The present invention relates to an improved floating wharf structure made up of a plurality of concrete float units wherein the walkway is provided by the top surfaces of the float units themselves.

In my patent No. Re. 24,837, issued June 14, 1960, there is shown a floating wharf structure made up of concrete float units. These float units each take the form of a waterproof, hollow box whose top, bottom, side and end walls are made of reinforced concrete. Along each side of the box and adjacent to its top surface there is provided a row of bolts which are embedded in the concrete and protrude outwardly. A number of aligned individual float units are fastened together by utilizing wooden tie rails placed along the sides of the float units and secured to the bolts.

It is a major object of the present invention to provide an improved floating wharf structure of the above nature wherein cross rods are utilized as fastening means rather than bolts and the tie rails are fastened to the individual float units by such cross rods in a unique manner. Another object of the present invention is to provide an improved floating wharf structure of the above nature utilizing a unique tie rail arrangement.

Another object of the present invention is to provide a floating wharf structure of the abovementioned nature having maximum structural strength for a given weight and size. A further object of the present invention is to provide a floating wharf structure of the aforementioned nature capable of affording a long and trouble-free service life, and having a low initial cost.

The present invention has the following other objects and advantages: The present invention will become apparent from the following detailed description, when taken in conjunction with the appended drawings wherein:

- FIGURE 1 is a perspective view of an improved floating wharf structure embodying the present invention, with the center portion thereof cut away so as to show the interior of such structure;
- FIGURE 2 is a top plan view of a separate float unit of such floating wharf structure, such view being in enlarged scale relative to FIGURE 1;
- FIGURE 3 is a vertical sectional view taken along line 3–3 of FIGURE 2;
- FIGURE 4 is a central vertical sectional view taken through one of the individual float units of FIGURES 2 and 3;
- FIGURES 5 and 6 are diagrammatic showings of the forces created when a floating wharf structure of the type contemplated by the present invention is struck by a moving object such as a boat; and
- FIGURE 7 is a vertical sectional view taken on line 7–7 of FIGURE 6.

Referring to the drawings and particularly FIGURE 1 thereof, there is shown a preferred form of floating wharf structure constructed in accordance with the present invention. This structure includes separate float units F-1, F-2, and F-3, the right-hand side of float F-3 being broken away. These float units are aligned to provide a wharf or other like marine structure which may be of the type shown in my patent mentioned above. The float units F-1, F-2, and F-3 are tied together in aligned relationship by means of a plurality of parallel tie rails T-1 and T-2. The tie rails T-1 and T-2 are fastened to the sides of the separate float units by a plurality of cross rods that extend transversely through the upper interior of each of such float units.

More particularly, each of the separate float units F-1, F-2, and F-3 are substantially identical and consist essentially of a hollow box whose length and width are substantially greater than its depth. The top, bottom, side and end walls of such box are made of reinforced concrete. A top slab 12 and a bottom slab 14 are parallel to one another since the box has a uniform depth throughout. End walls 16 and 18 integrally interconnect the top and bottom portions of the box, with the basic structure being completed by side walls 20 and 22.

The concrete box units may be formed by any suitable method known to those skilled in the art. Thus, such units may either be of cast monolithic construction or alternatively they may be assembled from separate elements. Generally, it is desirable to reinforce the concrete walls as well as the top slab by corrosion-resistant wire mesh screen 30, or other reinforcing filaments.

Preferably, a reinforced concrete flange 31 protrudes outwardly from the sides of the box. A similar flange 32 protrudes from the ends thereof. These flanges provide an extension of the top surface of the box. Alternatively, these flanges may be formed on the inner portion of the upper walls of the box. The flanges 31 and 32 protect the top slab 12 from bending or breaking and also form a bumper means to receive impacts, as where a boat is being docked.

Referring particularly to FIGURE 3, the opposite ends of the cross rods 10 are disposed within aligned sleeves 34 and 36 which may be cast into the side flanges 31. The rods 10 are of metallic construction, as by way of example, galvanized steel. Suitable nuts 38 are adapted to be threaded upon the opposite ends of each of the rods 10. Washers (not shown) may additionally be employed. It should be particularly noted that the top slab 12 is provided with an integral depending reinforcing rib 40 above each of the rods 10.

The tie rail T-1 is made up of a pair of abutting stringers 42 and 44. Similarly, the tie rail T-2 is made up of a pair of abutting stringers 46 and 48. These stringers are fabricated from a suitable wood, such as treated Douglas fir. As is well known, stringers of this nature are commercially obtainable in standard lengths of 16 feet. Although it is possible to obtain longer lengths, the cost of such longer lengths is generally prohibitive. It is an important feature of the present invention that the stringers 42, 44, 46 and 48 have their ends staggered, the stringers being of a length approximately twice the length of each float unit, the joints between the ends of the stringers being longitudinally staggered a distance approximately the length of each of the floats. Thus, referring to FIGURE 1, the outer stringers 42 and 48 extend from the left-hand end of the float F-1 to the midportion of the float F-2, as indicated by the joints 50 and 52. The endmost inner stringers 44 and 46 extend from the left-hand end of the float F-1 to the midportion thereof, as indicated by the joints 54 and 56. The next lengths of the inner stringers 44 and 46 extend from the joints 54 and 56 past the right-hand end of the float F-2 and abut other inner stringers at the sides of the float F-3, e.g. near the midpoint thereof, at junctions not shown. Hence, the joints between the ends of the stringer pieces are longitudinally staggered.

This arrangement insures maximum strength for the floating wharf structure. It is this arrangement that causes any laterally directed load such as the impact of a moving boat to be transferred to the floating wharf structure in compression. If the inner and outer stringers had their joints in lateral alignment the imposition of a laterally directed load could easily rupture such joint and cause the load to be applied to the floating wharf.
3. structure in tension. Concrete, as is well known, has little strength in tension but very substantial strength in compression. Thus, it is extremely desirable to avoid imposing tension upon a concrete structure of this nature. A way of example, attention is directed to FIGURES 5 and 6. These figures represent a diagrammatic showing of the forces created when a laterally directed load, such as would be applied by a moving boat B, strikes one side of a floating wharf structure of this type. In FIGURE 5 the tie rails T'-1 and T'-2 are made up of stringers having their joints in longitudinal alignment. These joints are indicated by the reference numerals 64 and 66, respectively. When a moving object such as a boat B strikes the tie rails T'-2 a sharp laterally directed load is applied against the float unit F-2 adjacent the point of impact 68. The load is in turn transferred across the float unit F-2 to the opposite tie rail T-1 (upwardly relative to the drawings). So long as the joint 64 retains its integrity the tie rail T-1 will remain substantially parallel with its respective side of the float F-2. If, however, the joint 64 is ruptured the tie rail T-1 will no longer be able to restrain movement of the float unit F-2 away from the moving boat B. The side of the float unit F-2 adjacent the tie rail T-1 will then be placed in tension as indicated by the double-headed arrows in the upper portion of FIGURE 5. The application of this tensile force may readily rupture the concrete, as indicated at 70, inasmuch as concrete has very little strength in tension.

Referring now to FIGURE 6, there is shown a floating wharf structure wherein the joints between the tie rail stringers are longitudinally staggered in the manner indicated particularly in FIGURE 1. With this arrangement, the laterally directed load applied by a moving object such as a boat B is transferred in compression across the float F-2. The tie rail T-1 in the case of FIGURE 6 will take the tension and will restrain lateral movement of the float unit in a direction away from the boat B. Because of the improved strength where the joints in the tie rail stringers are longitudinally staggered rather than being in-line, the tie rail T-1 can resist considerably more force than if the joints were longitudinally aligned as in the case of the structure of FIGURE 5. Thus, the tie rail T-1 will hold under almost any normal situation.

It is important to note that the tie rail T-1 will impose solely a compressive load upon the adjacent side of the float F-2, as indicated by the arrows in the upper portion of FIGURE 6. In this regard attention is now directed to FIGURE 7. As shown in this figure any tendency of the tie rail T-1 to be displaced outwardly (to the left in this figure) will be resisted by the cross rods 10, the latter being placed in tension. This tensile force will be transferred by the cross rods 10 across the float unit to the inner stringer 46 so as to urge such stringer to the left. The stringer's movement will be resisted by the reinforced upper portion of the side wall 22 and more particularly by the top slab and its depending reinforcing ribs 40, such members being placed in compression. In this regard, it should be noted that the positioning of the cross rods 10 below the ribs 40 of the top slab provides maximum strength for the top slab adjacent the cross rods. Also, that the cross rods 40 serve as tension transfer elements in that they transfer tensile forces from the tie rails on one side to the tie rails on the opposite side.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention or the scope of the following claims.

I claim:
1. A floatable wharf structure for use on a body of water subject to wave action, said wharf structure comprising a plurality of wide float units of shallow depth each comprising concrete bottom and top walls joined by concrete side and end walls to form a chamber of sufficient size to provide buoyancy to such float unit, said float units being aligned end to end in adjoining relation in a single series, each float having opposed pairs of axially-aligned openings through said side walls opening inwardly on said chamber, the outer ends of said openings opening outwardly of said side walls; and said float units in such means for flexibly interconnecting said float units in such aligned end to end series with the ends of adjacent float units closely adjacent and with the float units of said series capable of undergoing relative deflection due to said wave action, said connection means including two long narrow flexible tie rail means each of said means comprising only a small fraction of the width of said float units respectively on opposite sides of said aligned float units extending continuously from end to end of said series and being of substantially uniform cross-sectional area throughout their lengths, a plurality of transverse tension elements extending across each float unit at anchor positions spaced therealong, each tie rail means being formed of inner and outer stringer means each formed of wooden stringers disposed end to end with the joints between the ends of the stringers of the inner and outer stringer means being longitudinally staggered, wooden stringer means having a length approximately twice the length of each float unit, said joints being staggered a distance approximately the length of each of said float units, each stringer having openings in each of the respective halves thereof receiving tension elements of two adjoining float units, and enlargements on the ends of each tension element respectively bearing against said tie rail means, said enlargements placing said tension elements in tension and holding the tie rail means firmly to the sides of said float units at said anchor positions and in sealing relationship with said outer ends of said side-wall openings while placing the concrete of said float units between said enlargements in compression, the flexibility of said rail means between the closest anchor positions of adjacent float units of said series permitting said relative deflection in response to wave action.
2. A floatable wharf structure as defined in claim 1 including sleeve means cast in the opposed side walls of each float unit with axes extending laterally of said float unit, said sleeve means forming said axially aligned openings, the outer ends of said sleeve means engaging said tie rail means, said sleeve means having passages only slightly larger than the corresponding tension elements to receive same.
3. A floatable wharf structure as defined in claim 1 in which the opposed side walls of each float unit include members of aligned sleeves cast in and transversing such walls and opening on said chamber, said aligned sleeves forming said axially aligned openings, the aligned sleeves of each pair having passages only slightly larger than a corresponding tension element to receive same.
4. A floatable wharf structure for use on a body of water subject to wave action, said wharf structure comprising: a plurality of float units each comprising concrete bottom and top walls joined by concrete side and end walls to form a chamber of sufficient size to provide buoyancy to such float unit, each float unit being joined with a reinforcing flange adjacent the junction of the side wall and said top wall, the top wall of each float unit including a plurality of transverse concrete reinforcing ribs depending in said chamber and extending between the opposed side walls of the float unit; and connection means for flexibly interconnecting said float units in said aligned end to end series with the ends of adjacent float units closely adjacent and with the float units of said series capable of undergoing relative deflection due to said wave action, said connection means including two long flexible tie rail means respectively on opposite sides of said aligned float units extending continuously from end to end of said series, each tie rail means including inner and outer stringer means each formed of stringers disposed end to end with the joints between the ends of
6. A floatable wharf structure for use on a body of water subject to wave action, said wharf structure comprising: a plurality of float units each comprising concrete bottom and top walls joined by concrete side and end walls to form a chamber of sufficient size to provide buoyancy to such float unit, connection means for flexibly interconnecting said float units in aligned end-to-end series with the ends of adjacent float units closely adjacent and with the float units of said series capable of undergoing relative deflection due to wave action, said connection means including two long flexible tie rail means respectively on opposite sides of said aligned float units extending continuously from end to end of said series and being of substantially uniform cross-sectional area throughout their lengths, a plurality of transverse tension elements extending across each float unit through the chamber thereof at positions spaced therealong, said flexible tie rail means having openings aligned with the ends of said tension elements receiving same, and enlargements on the ends of each tension element respectively bearing against said tie rail means, said enlargements placing said tension elements in tension and holding the tie rail means firmly to the sides of said float units while placing the concrete of said float units between said enlargements in compression, the flexibility of said tie rail means permitting said relative deflection in response to wave action; and a number of longitudinally spaced concrete reinforcing ribs depending in the chamber of each float unit extending therethrough respectively above said tension elements and corresponding in number to such tension elements, each reinforcing rib extending between the opposed side walls of the float unit and being placed in compression by the tension in the corresponding tension element.

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the stringers of the inner and outer stringer means being longitudinally staggered, a plurality of transverse cross rods extending across each float unit through the chamber thereof at positions respectively below said concrete reinforcing ribs, said stringers having openings aligned with the ends of said cross rods receiving same, and enlargements on the ends of each cross rod bearing against said tie rail means, at least one of said enlargements comprising a nut threaded to the corresponding end of the cross rod to tension same and hold said tie rail means firmly to the sides of said float units while placing the intervening concrete in compression, the flexibility of said tie rail means between the closest cross rods of adjacent float units comprising the sole flexible connection thereof permitting said relative deflection in response to wave action.

5. A floatable wharf structure for use on a body of water subject to wave action, said wharf structure comprising: a plurality of float units each comprising concrete bottom and top walls joined by concrete side and end walls to form a chamber of sufficient size to provide buoyancy to such float unit; connection means for flexibly interconnecting said float units in aligned end-to-end series with the ends of adjacent float units closely adjacent and with the float units of said series capable of undergoing relative deflection due to said wave action, said connection means including two long flexible tie rail means respectively on opposite sides of said aligned float units extending continuously from end to end of said series and being of substantially uniform cross-sectional area throughout their lengths, a plurality of transverse tension elements extending across each float unit through the chamber thereof at positions spaced therealong, said flexible tie rail means having openings aligned with the ends of said tension elements receiving same, and enlargements on the ends of each tension element respectively bearing against said tie rail means, said enlargements placing said tension elements in tension and holding the tie rail means firmly to the sides of said float units while placing the concrete of said float units between said enlargements in compression, the flexibility of said tie rail means permitting said relative deflection in response to wave action; and a number of longitudinally spaced concrete reinforcing ribs depending in the chamber of each float unit extending therethrough respectively above said tension elements and corresponding in number to such tension elements, each reinforcing rib extending between the opposed side walls of the float unit and being placed in compression by the tension in the corresponding tension element.