
OPEN FORUM PROBLEMS AND SOLUTIONS

The comments and opinions expressed herein are those of the contributing authors and do not necessarily reflect official PCI policy. Some of the provided answers may have alternate solutions. Reader comments are invited.

Evaluation of Prestressing Strand After Submersion in Saltwater

In the aftermath of Hurricane Katrina in August 2005, several precast concrete production plants located in the storm-impacted areas of the Gulf Coast asked PCI for advice on the viability of cleaning and reusing prestressing strand that was submerged in hurricane (saline) surgewaters.

Q1: Can prestressing strand that was submerged in hurricane surgewaters be cleaned of chloride contamination?

A1: First, if it were possible to properly clean the strand in question, the strand would need to be quickly sent—or as soon as possible after submersion—to a strand manufacturing facility. There it would be subjected to an in-line cleaning process that would be able to reach the inner surfaces, or interstices, of the woven strand to ensure that all exposed surfaces are thoroughly cleaned. Once the strand was completely cleaned followed by a series of rinses, it would need to be tested for any contaminant residue and evaluated for material strength and viability before the strand could then be packaged for reuse.

Before we can be satisfied that the proposed remedy may work, a research program is needed to establish guidelines for the amount of time that may expire before the strand is cleaned and still meet industry specifications for use. Research is also needed to determine which cleaning solutions will work most effectively in removing contaminants and whether these solutions will have an adverse effect on strand quality.

As noted in Gus Sason's article¹ addressing conditions of stockpiled, on-site prestressing strand, however, once stored strand has begun to pit from rusting—let alone strand submerged in seawater—it is too late to salvage it. In addition to chloride, the strand in question may have been exposed to other contaminants in the storm surgewaters and these contaminants will also need to be identified and thoroughly re-

moved. If a large amount of prestressing strand is involved, it would be advisable to initiate a pilot program to clean the strand and then evaluate samples of the repackaged material for viability in test precast concrete applications. In any case, State Departments of Transportation (DOT) would not allow use of strand exposed to seawater in any application.

Q2: Would the use of special concrete mixtures protect the strand from further corrosion in use?

A2: Chloride-preventing admixtures in the concrete, once completely encasing the cleaned strand, may help to minimize risks of corrosive processes. But, once again, only through research can the extent of protection from concrete admixtures be adequately assessed.

Q3: When is it cost-effective, in terms of the quantity of steel in question, to have prestressing strand professionally unwound and cleaned by the strand manufacturer?

A3: The cost of cleaning a large quantity of prestressing strand is difficult to assess. To our (manufacturers') knowledge there has not been a reason to attempt to clean strand immersed in saltwater to date. Hypothetically, a production line would have to be built specifically for cleaning the submerged strand. A special cleaning production line might take six to nine months to set up and cost about \$1 million; this amount would have to be amortized in the cost of cleaning the strand. Transportation costs to ship the affected strand could run over \$150,000.

Once all the production, shipping, cleaning, and testing procedures and costs are established, only then could cost-effectiveness be determined. Even if it were economical to clean the amount of strand affected, the strand in question would continue to rust and no doubt be pitted to the extent

that it would not be usable while the hypothetical production line for cleaning was being built.

Q4: Can the strand be recycled?

A4: Contaminated strand could be sold for scrap to a steel mill or other steel product company where the steel would be melted down and processed for reuse. Even as a substitute for mild steel reinforcing, however, the prestressing strand in question could not be recycled in any other prestressed concrete products for public or private infrastructure because we do not know the use ramifications of strand submersion in saltwater and other contaminants.

Q5: Does the prestressing steel industry have sufficient stock on hand to replace the large quantity of material that was lost in Hurricane Katrina, and if not, would federally funded projects allow the mixing of domestic and foreign product?

A5: American strand manufacturers are in agreement that they have sufficient capacity and inventory to easily replace any amount of contaminated prestressing strand, and it is unnecessary to resort to foreign manufacturers. Some state DOT frown on mixing strand manufacturers and others do not. Mixing strand (supplied by different producers) should not be a problem as long as the strand testing protocol and steel quality meet the specifications for the job.² Record keeping on projects using mixed strand is important to ensure all strand meets American Society for Testing and Materials (ASTM) A 416³ and to document strand area and elongation specification compliance.

Q6: Will submersion of packs of prestressing strands in seawater affect the performance of the strand used for pre-tensioning?

A6: The only way to determine the effects of submersion in seawater on prestressing strand is to conduct adequate research. Any visual pitting in prestressing strand as a result of rusting is a serious concern because pits may constitute material stress points that will serve as initiation sites for fatigue failure.¹ Submersion of steel strand in seawater followed by exposure to the humid climate of the U.S. Gulf Coast region

are probably ideal conditions that are conducive to the rapid formation of oxidation, rusting, and pitting.

The general consensus within the PCI membership, and particularly the members of PCI's Prestressing Steel Committee, is that using any steel prestressing strand after exposure to seawater is not worth the risk in any application. This industry consensus against use of contaminated strand is based not only on technical concerns for structural soundness, but more importantly, out of respect for potential negative public perception should a structural failure occur down the road for any reason—even a failure not due to questions of strand quality. The majority of those professional members responding to this Open Forum question seem to agree that the integrity of the precast/prestressed industry as a whole and public confidence and perception of the industry's quality control standards outweigh any subjective evaluation of the affected strand as being viable for use in any application, even after thorough cleaning and testing.

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REFERENCES

1. Sason, A. S., "Evaluation of Degree of Rusting on Prestressed Concrete Strand," *PCI*, V. 37, No. 3, May-June 1992, pp. 25-30.
2. PCI MNL 116-99, *Manual for Quality Control for Plants and Production of Structural Precast Concrete Products*, Precast/Prestressed Concrete Institute, Chicago, IL, 1999.
3. ASTM A416/A416M-05, *Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete*, American Society for Testing and Materials, Philadelphia, PA, 2005.