Installation of Post-Tensioning Tendons

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Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the mechanical principles of prestressing and how they enhance the durability and load capacity of concrete structures.
- **Distinguish** between various post-tensioning applications, including segmental, cast-in-place, and substructure systems.
- **Evaluate** the selection of appropriate post-tensioning hardware (strands vs. bars) based on permanent or temporary structural requirements.

Executive Summary: Post-tensioning is a method of reinforcing concrete by applying compressive forces via high-strength steel tendons after the concrete has hardened. This technique offsets tensile stresses, eliminates or reduces cracking, and allows for longer spans and more efficient bridge designs.

Fundamentals of Post-Tensioning

Benefits of Post-Tensioning

Concrete is inherently strong in compression but weak in tension (typically only **10%** of its compressive strength). In standard reinforced concrete, steel bars resist tensile forces, but the concrete must often crack before the steel is fully engaged. Post-tensioning proactively compresses the concrete, preventing these cracks and enhancing long-term durability.

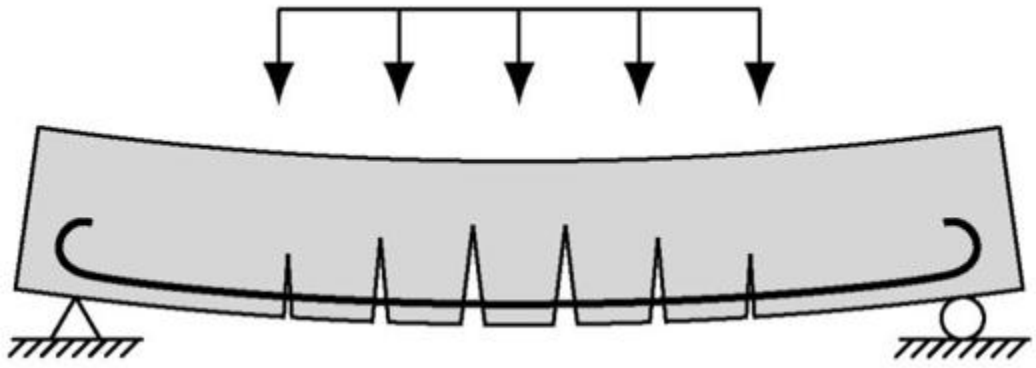

Figure 1.1. Reinforced Concrete Beam Under Load

Principle of Prestressing

The function of prestressing is to place the concrete structure under compression in regions where load causes tensile stress. Tension caused by applied loads must first cancel the compression induced by the prestressing before it can crack the concrete.

- **Simple Spans:** Tendons are placed low to counteract bottom-tension.
- **Cantilevers:** Tendons are placed high to counteract top-tension.

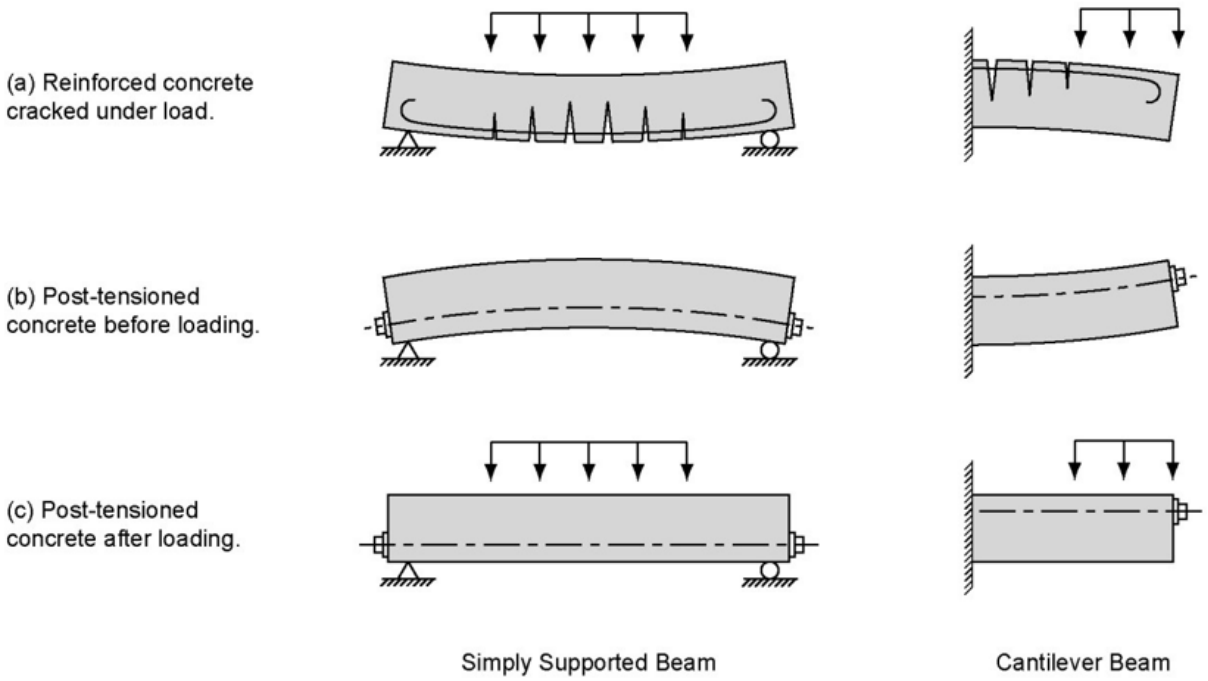

Figure 1.2. Comparison of Reinforced and Prestressed Concrete Beams

Post-Tensioning Operations

Compressive forces are induced by tensioning steel tendons (strands or bars) placed in ducts embedded in the concrete.

- **Jacking:** A hydraulic jack is pressurized to a predetermined value while bearing against the end of the concrete beam.
- **Anchoring:** Strands are secured by **wedges** in a wedge plate; bars are usually anchored by **spherical nuts** against a bearing plate.
- **Grouting:** Protruding "tails" are cut using an abrasive disc saw or plasma cutting (never flame cut). Tendons are then grouted using a cementitious grout to ensure corrosion protection.

⚠️ **Safety Constraint:** Flame cutting should not be used for removing strand or bar tails as it negatively affects the metallurgical characteristics of the prestressing steel.

Post-Tensioning Systems

Common systems include multi-strand systems for permanent tendons and bar systems for both temporary and permanent situations.

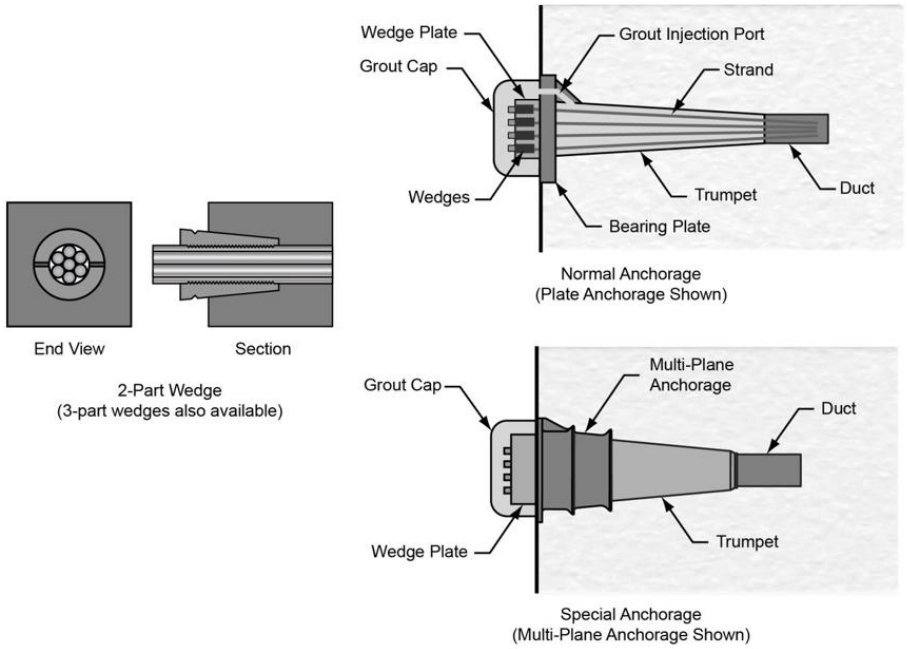

Figure 1.3. Typical Post-Tensioning Anchorage Hardware for Strand Tendons

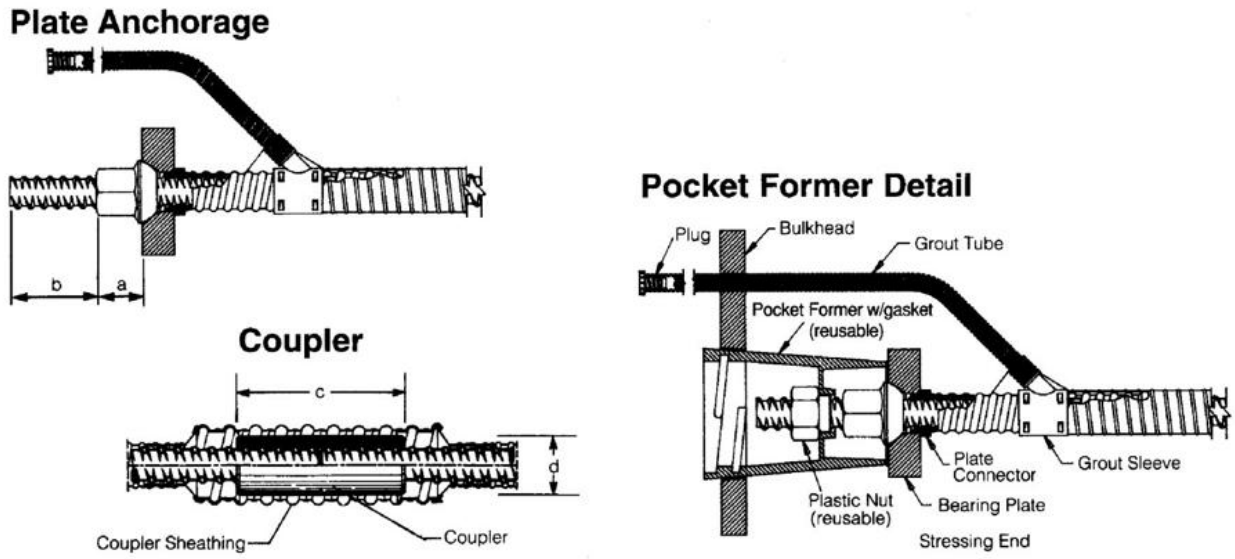

Figure 1.4. Typical Post-Tensioning Bar System Hardware (Courtesy of Dywidag Systems International)

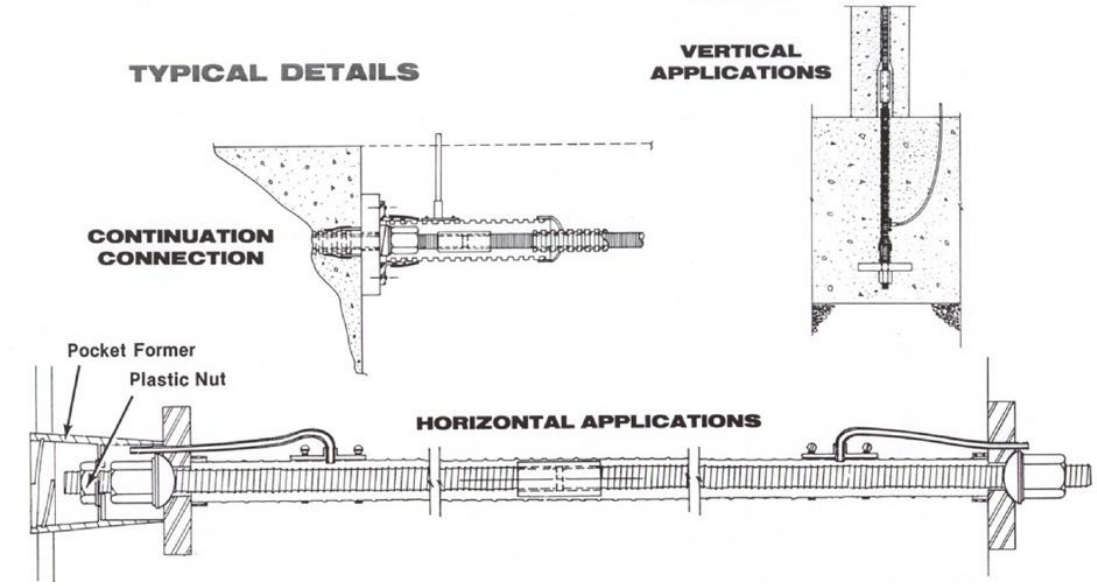

Figure 1.5. Typical Post-Tensioning Bar System Hardware (Courtesy of Williams Form Engineering Corporation)

Permanent Post-Tensioned Applications

Cast-in-Place Bridges on Falsework

Built on-site using formwork supported by temporary falsework. Longitudinal post-tensioning typically comprises multi-strand tendons **draped** along the girder to match the moment profile.

Figure 1.6. Cast-In-Place Post-Tensioned Construction in California

Post-Tensioned AASHTO, Bulb-T, and Spliced Girders

Girders are erected as simple spans and made continuous via cast-in-place joints. Post-tensioning ducts are spliced at these joints, and tendons are stressed through the full length of the multi-span unit.

Figure 1.7. Spliced Haunched I-Girder of Main Span Unit

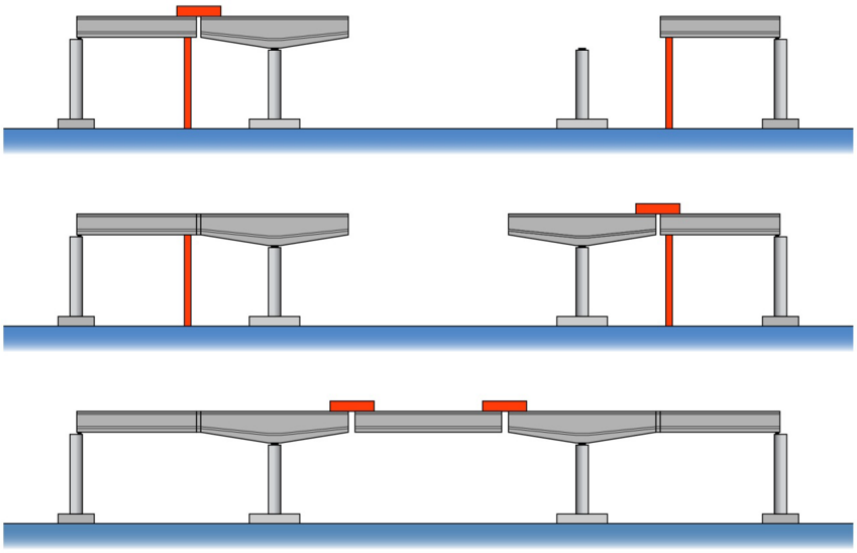

Figure 1.8. Erection Sequence and Temporary Supports for Spliced I-Girder

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