REINFORCED CONCRETE VESSELS*

By Walter Pollock

DEVELOPMENT of reinforced concrete vessels is in a very embryonic stage and seagoing experience is practically nil. The war situation brings the question before shipowners and shipbuilders as one not to be lightly dismissed, and has resulted in close co-operation of naval architects with experts in concrete structures, to produce the best designs that present knowledge permits.

Three principal causes have been at work to direct attention to this subject, viz. (1) the imperative need of economy in steel and timber owing to vast calls on these materials for numerous war munitions and equipment, (2) the urgent necessity to use a minimum amount of skilled labor in home industries, and (3) the insufficient number of small mercantile vessels such as coasters, tugs, and lighters that have been built owing to the prior claim of naval vessels.

It is only fair to say that the present programme of construction of reinforced concrete vessels would not have been possible had it not been for the pioneer work which established its possibilities before the autumn of 1917.

Limitations

For river craft, pontoons, floating dry docks, floating piers, etc., reinforced concrete construction will probably develop and become a permanent industry.

For river and harbor lighters, tugs and coasting vessels, this form of construction will, if all the present experimental vessels are successful, probably remain a recognized form of construction for some years to come. Steel vessels may come back to their own as soon as freights are low and the competition keen. For larger vessels, up to, say, 2,000 tons deadweight capacity, reinforced concrete will no doubt prove a practical and commercial proposition for a few years.

Ideal Points Aimed At

Designers and builders are striving to produce a reinforced concrete vessel:—

(a) That will as nearly as possible reduce the weight of the hull to that of a steel ship of the same deadweight capacity.

(b) That will contain not more than one-quarter or one-fifth of the steel that is required in a steel ship.

(c) That will be sufficiently strong and safe with a thin concrete hull to stand stresses and ordinary knocks and at the same time have the necessary density to ensure watertightness.

(d) With a concrete that will not fracture by expansion and contraction, and that can be protected from disintegration in contact with acids, etc.

(e) That can be launched quickly after completion, without danger to the concrete work.

(f) That after bottom and side damage has been repaired, can be put to work again quickly without waiting several weeks for the repair work to set and harden.

Co-operation of Experts

It is necessary to combine the knowledge and experience of the designers of reinforced concrete work on land with that of a naval architect who has had experience in the design and construction of vessels of the type to be adopted. Neither party can at present hope to attain the best results without the other.

Consideration of Design

The underlying principles are to use only the amount of steel necessary to take up the tensile stresses and for the concrete to do the rest and stiffen the structure.

The ideal design would appear to be a vessel with longitudinal construction (dispensing with two-thirds of the usual floors and frames), fitting only a few web-frames and as many bulkheads as possible, and in addition to the usual longitudinal rods, a series of diagonal ones. In larger size vessels it would no doubt be advisable to fit a centre bulkhead for the full length of the ship, but in any case it is advisable for cargo vessels to have the hatch coamings continuous all fore and aft. In smaller vessels a continuous carling, even if it projects 6 inches above the deck, is desirable.

It is not difficult to design a reinforced concrete vessel with graceful form, nice curved lines and a handsome sheer, though difficulty and expense are involved in building and in keeping the steel reinforcement in place during moulding and casting. To overcome these difficulties, the writer designed the "straight-lined" vessels in July, 1917, and published a number of designs wherein all the transverse sections are straight lines throughout the ship, the sheer being also in straight lines.

If the steel reinforcement is not kept in its proper position both vertically and horizontally in the thin slab walls of the shell, bulkheads, hatch coamings, bulwarks, casings, etc., a considerable amount of the strength of the reinforced concrete structure will be sacrificed. Take for an example a 3-inch slab curved vertically, horizontally, and diagonally, as is the case on the bow of an ordinary ship-shaped vessel. It is almost impossible to keep all the steelwork in its proper position, and a deviation of only ¼ inch of the bars one side will bring them so close to the surface as probably to throw off the concrete, or if set inwards will considerably reduce the strength of the slab locally. Furthermore, if the steel rods be not true to line, they tend to straighten out when subject to a tensile pull and cause the concrete to burst off, besides reducing their effectiveness by introducing secondary stresses.

The unit or sectional method of construction is being tried, but the advantages for ship work have yet to be proved, while the disadvantages are serious; so that the monolithic system, which makes it easy to obtain continuity of strength, is almost universally used.

For small vessels, barges, etc., a slab form of construction should be much more economical, as it dispenses entirely with floors and frames, side keelsons, stringers, beams, etc. The shuttering, being reduced to a minimum, is quickly placed in position and more rapid construction attained.

There are the following methods of reinforcement:—

(a) Wire netting, expanded metal, and similar meshwork with or without bars.

(b) Flat bars, special bars, steel joists, etc.

(c) Round bars of varying diameters.

All of these are suitable for either the unit method or the monolithic method of construction, and may be used either singly or in combination.

There are four methods of jointing the steel rods: (1) by a long overlap, (2) by a short overlap with hooked ends, (3) by welding, and (4) by turnbuckles or other mechanical attachment. The long overlap, which is usually forty diameters of the rod, although some go as low as twenty diameters, relies entirely upon the adhesion or grip of the concrete to the bar. The short overlap, of

*Read at the Spring Meeting of the British Institution of Naval Architects.