

Analysis of Technical Standards for In-service Inspection of HDPE Coated and Greased Tendon System in Reactor Containment Building

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1. Introduction

Unbonded post-tensioning system in reactor containment building have been adopted for most nuclear power plants. However, the grease filled to prevent corrosion of the bare strands in ducts is very difficult to handle and manage during in-service inspection. Recently, several experimental studies have been performed to apply HDPE (High Density Polyethylene) coated and greased tendon system with three anti-corrosion concepts (greased steel strand + HDPE sheath + cement grout filling in duct) as an alternative to the existing unbonded post-tensioning system for reactor containment building. Fig. 1 shows the concept of HDPE coated and greased tendon system. In this paper, technical standards on the post-tensioning system were analyzed from the perspective of in-service inspection.

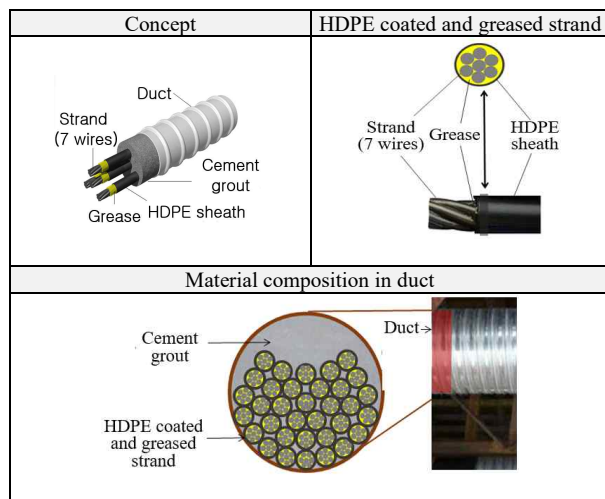


Fig. 1. HDPE coated and greased tendon system

2. Technical Standards for In-service Inspection of Post-tensioning System

The in-service inspection on the post-tensioning system have been performed using references such as ASME Sec. XI, Div. 1, Sub. IWL [1] and KEPIC MIL [2]. The technical standards consist of the following chapters:

- Scope and responsibility (ASME IWL-1000 and KEPIC MIL 1000)
- Examination and inspection (ASME IWL-2000 and KEPIC MIL 2000)
- Acceptance standards (ASME IWL-3000 and KEPIC MIL 3000)
- Repair/replacement activities (ASME IWL-4000 and KEPIC MIL 4000)
- System pressure tests (ASME IWL-5000 and KEPIC MIL 5000)

In this paper, the technical standards [1, 2] referred for the in-service inspection were analyzed from the perspective of HDPE coated and greased tendon system, and the items necessary to be revised for applying the system were identified. The chapters reviewed for the analysis are as followed:

- Examination and Inspection (ASME IWL-2000 and KEPIC MIL 2000)
- Acceptance Standards (ASME IWL-3000 and KEPIC MIL 3000)

3. Analysis of Technical Standards

3.1. Examination and Inspection (ASME IWL-2000 and KEPIC MIL 2000)

For tendon detensioning and sample removal chapters, ASME IWL-2523.1 and KEPIC MIL 2523.1, the instructions state that one sample tendon of each type shall be completely detensioned, and a single wire or strand shall be removed from each detensioned tendon. However, there is a possibility of double bite by wedges when the tendon is retensioned after detensioning, which can lead to damage. For HDPE coated and greased tendon system, each strand can be individually detensioned without detensioning tendon for extraction of a single strand. In order to apply HDPE coated and greased tendon system for reactor containment building, the following revision was proposed.

- (Original) Extraction of a single strand after complete detensioning for one sample tendon
- (Proposed) Extraction and detensioning of random strands (e.g. approximately 5% of total strand) for one sample tendon

For chapters on removal and replacement of corrosion protection medium, ASME IWL-2526 and

KEPIC MIL 2526, the instructions state that the total amount replaced in each tendon sheath shall be recorded and differences between amount removed and amount replaced shall be documented. For HDPE coated and greased tendon system, the corrosion protection medium (grease) is placed between the strand and the HDPE sheath, and is not typically replaced except for replacing greased strands. The removal of the corrosion protection medium (grease) and a quantitative evaluation for difference between amount removed and amount replaced is impossible. An exception rule on the inspection requirement should be added for HDPE coated and greased tendon system.

3.2. Acceptance Standards (ASME IWL-3000 & KEPIC MIL 3000)

For corrosion protection medium chapters, ASME IWL-3221.4 and KEPIC MIL 3221.4, the instructions state that the absolute difference between the amount removed and the amount replaced shall not exceed 10% of the tendon net duct volume. As mentioned 3.1, an exception rule on the inspection requirements should be added for HDPE coated and greased tendon system, because a quantitative evaluation for difference between amount removed and amount replaced is impossible.

4. Conclusions

In this paper, the technical standards referred for the in-service inspection were analyzed from the perspective of HDPE coated and greased tendon system, and the items necessary to be revised for applying the system were identified. Based on these analyses, the following chapters should be revised for applying the HDPE coated and greased tendon system.

- Tendon detensioning and sample removal (ASME IWL-2523.1 and KEPIC MIL 2523.1)
- Removal and replacement of corrosion protection medium (ASME IWL-2526 and KEPIC MIL 2526)
- Corrosion protection medium (ASME IWL-3221.4 and KEPIC MIL 3221.4)

REFERENCES

- [1] ASME, Requirements for Class CC Concrete Components of Light-Water-Cooled Plants, ASME Sec. XI, Div. 1 Sub. IWL, 2023.
- [2] KEPIC, Class CC Concrete Components, KEPIC MIL, 2022.