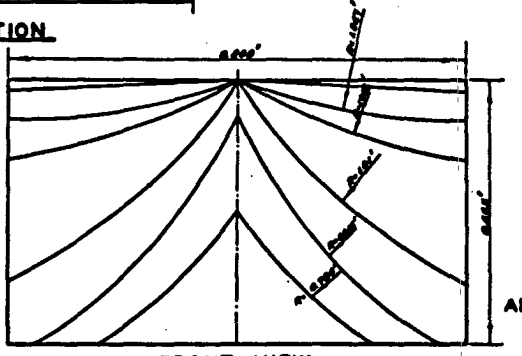
PLAN



TYPE 5 ATTACHMENT INDICATED BY DASHED LINES.

ELEVATION





FRONT VIEW

TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

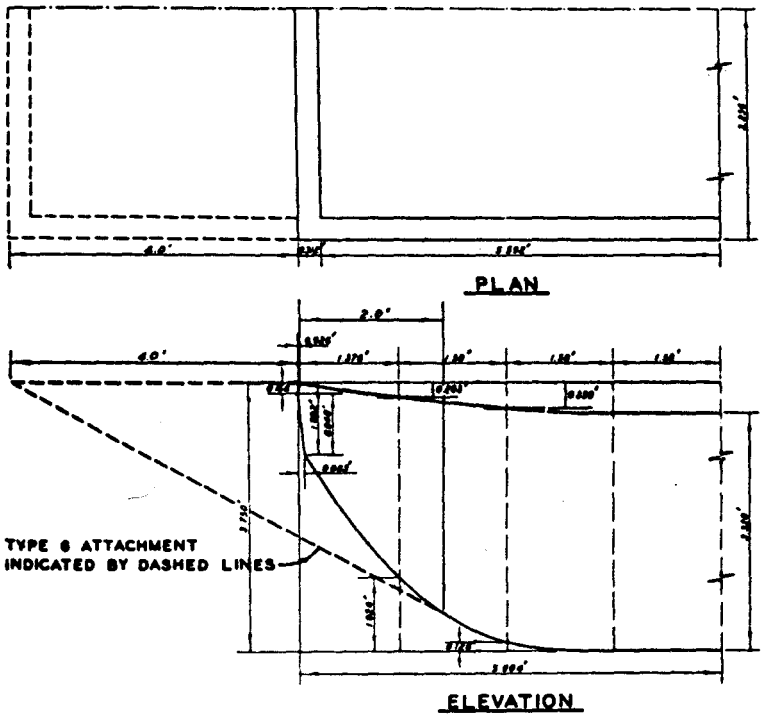
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

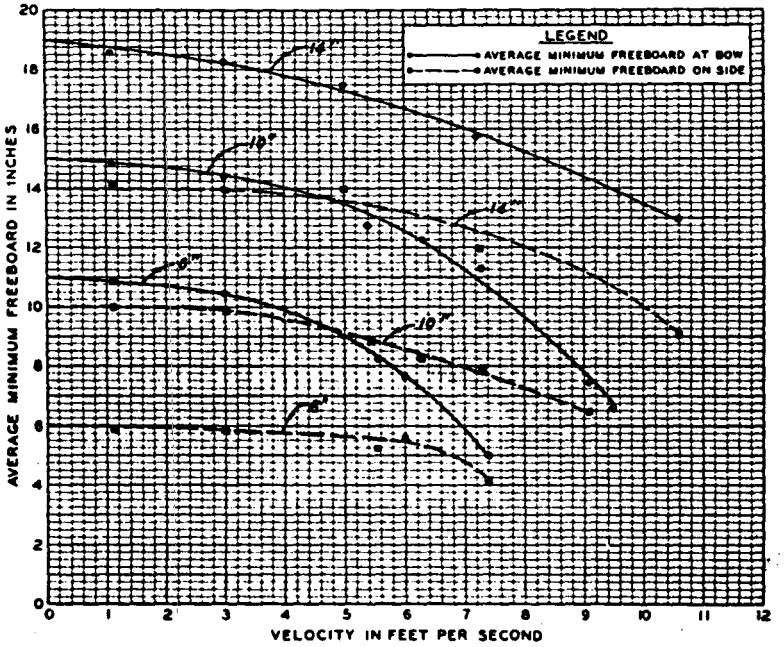
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 5 ATTACHMENT

SCALE

PLATE 12





TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

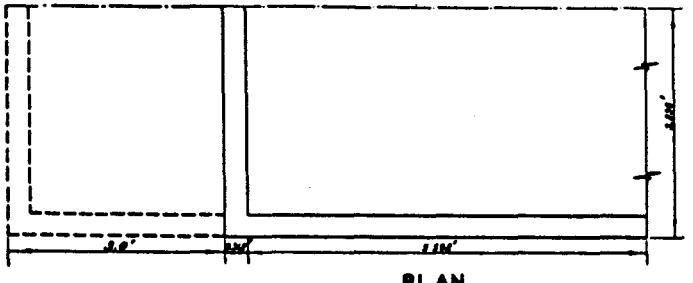
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 6 ATTACHMENT

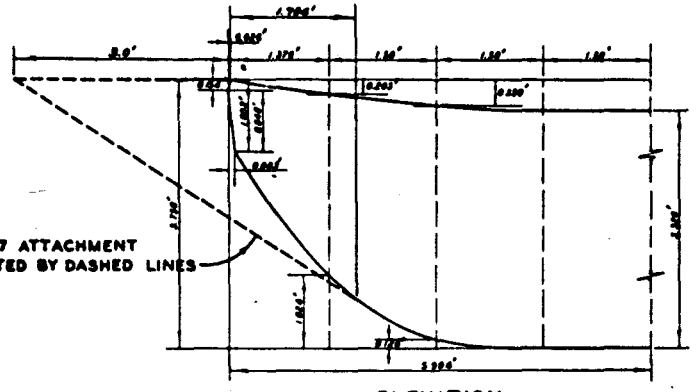
SCALE

1 0 1 2 3 4 5 FEET

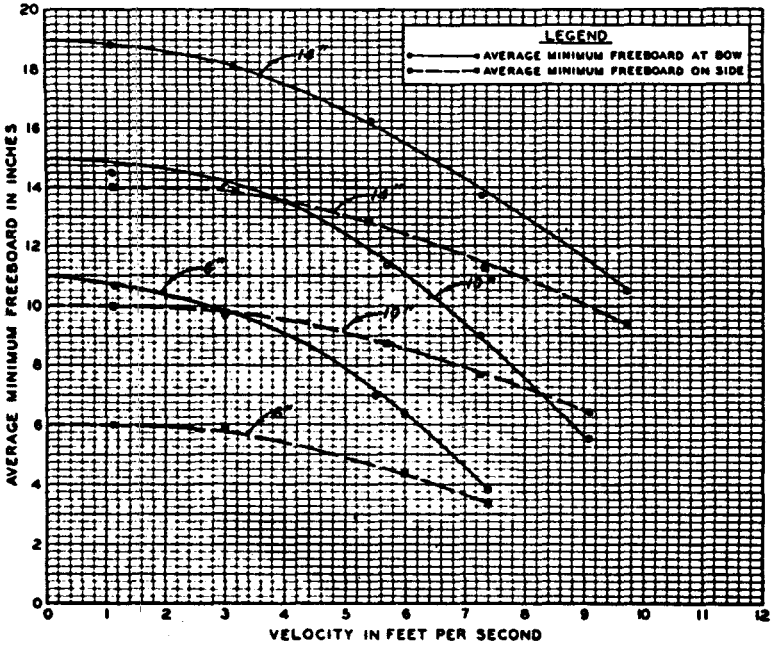
PLATE 13



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

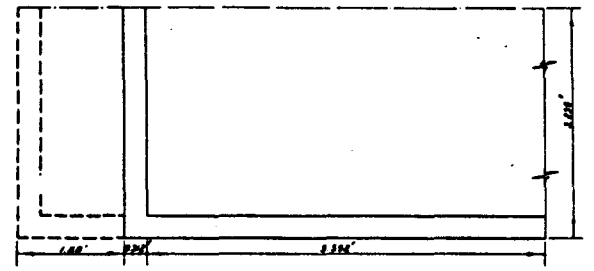
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 7 ATTACHMENT

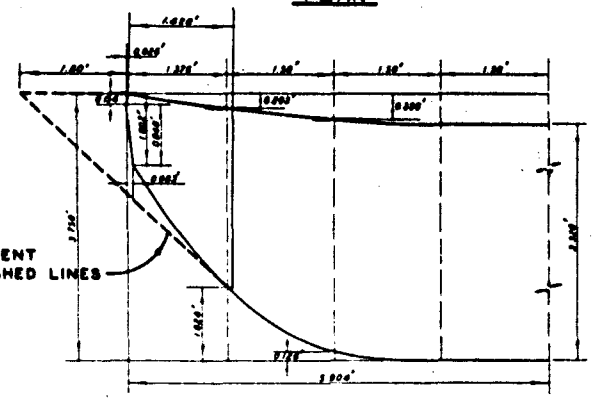
SCALE

1 0 1 2 3 4 5 FEET

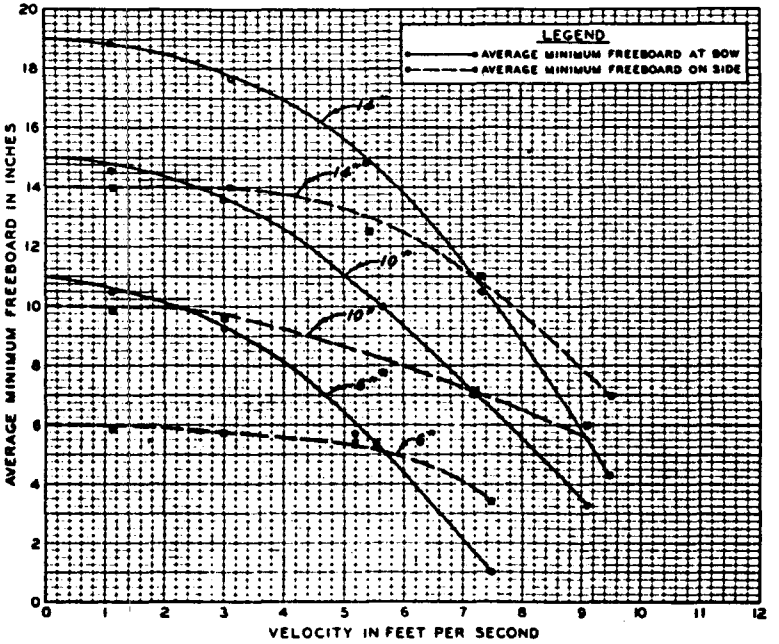
PLATE 14



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 8 ATTACHMENT

SCALE

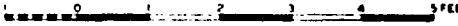
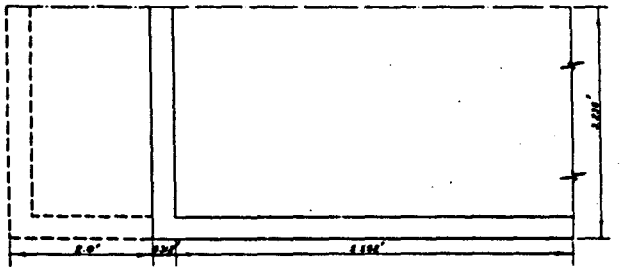
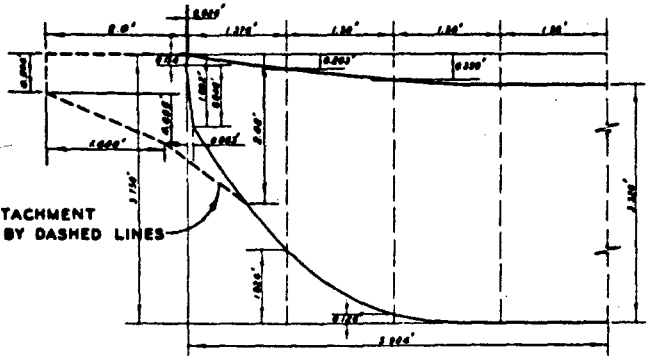


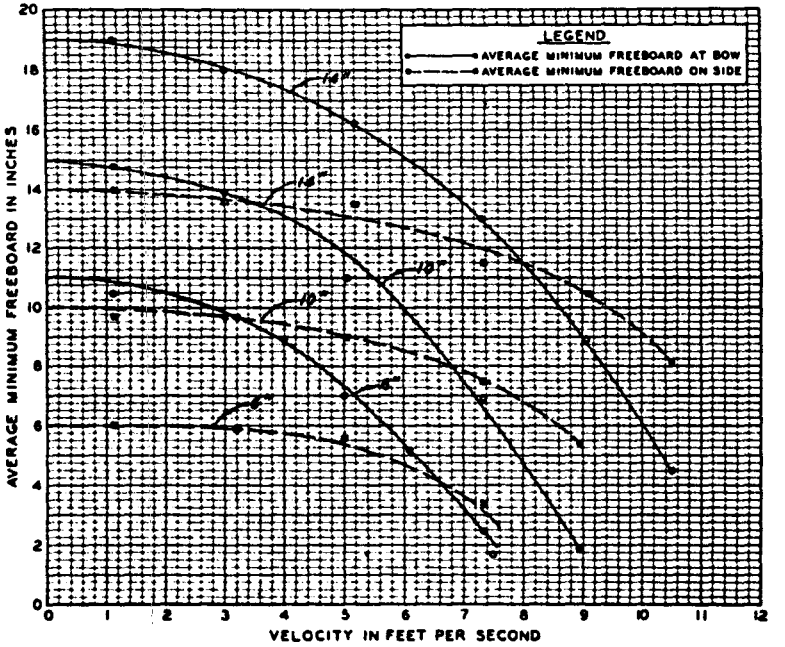
PLATE 15



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

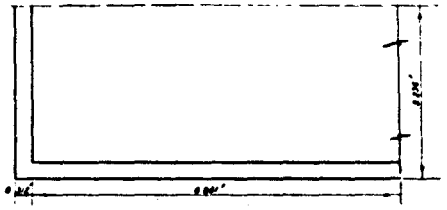
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

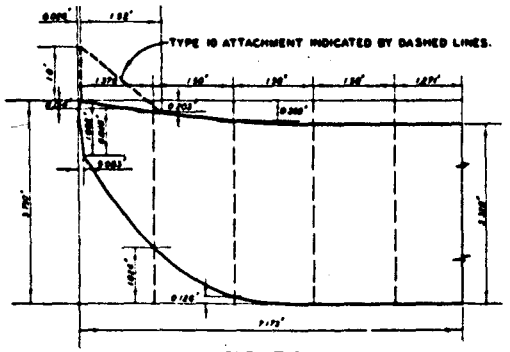
AMERICAN 25-TON PONTON—TYPE 9 ATTACHMENT

SCALE

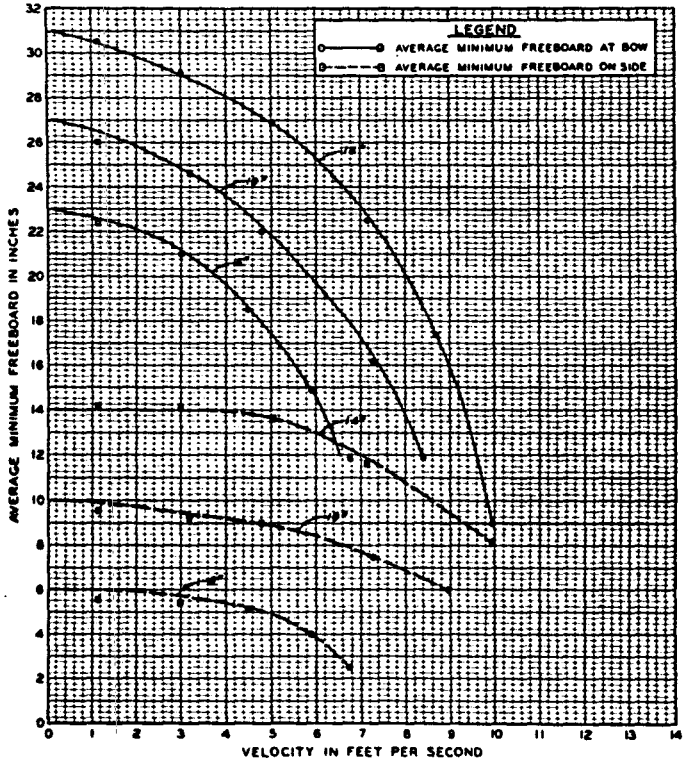
PLATE 16



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

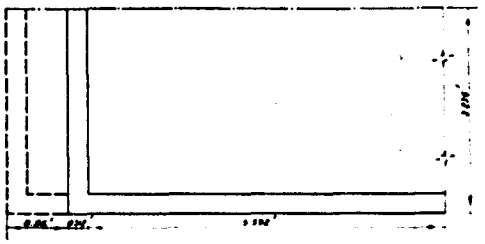
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

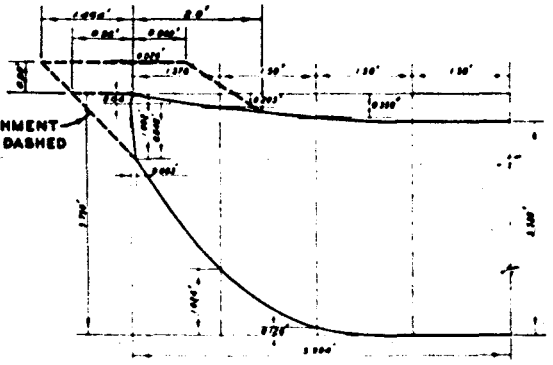
AMERICAN 25-TON PONTON—TYPE 10 ATTACHMENT

SCALE

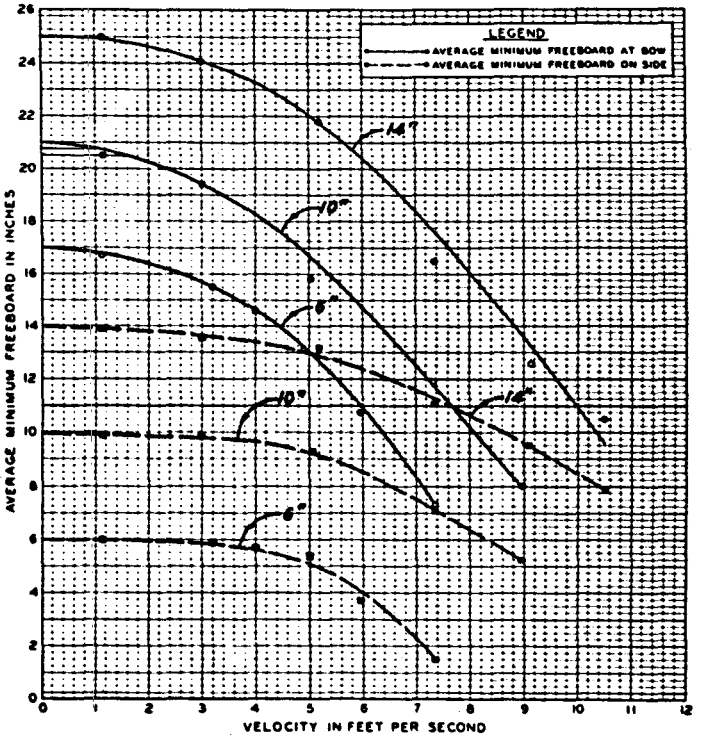
PLATE 17



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

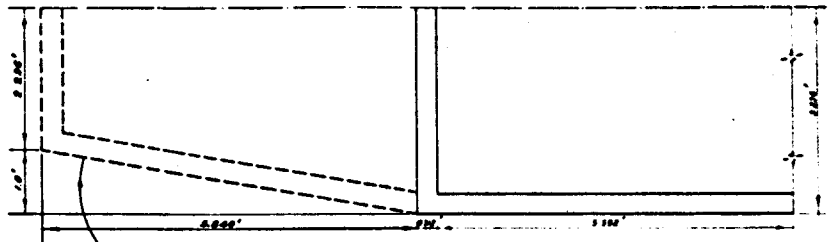
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE II ATTACHMENT

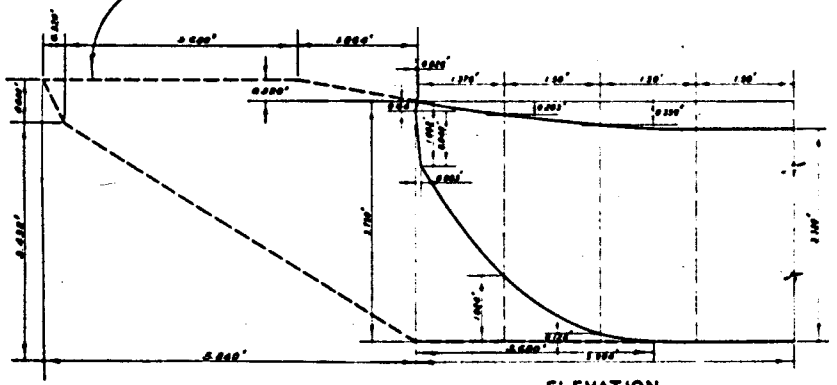
SCALE

PLATE 18

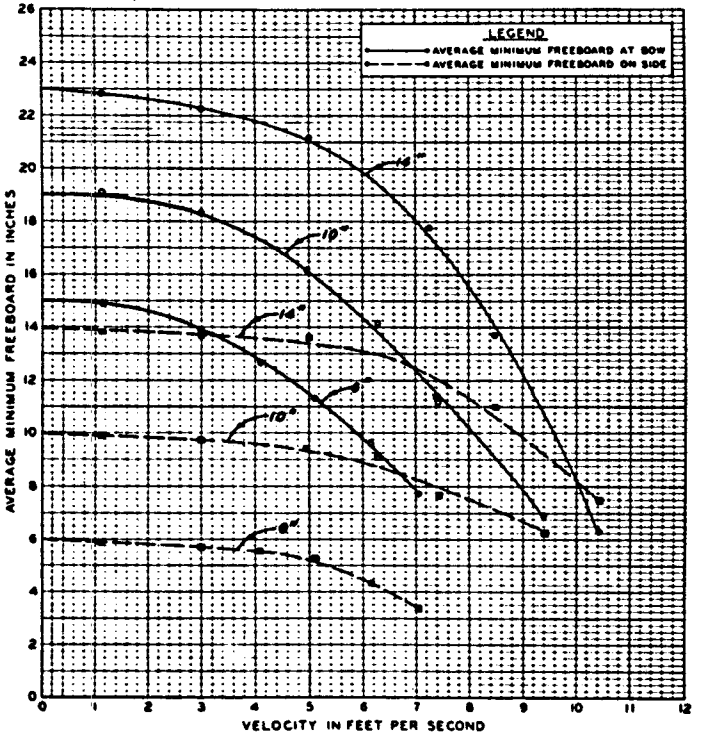


PLAN

TYPE 12 ATTACHMENT
INDICATED BY DASHED LINES



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

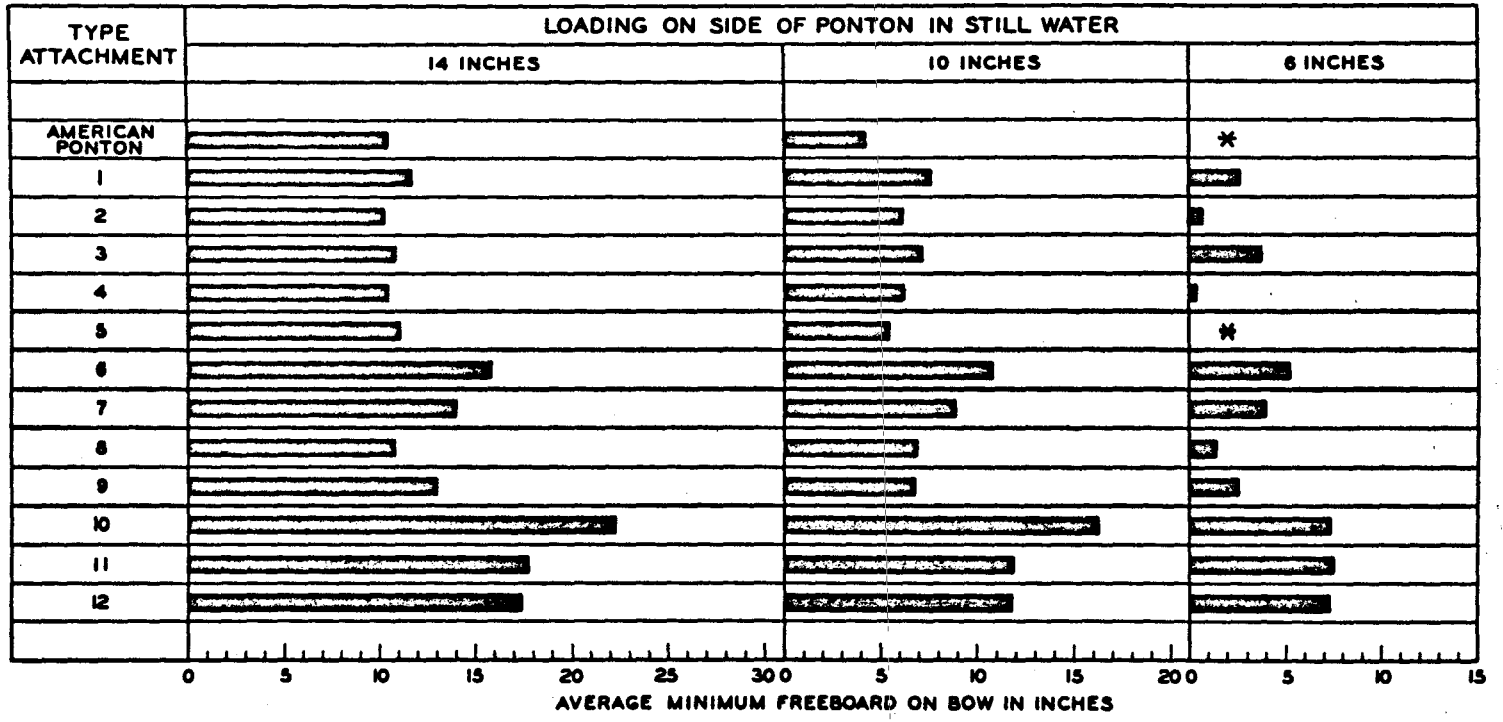
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—TYPE 12 ATTACHMENT

SCALE

1 0 1 2 3 4 5 FEET

PLATE 19



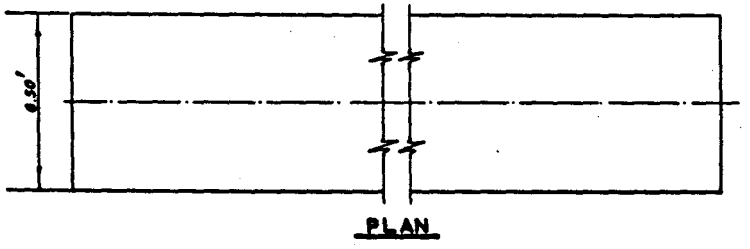
* ZERO FREEBOARD EXISTED BEFORE A VELOCITY OF 7.3 FT PER SEC WAS REACHED.

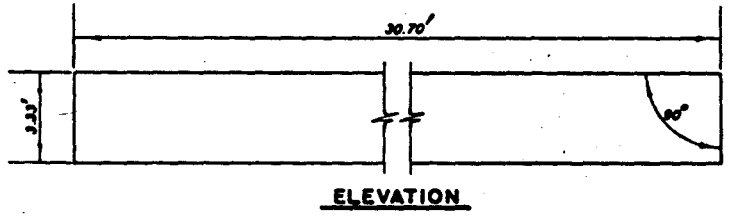
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

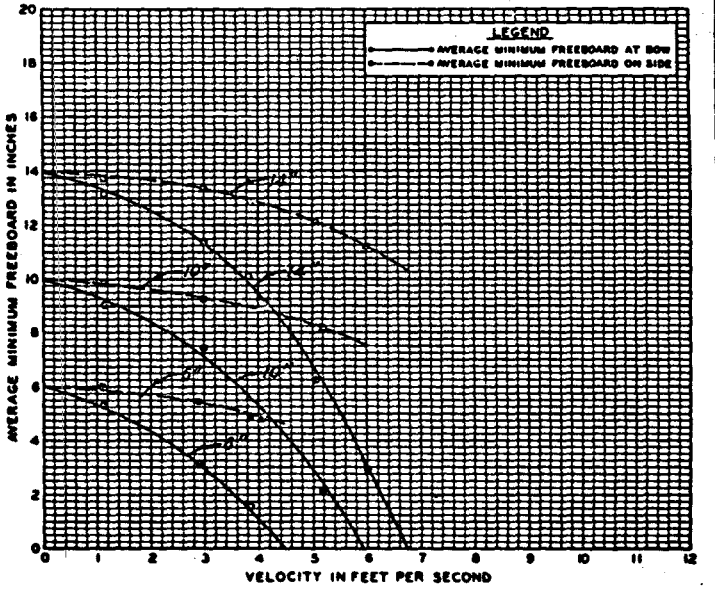
SUMMARY OF RESULTS

TYPES 1-12 ATTACHMENTS
VELOCITY = 7.3 FT PER SEC

PLATE 20







TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

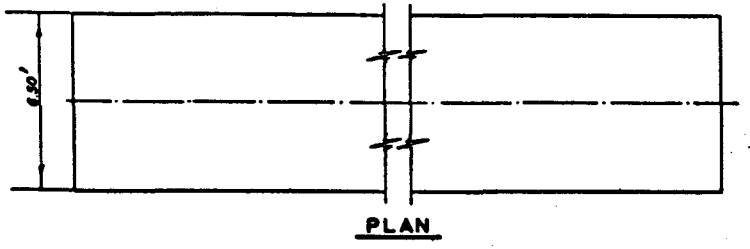
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE, A

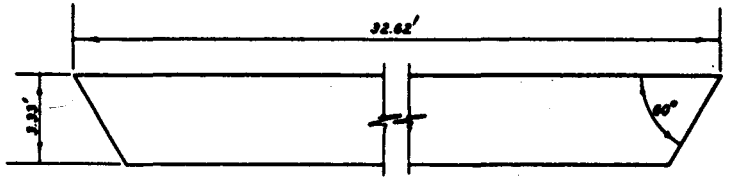
SCALE

2 1 0 2 4 6 8 10 FEET

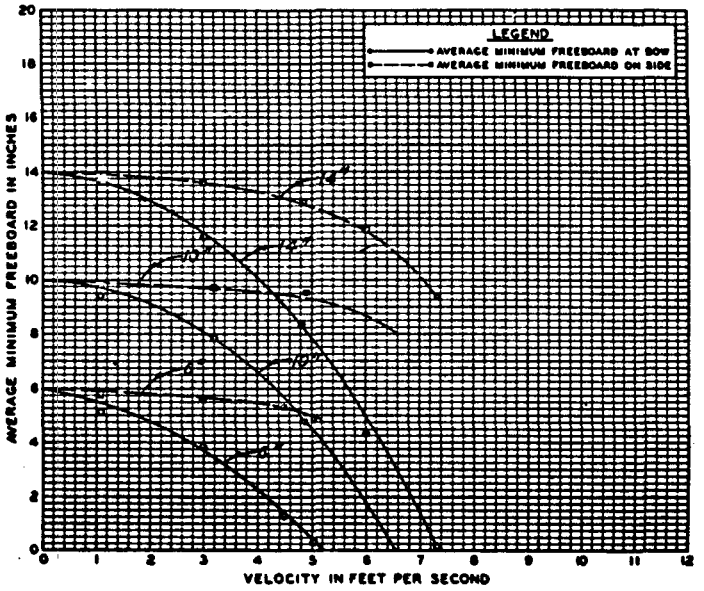
PLATE 21



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

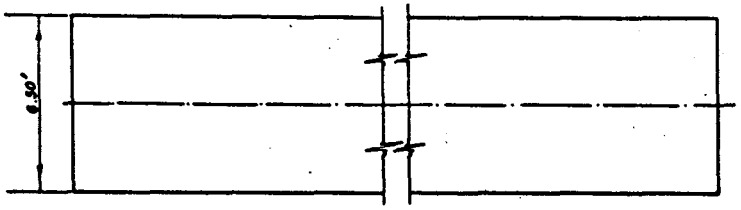
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE B

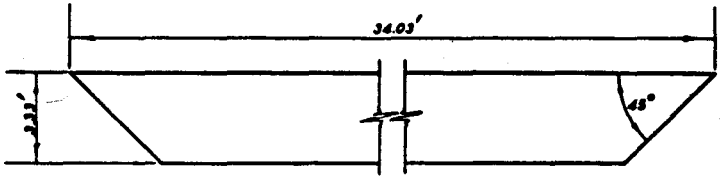
SCALE

2 1 0 2 4 6 8 10 FEET

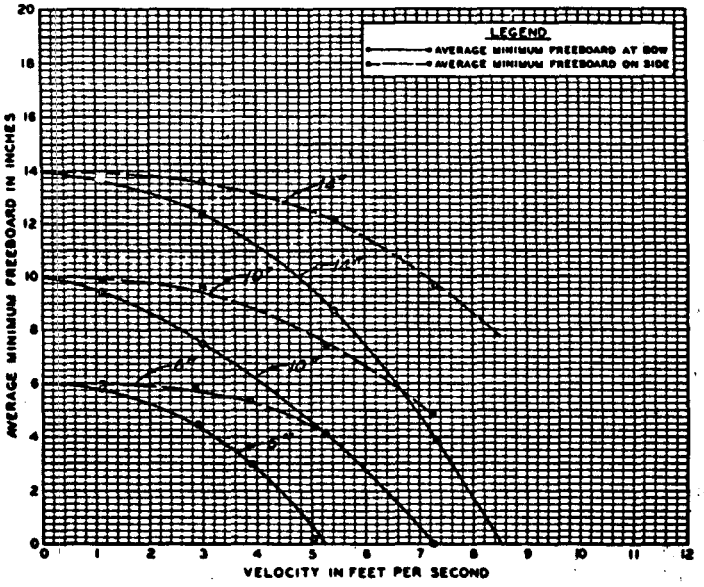
PLATE 22



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

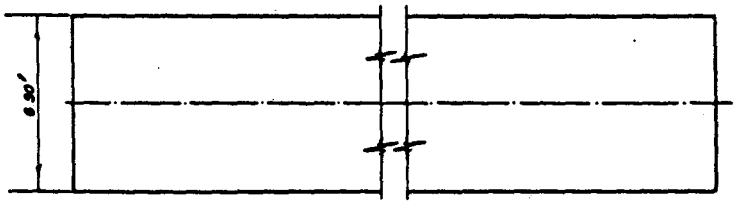
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE C

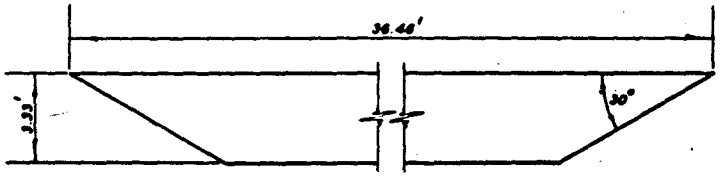
SCALE

0 1 0 2 4 6 8 10 FEET

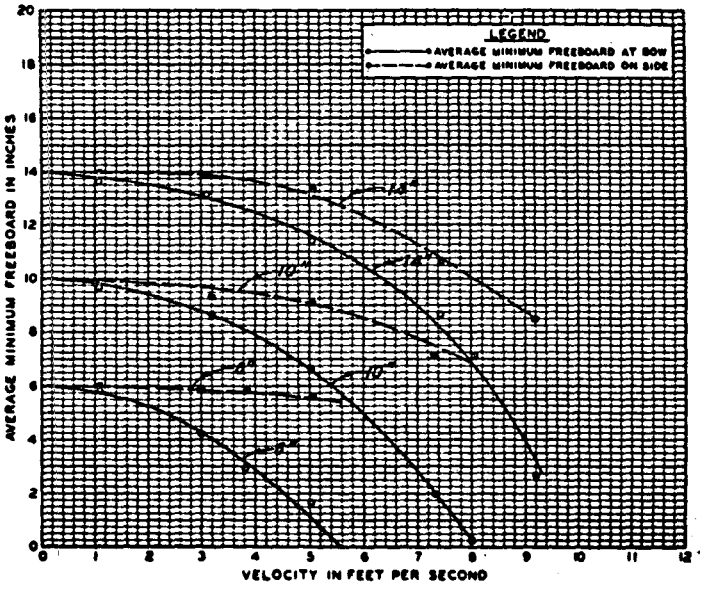
PLATE 23



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 8 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

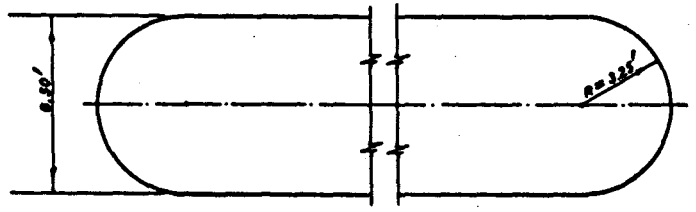
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE D

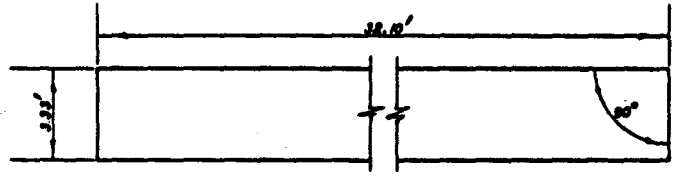
SCALE

2 1 0 2 4 6 8 10 FEET

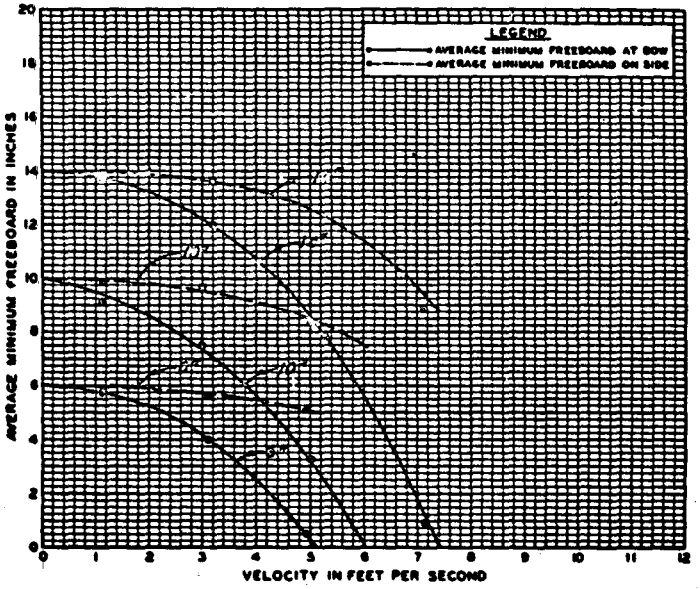
PLATE 24



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

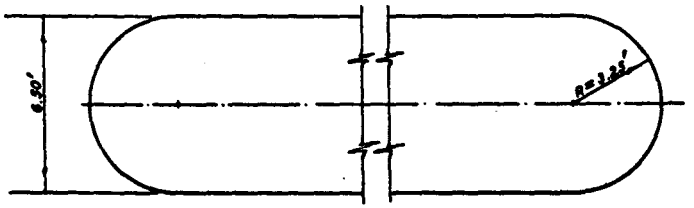
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE E

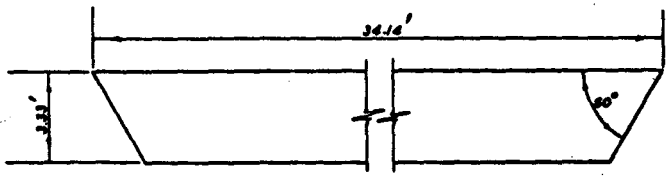
SCALE

2 1 0 2 4 6 8 10 FEET

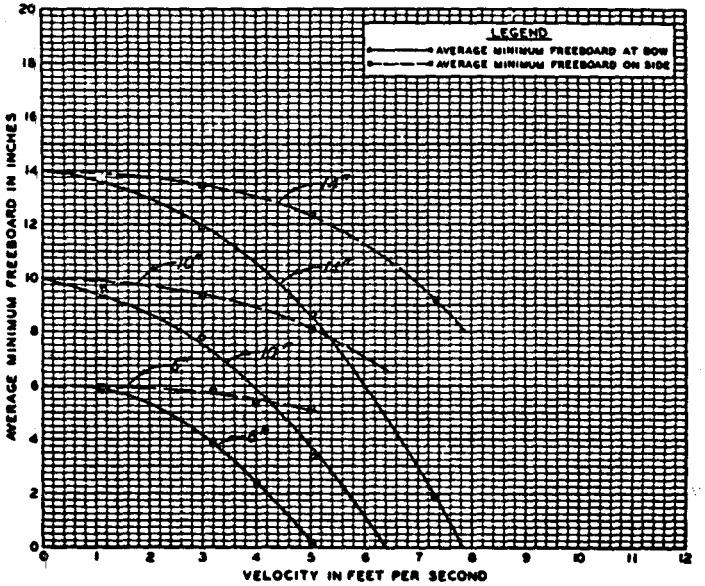
PLATE 25



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

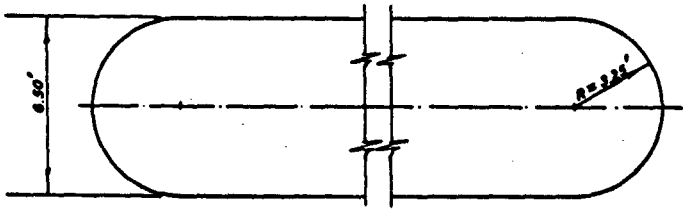
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE F

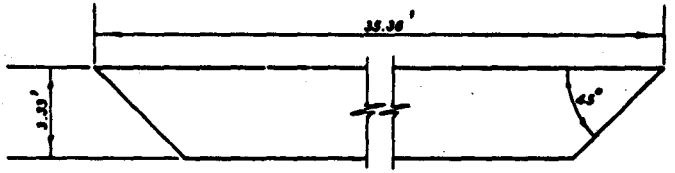
SCALE

2 1 0 2 4 6 8 10 FEET

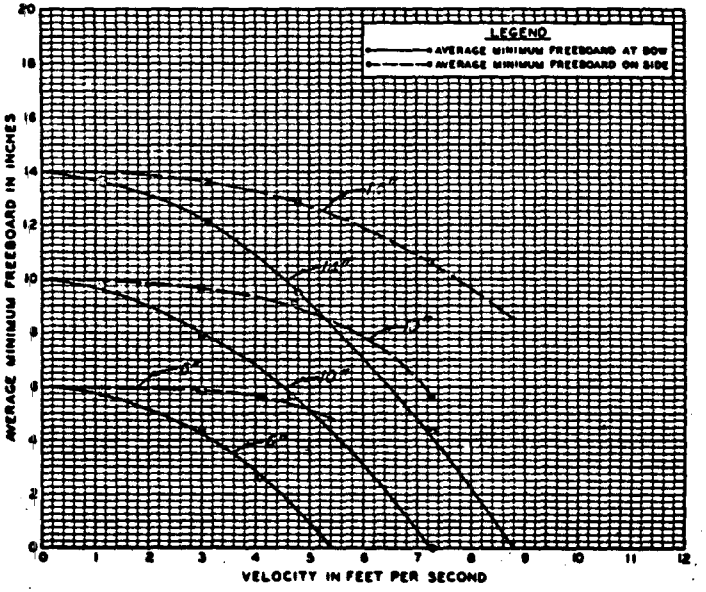
PLATE 26



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

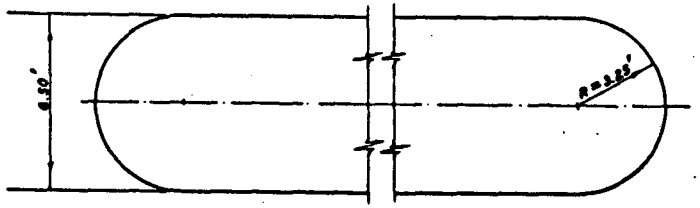
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE G

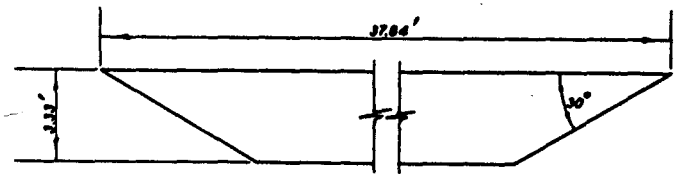
SCALE

2 1 0 2 4 6 8 10 FEET

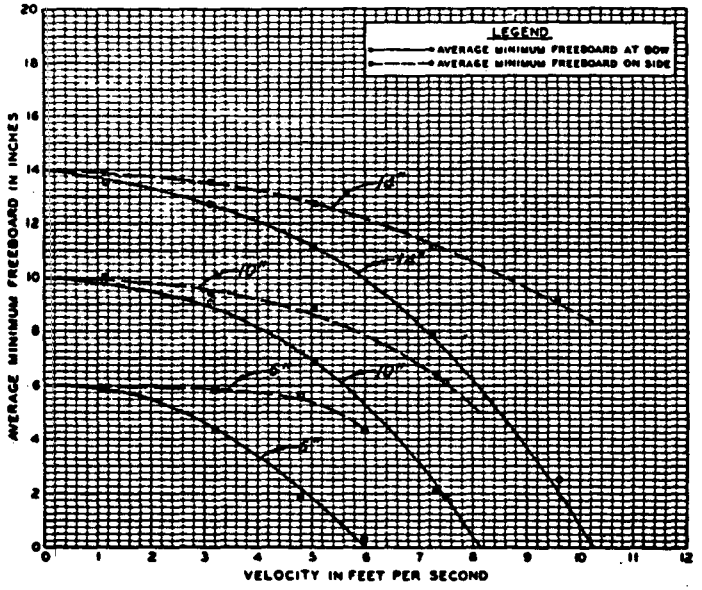
PLATE 27



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

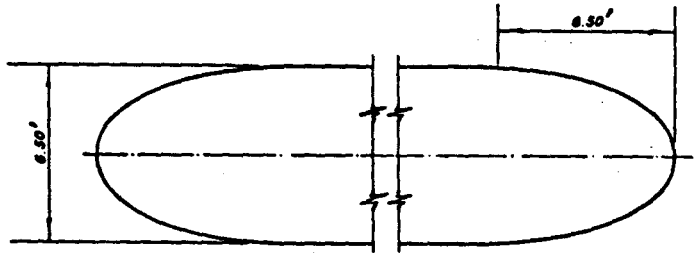
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE H

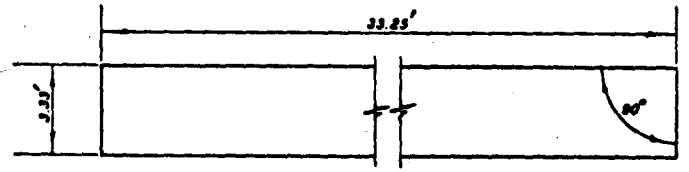
SCALE

2 1 0 2 4 6 8 10 FEET

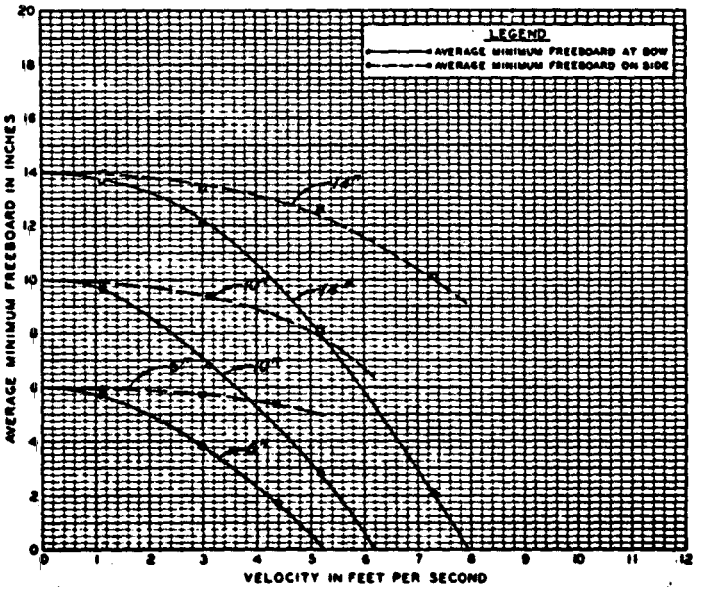
PLATE 28



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

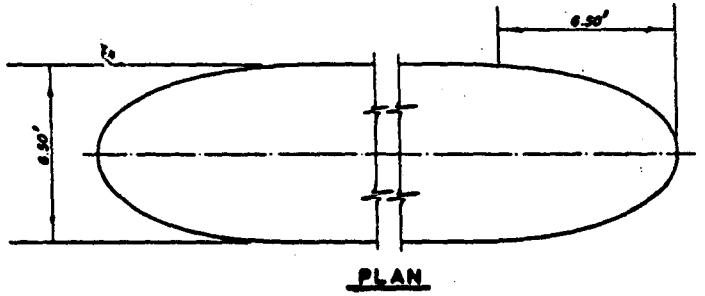
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

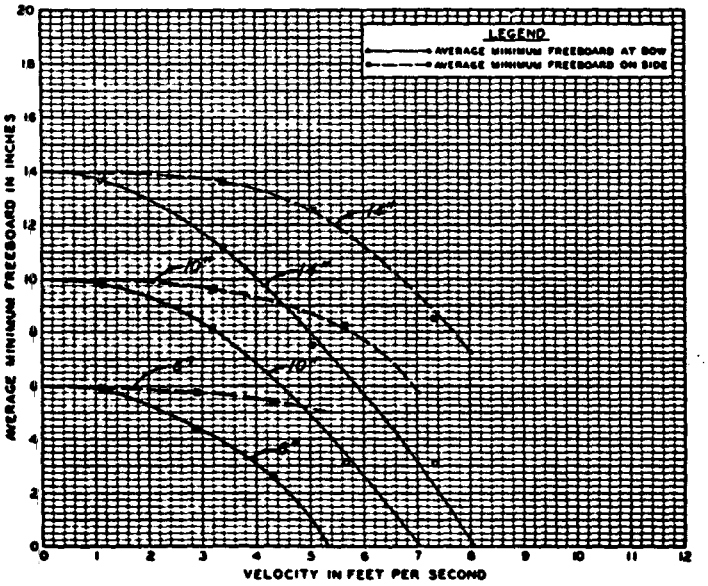
DESIGN FOR NEW PONTON—TYPE I

SCALE

2 1 0 2 4 6 8 10 FEET

PLATE 29





TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

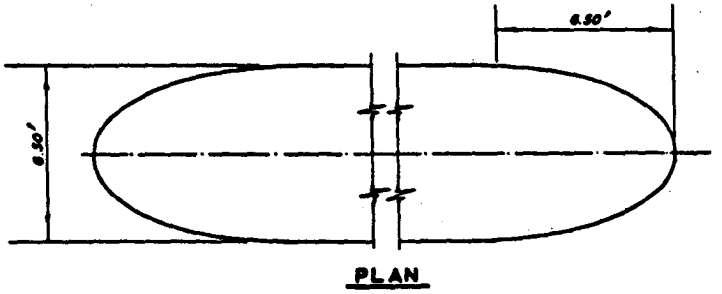
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE J

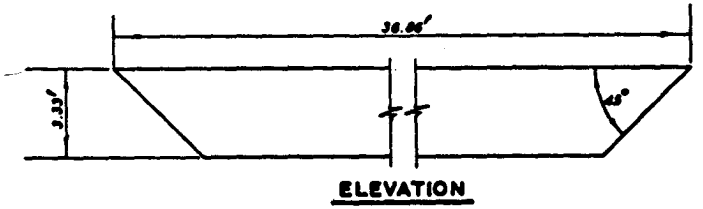
SCALE

2 1 0 2 4 6 8 10 FEET

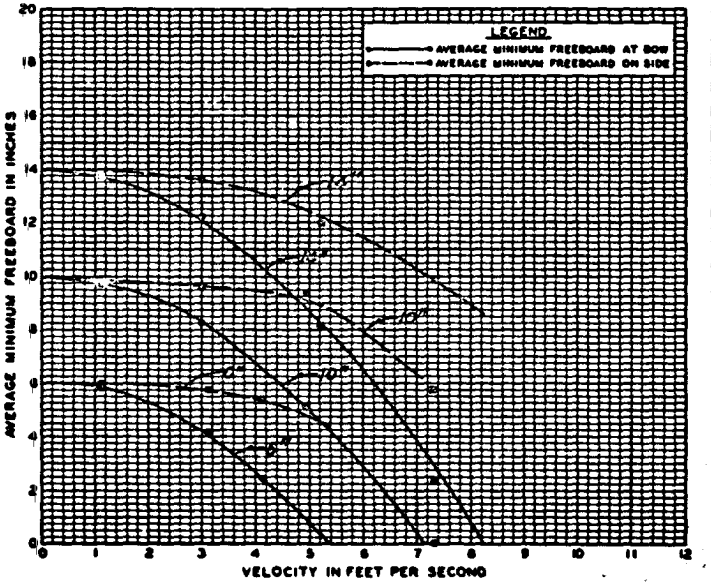
PLATE 30



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

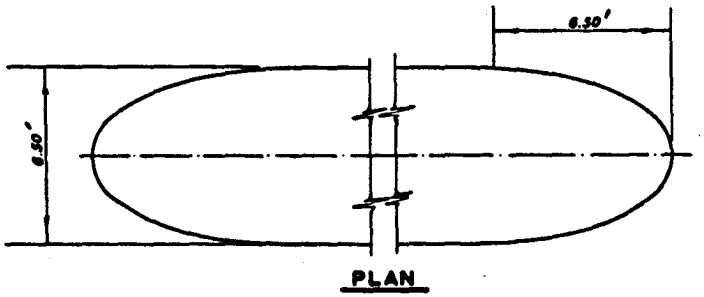
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE K

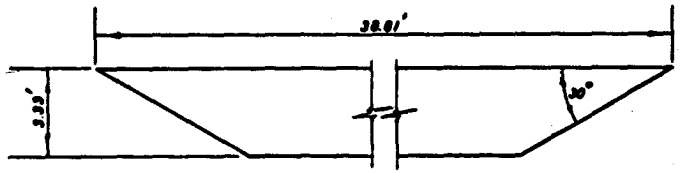
SCALE

2 1 0 2 4 6 8 10 FEET

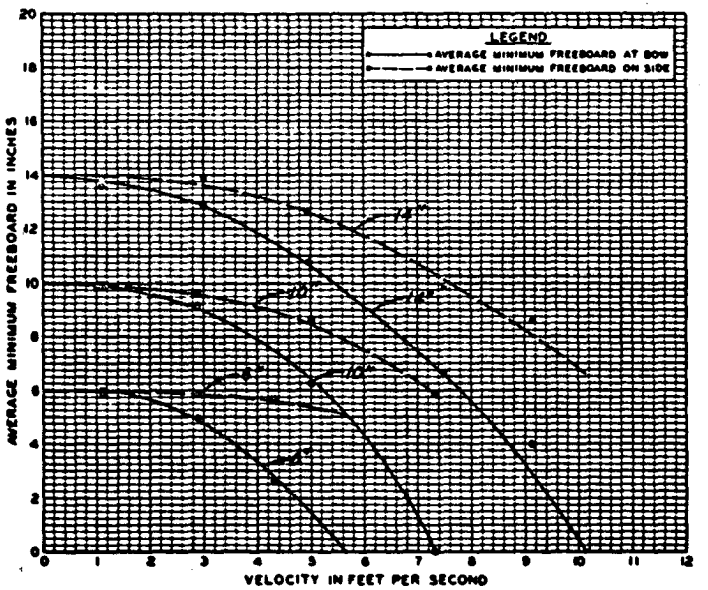
PLATE 31



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

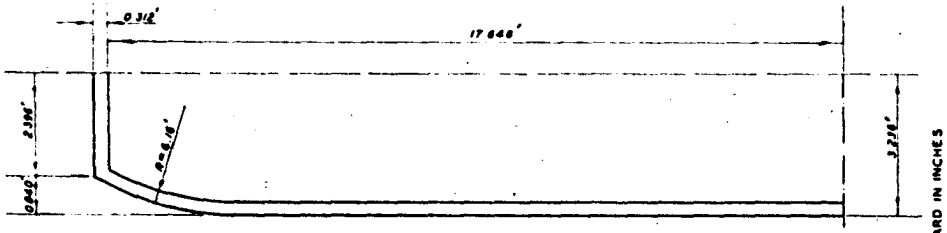
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON-TYPE L

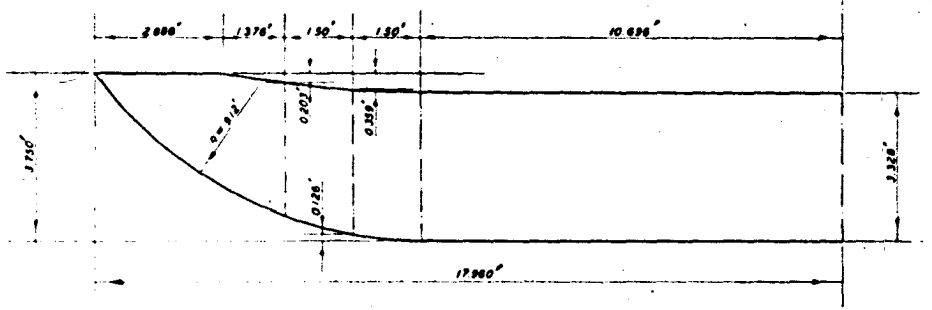
SCALE

PLATE 32

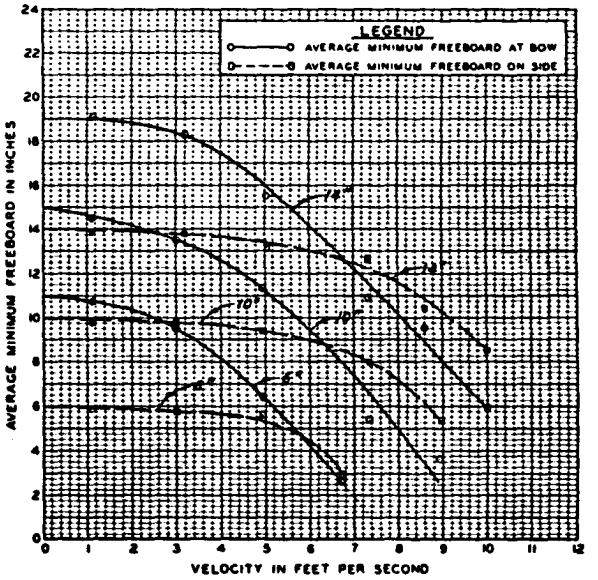


PLAN

SYMMETRICAL ABOUT CENTERLINE



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

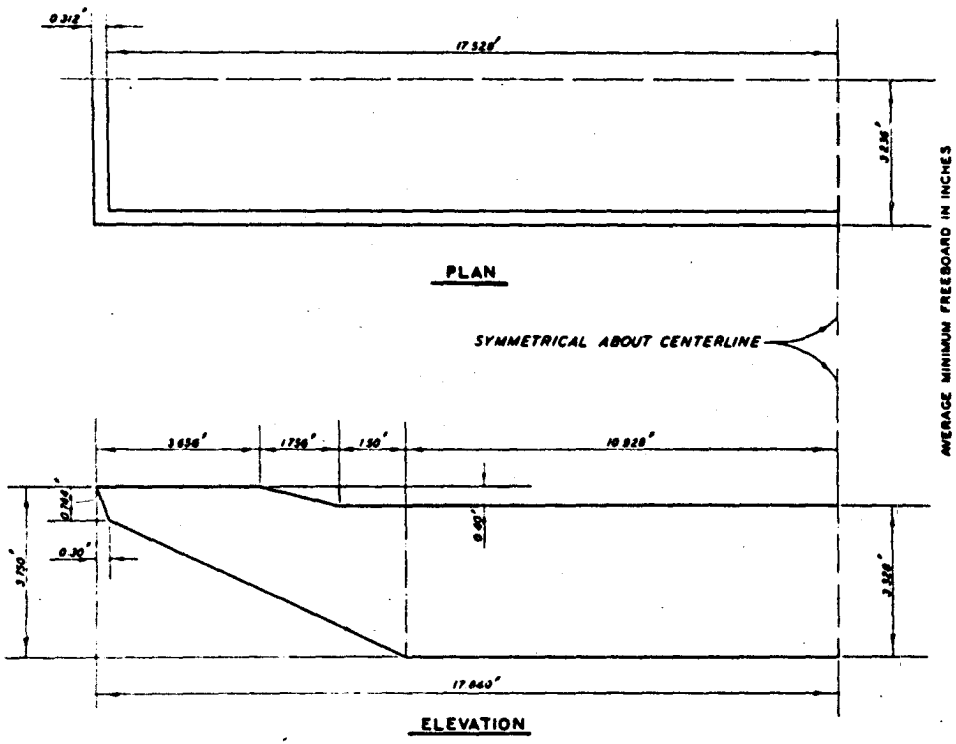
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

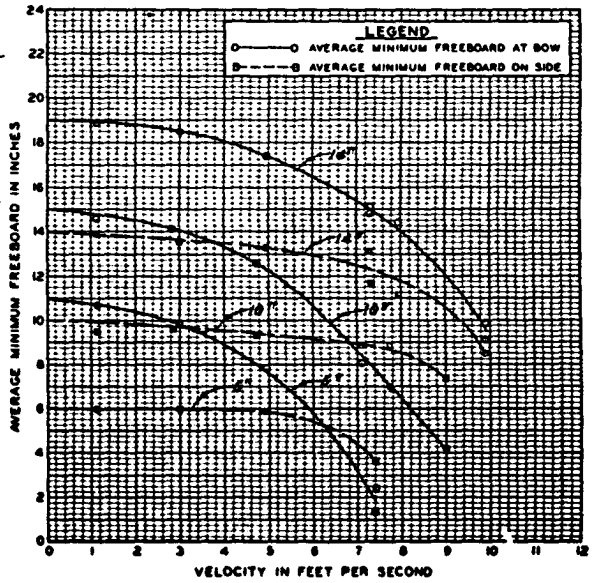
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE I

SCALE
1 0 1 2 3 4 5 FEET

PLATE 33





TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 16, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

PONTONS AND PNEUMATIC FLOATS

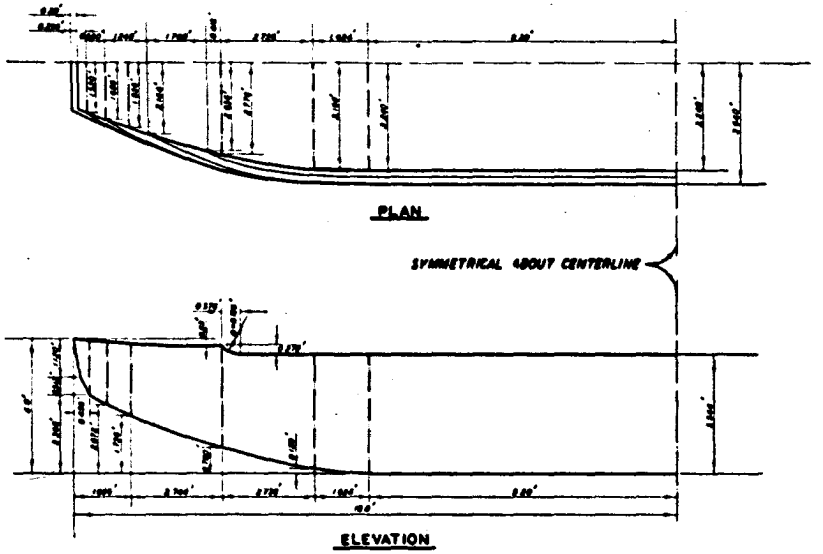
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

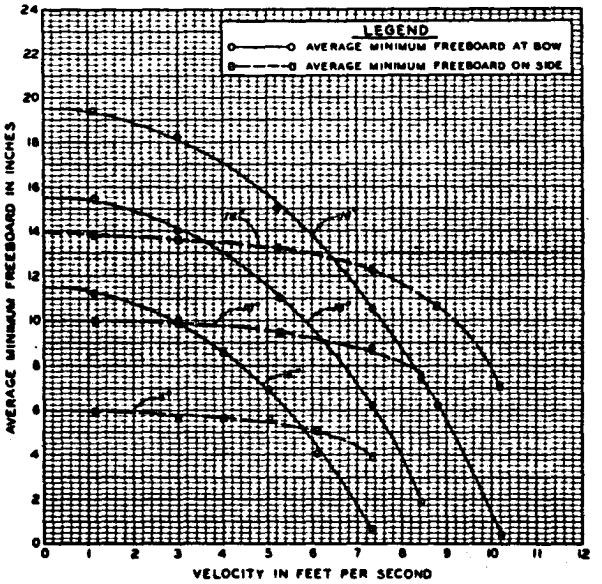
DESIGN FOR NEW PONTON—TYPE 2

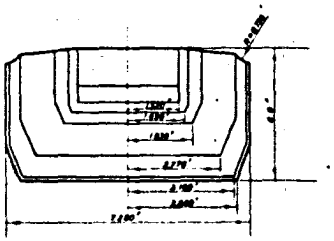
SCALE

1 0 1 2 3 4 5 FEET

PLATE 34







TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

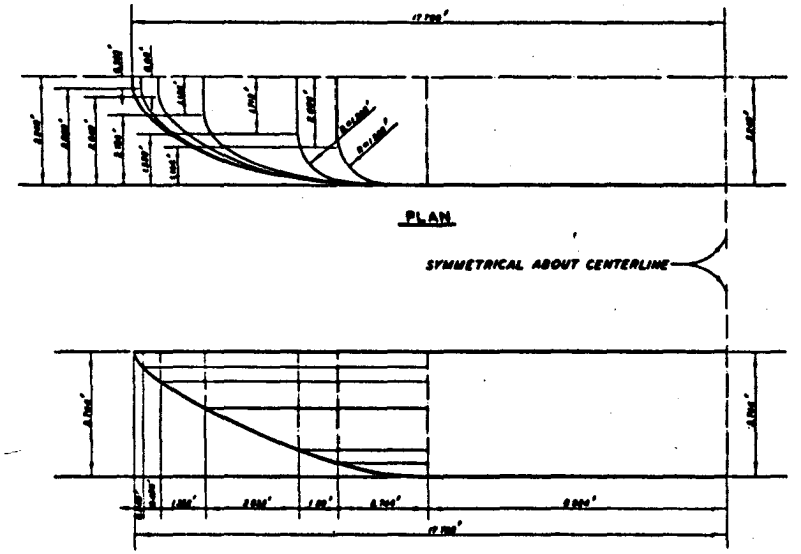
PONTONS AND PNEUMATIC FLOATS

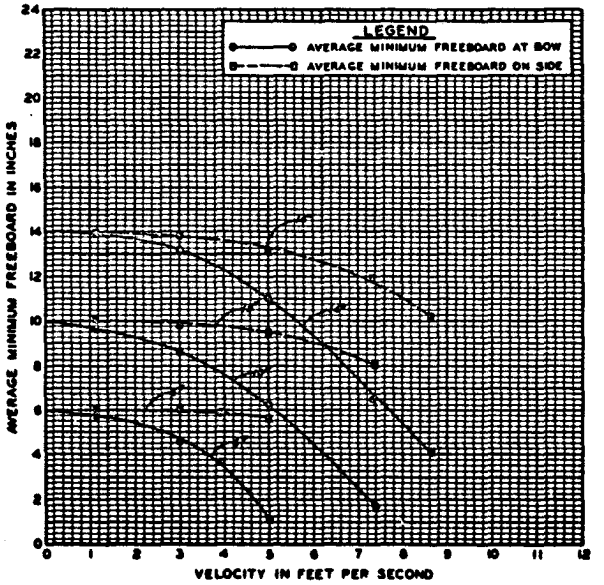
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

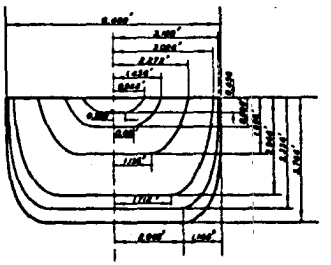
DESIGN FOR NEW PONTON—TYPE 3

SCALE

PLATE 35







TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES; RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

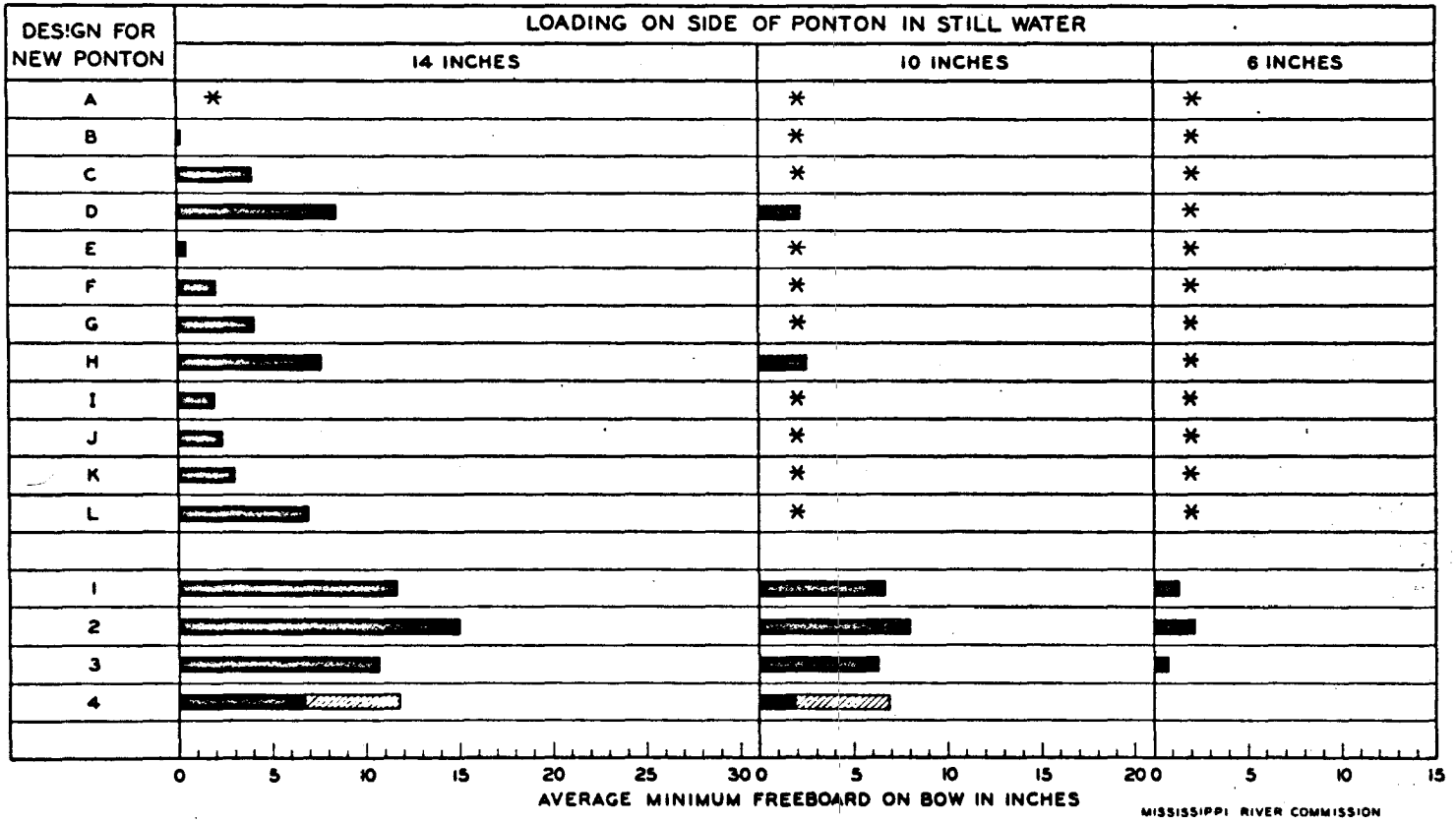
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

DESIGN FOR NEW PONTON—TYPE 4

SCALE

PLATE 36



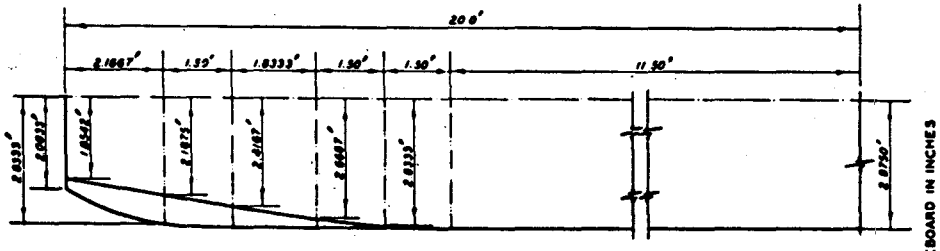
* ZERO FREEBOARD EXISTED BEFORE A VELOCITY OF 7.3 FT PER SEC WAS REACHED.

▭ INCREASED FREEBOARD CONSIDERING BOW HEIGHT RAISED 5 INCHES ABOVE SIDE AS IN PREVIOUS PONTON DESIGNS

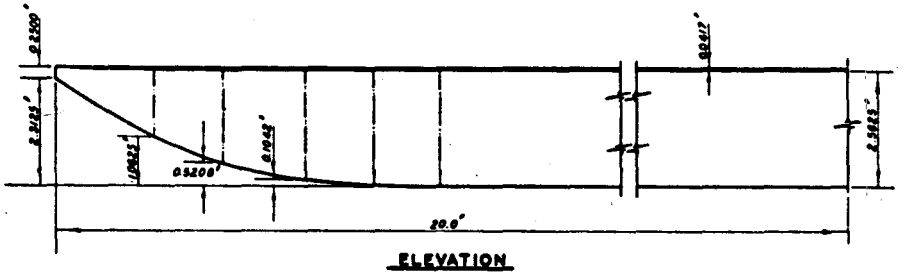
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

SUMMARY OF RESULTS
DESIGN FOR NEW PONTON TYPES A-L AND TYPES 1-4
VELOCITY = 7.3 FT PER SEC

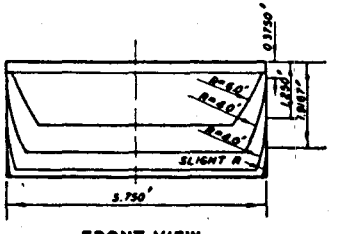
PLATE 37



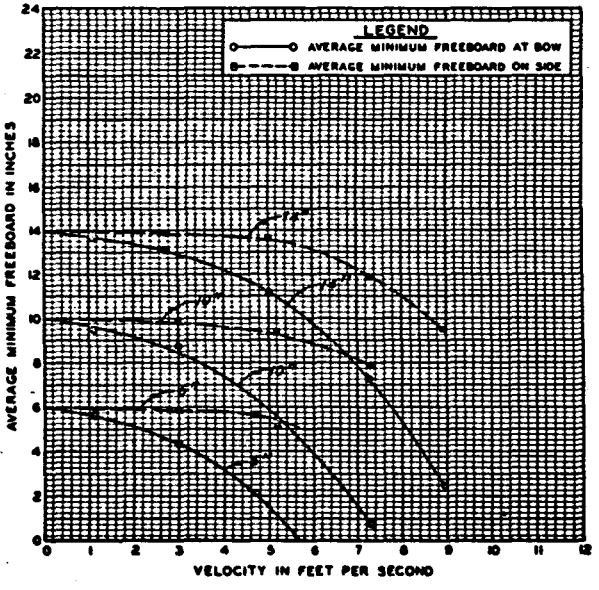
PLAN



ELEVATION



FRONT VIEW



TEST CONDITIONS

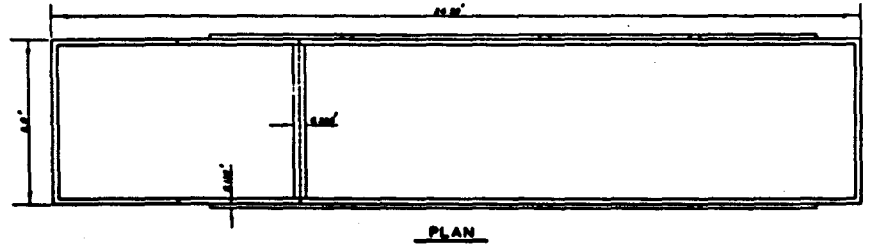
PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.
PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.
LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW
DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

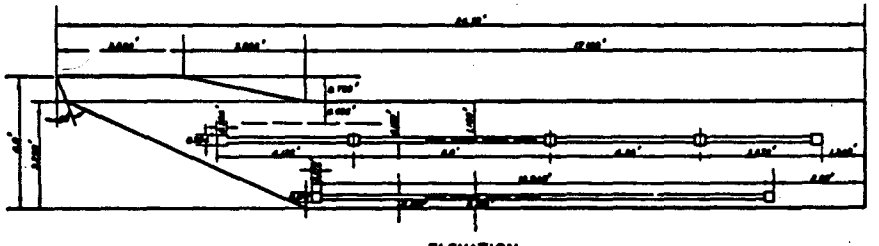
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES BRITISH PONTON MARK V

SCALE

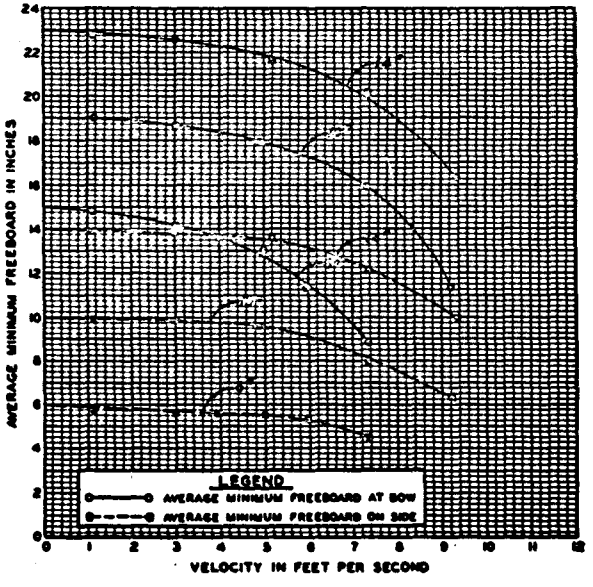
PLATE 38



PLAN



ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

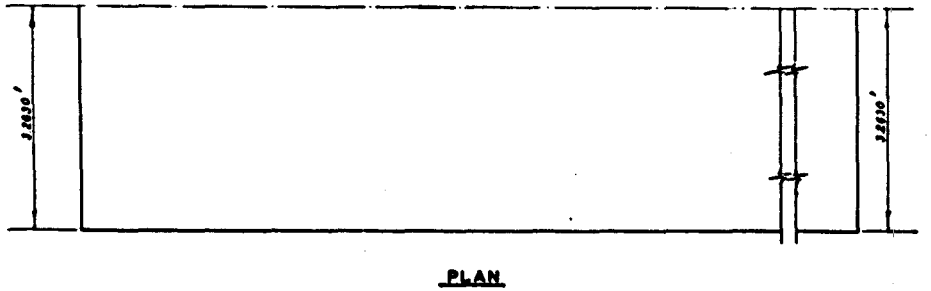
PONTONS AND PNEUMATIC FLOATS

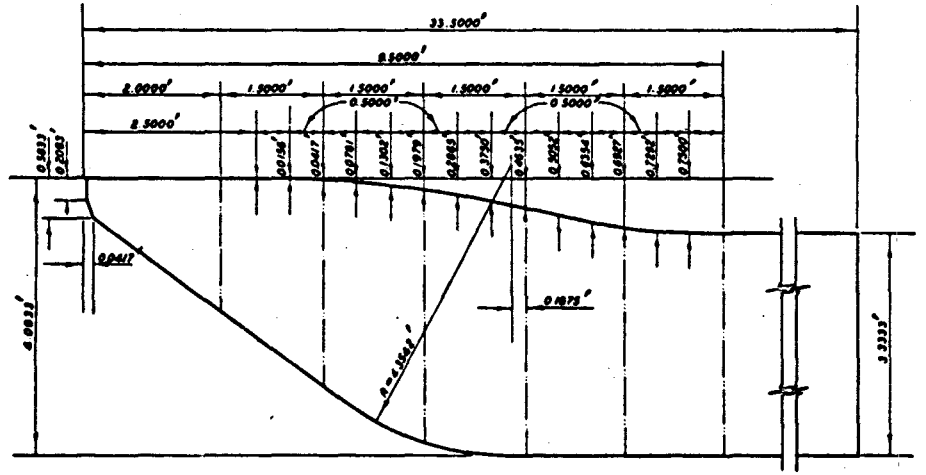
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

GERMAN PONTON

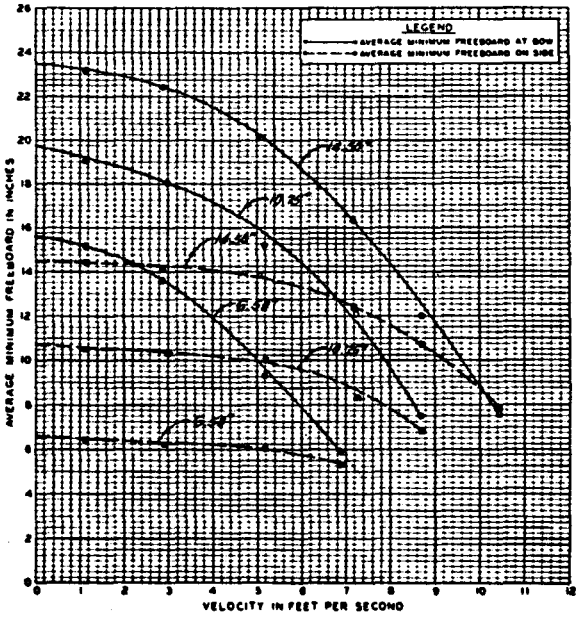
SCALE

PLATE 39





ELEVATION



TEST CONDITIONS

PONTON LOADED IN STILL WATER TO FREEBOARD OF 14.50, 10.75, AND 6.50 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

PONTON ANCHORED BY LINE OVER BOW CONNECTED TO CAPSTAN

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION

U. S. WATERWAYS EXPERIMENT STATION

MODEL STUDY OF

PONTONS AND PNEUMATIC FLOATS

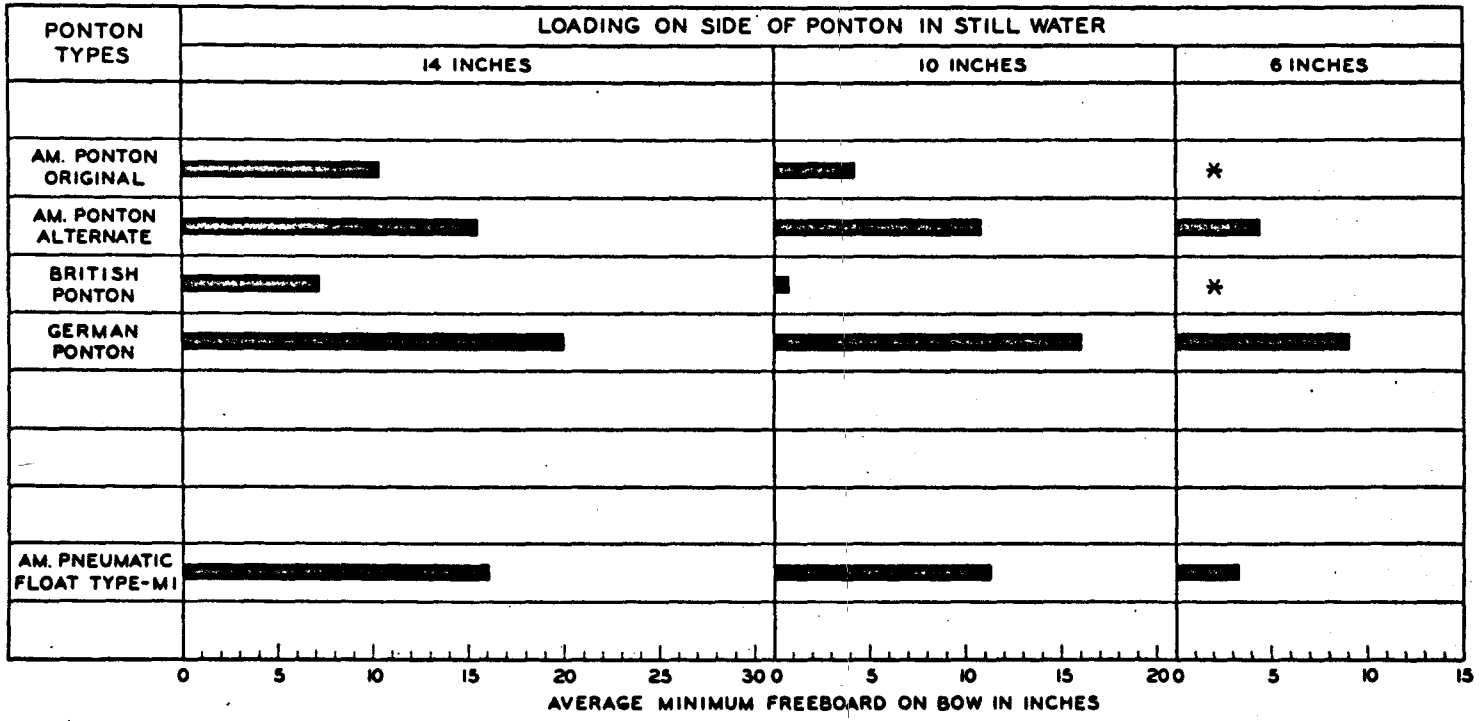
AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

AMERICAN 25-TON PONTON—ALTERNATE DESIGN

SCALE

0 1 2 3 4 FEET

PLATE 40



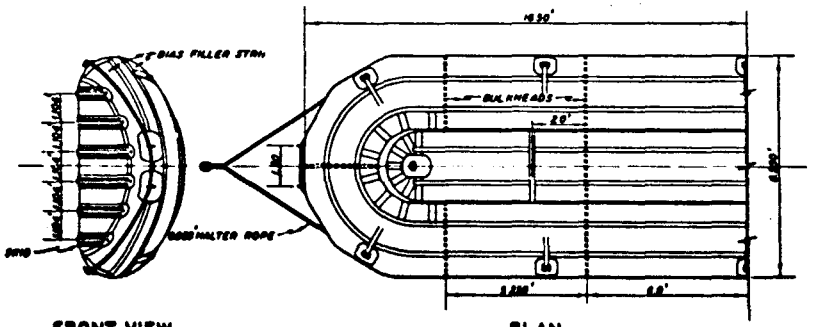
* ZERO FREEBOARD EXISTED BEFORE A VELOCITY OF 7.3 FT PER SEC WAS REACHED.

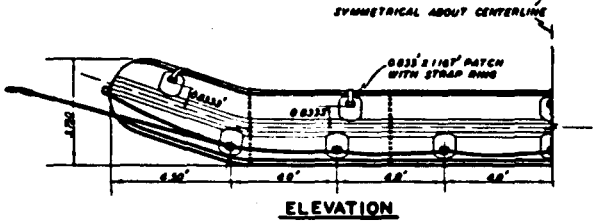
MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

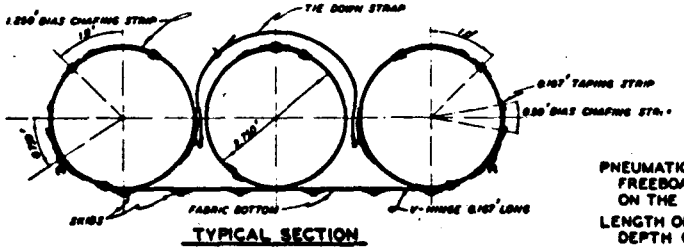
COMPARISON OF PONTON TYPES

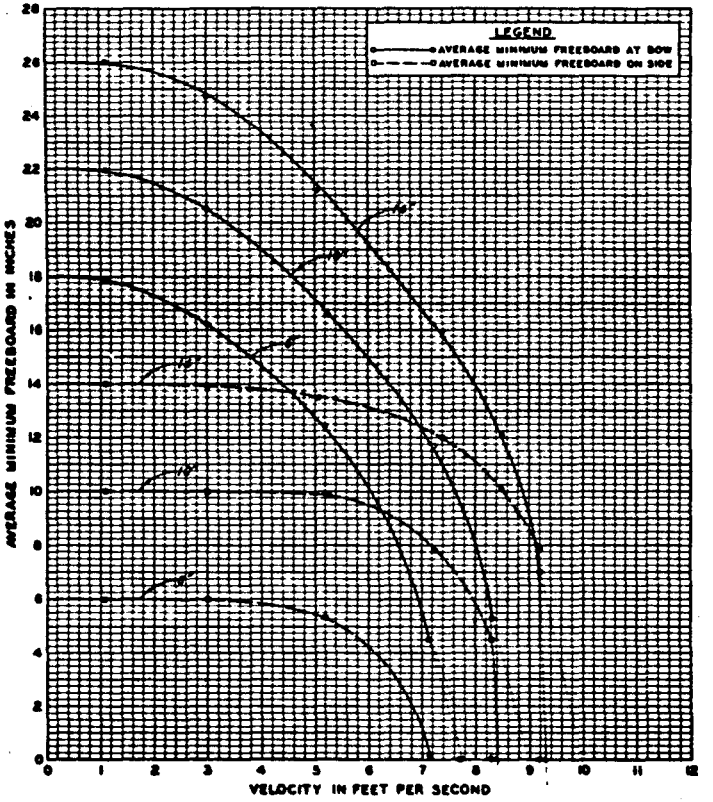
VELOCITY = 7.3 FT PER SEC

PLATE 41









TEST CONDITIONS

PNEUMATIC FLOAT LOADED IN STILL WATER TO FREEBOARD OF 14, 10, AND 6 INCHES, RESPECTIVELY, ON THE SIDE AT START OF TEST.

LENGTH OF ANCHOR LINE EQUALS 10 TIMES DEPTH OF FLOW.

DEPTH OF FLOW EQUALS 20 FEET.

MISSISSIPPI RIVER COMMISSION
U. S. WATERWAYS EXPERIMENT STATION
MODEL STUDY OF
PONTONS AND PNEUMATIC FLOATS

AVERAGE MINIMUM FREEBOARD VELOCITY CURVES

33FT PNEUMATIC FLOAT—M I

SCALE

PLATE 42