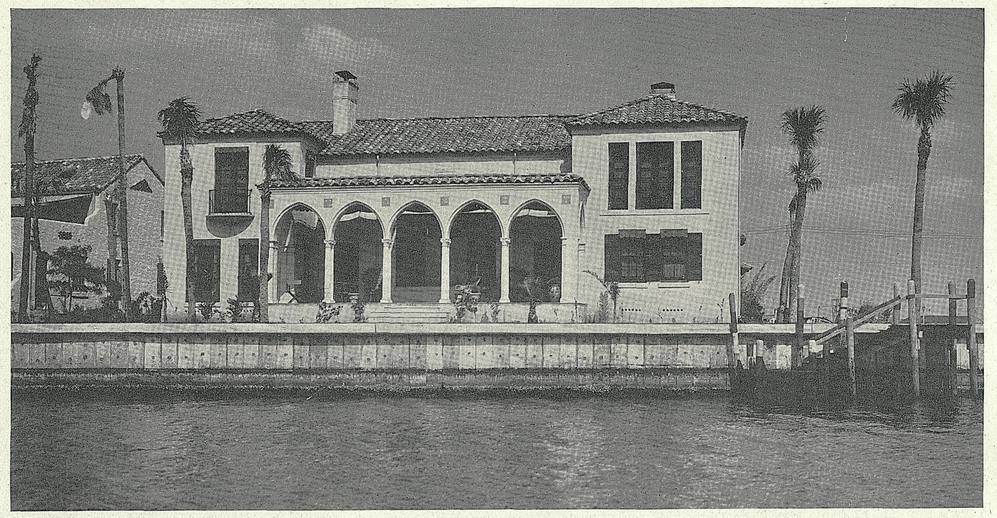
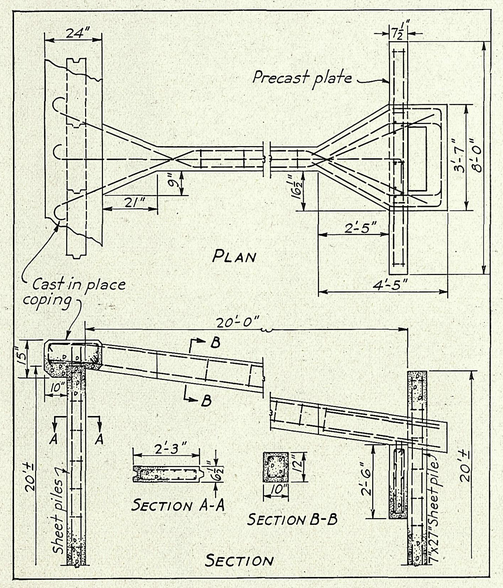


A winter residence in Florida protected by a concrete sheet pile bulkhead.



Sectional detail of sheet pile bulkhead shown above. Reinforced tie-backs located 18 to 22 feet apart, extend from the over-lapping coping to concrete pile and plate arrangement shown. The coping is cast in place after the sheet piles are sunk and grouted. It is important that all reinforcement in piles and tie-backs have at least 2 to 3 inches protective coating of concrete to prevent spalling due to oxidation.

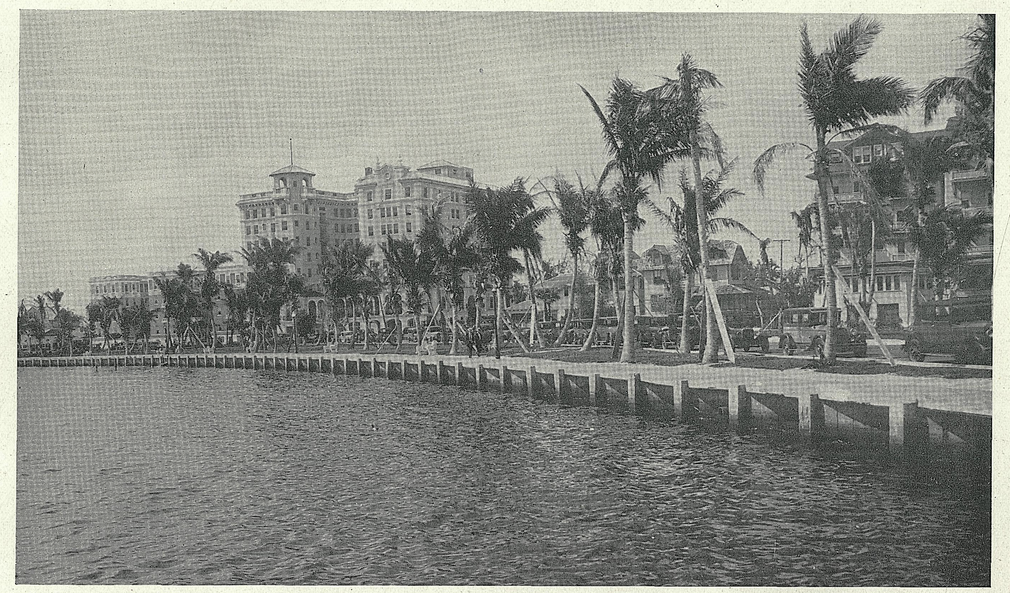
cement-water paste, it is evident that the entire space must be filled with paste containing as few voids as possible. In addition to this, the concrete mixture must be of a plastic consistency so that the material can be worked readily into forms and incorporate completely the reinforcement.

To obtain a plastic consistency there must be sufficient paste actually to float the particles. Otherwise the concrete will be harsh and will require excessive labor in placing to avoid honeycombing and to insure a watertight, durable structure.

The water-cement ratio affects the watertightness of concrete in two important respects: first through its influence on the imperviousness of the paste, and, second, through its influence on the workability of the mass.

From laboratory experiments and actual experience in the field, it has been determined that the production of strong, watertight and durable concrete is governed by controlling the amount of water used to produce and place a workable and plastic mass. In other words, for plastic mixes, using sound aggregates, the strength and other desirable properties of concrete under given job conditions are governed by the net quantity of mixing water used per sack of cement.

In the light of this knowledge, proportioning



This concrete wall at West Palm Beach, Florida, was constructed in 1904, and after more than 25 years' constant exposure to sea water and tropical storms is in excellent condition.

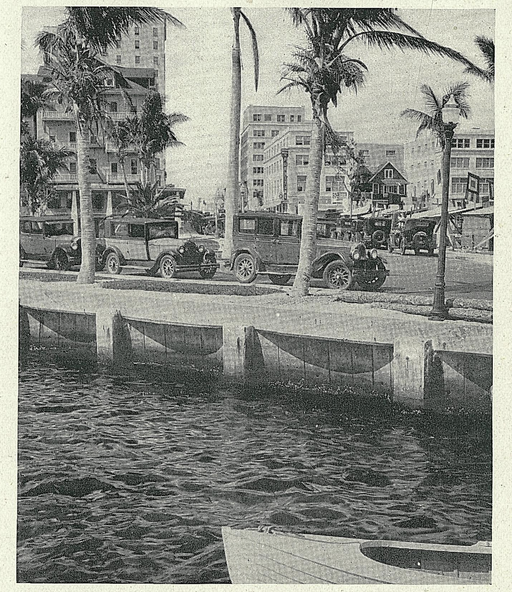
the ingredients of concrete is simple. Under this principle, concrete is not specified in proportions such as 1-2-4, or 1-2½-5, but, instead, the amount of water to use with each sack of cement is given. Workability will be the governing factor with the specified water-cement ratio, and it will be attained by adding to or reducing the quantity of sand and stone until a plastic mix is obtained. The specified amount of water must in all cases include the free water or moisture contained in the aggregate.*

The design of the mix consists of determining by trial batches the proportions and amounts of aggregates to use with a paste of known water-cement ratio which will produce a mixture that is plastic and workable. Workability is an important factor, and if a mixture has not workability the principle cannot be applied.

Importance of Curing

The remaining element which fixes the character of concrete, as reflected in the quality of

*The Portland Cement Association has published a booklet "Design and Control of Concrete Mixtures," which thoroughly explains proportioning under water-cement ratio control. This booklet may be had without cost on request.



A close view of the West Palm Beach wall. Concrete sheet piles were placed in segments of circles, between king piles. The cast-in-place coping is placed in a straight line with the king piles.