

# Tremie Concrete Reef Restoration Florida Keys National Marine Sanctuary, FL



Lowering of pre-cast concrete panels.

Working under contract with the National Oceanic and Atmospheric Administration for the design firm Olsen Associates, Inc. and later for the marine contractor Team Land Development, Inc., Ben C. Gerwick, Inc. developed tremie concrete procedures 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.

Restoration of the reef was essential because erosion from wave action was undermining the living coral around the rim of the crater causing the depression to become larger with time. The coral requires a firm, textured foundation to re-establish itself within the damaged area. Olsen Associates developed a plan to install textured pre-cast concrete panels into the crater to infill the interstitial spaces between the

panels and between the panels and the reef with tremie concrete. Use of tremie concrete was essential in order to both stop the precast panels from moving and to secure the living coral at the perimeter of the crater from further undermining.

Considerations in the development of a viable tremie concrete placement procedure included:

- Placement was to be made at an environmentally sensitive reef and dispersion of cement particles into the sea water needed to be kept to a minimum.
- Concrete was to be placed in very thin layers from approximately three feet down to three inches thick.
- In some areas the surface of the fresh concrete was to be worked underwater by inserting stone and coral into the fresh concrete to provide a textured surface for the living coral to anchor itself.

A tremie concrete mix was developed with an anti-washout admixture (Sika-

## Services Performed:

- Diving Activities
- Tremie Concrete
- Pre-cast Concrete

ment 100SC) and 43 lbs microsilica fume, 90 lbs fly ash and 600 lbs of cement per cubic yard of concrete. The water/cementitious material ratio was set at 0.40 in order to ensure a specified 28-day strength of 6,000 psi and a high dosage of superplasticizer was used to maintain a concrete slump of greater than ten inches.

The tremie concrete work was performed with concrete produced on a barge using a mobile continuous screw-type mixer and was pumped through a line suspended by a crane boom to a diver that controlled the concrete. The concrete was designed to be largely self-leveling and was successfully placed between the precast units and around the perimeter of the crater.



Placement of pre-cast concrete panels.

Year of Completion: 1996

Construction Cost: \$10M

Client: National Oceanic and Atmospheric Administration