Underwater concrete plays an important role in the construction of offshore structures.

It may be used to tie together various elements in composite action (i.e., to tie piling to the footing).
Tremie Concrete Mix
- Special mix with plasticizer
- High slump concrete with set retarders
- Smaller aggregate sizes
- Four-hour workability
- Designed for placement under water via tremie pipe

Underwater Concrete Mixes:
- **Structural concrete**
  - *Coarse Aggregate:* Gravel of 3/4” max. size. Use 50-55% of the total aggregate by weight.
  - *Fine Aggregate:* Sand, 45-50% of the total aggregate by weight.
  - *Cement:* Type II ASTM (moderate heat of hydration), 600 lbs/ yd³.
  - *Pozzolans:* ASTM 616 Type N or F, 100 lbs/ yd³.
Tremie Concrete

- **Water/Cement Ratio:** 0.42 (0.45 Maximum).
- **Water-Reducing Admixture** (preferably it is also plasticizer): Do not use superplasticizers.
- **Air-Entrainment Admixtures:** To give 6% total air.
- **Retarding Admixture:** To increase setting time to 4-24 hours, as required.
- **Slump:** 6 1/2 in. ± 1 in.
- This mix will develop compressive strength in the range of 5,600 – 7,000 psi at 28 days.
- It will flow out on a slope of 6:1 to 8:1 horizontal/vertical and, if properly placed, should give nominal segregation and laitance.

Tremie pipe

Breaking Tremie Tube - In this operation the contractor is removing a 20’ section from the 140’ + tremie tube to continue the first full depth placement in the UR pylon. Concrete placed will be about 400 CYs.
Tremie Concrete

Tremie pipe

Transition of the pipeline from vertical to horizontal.

Placement of Tremie Concrete

- The placement of tremie concrete is carried out through a tube, usually 10- to 12-in. pipe.
- The pipe may be sectional but joints should be flanged and bolted, with soft rubber gasket, so as to prevent any in-leakage of water.
- The tremie pipe must have sufficient wall thickness so that it negatively buoyant when empty.
Placement of Tremie Concrete

- Install a steel plate on the bottom end with a soft rubber gasket. The plate is tied with twine to the pipe.

- The placement is started by placing the sealed pipe on the bottom and then partially filling it with the tremie concrete mix.

- When tremie has been filled to a reasonable distance (distance required to overcome the frictional head \( \approx 1-2 \text{ m} \) above the balancing head of fresh concrete versus surrounding liquid, the pipe is raised 150 mm, allowing the concrete to flow out.

- The lower end of the pipe is kept embedded in fresh concrete, but no deeper than where the concrete has taken the initial set (with retarder to prevent the initial set, the depth of embedment becomes less sensitive).
Placement of Tremie Concrete

- The tip of the tremie pipe should always be immersed about 1 m as a minimum so as to prevent water inflow into the pipe.
- The flow of concrete should be smooth, consistent with the rate at which concrete can be delivered into the hopper at the top.
- The method of delivery should provide relatively even feed to the hopper rather than large batches being suddenly dumped.
- When large areas are to be covered, multiple tremie pipes should be used.
- The distance tremie can flow without excessive segregation is between 6 and 20 m.
Tremie Concrete - Application

- Tremie concrete procedures were used to repair damage to a reef in the Florida Keys caused by vessel impact.
- The impact site was located in six to ten feet of water off Miami, in a region of the reef frequented by sight-seeing boats and recreational divers. The ship impact destroyed the living surface of the reef over an area of approximately 50-ft by 70-ft, forming a shallow crater in the reef.

Diver places underwater tremie concrete between reef units and bottom. Bottom of the barge can been seen just a few feet above the diver's head.

Questions?

Kamran M. Nemati
nemati@uw.edu
Architecture Hall
Room 130J