SPEIGHT MARSHALL & FRANCIS
A Professional Corporation

Technical Bulletin

FROM SPEIGHT, MARSHALL & FRANCIS, P.C.

Structural Engineering - Special Inspections
March 2008
Bulletin No. XXXI

Post-Tensioning

Using stress and tension to reap benefits

Introduction

The purpose of this technical bulletin is to provide basic information regarding the concepts of post-tension construction. Post-tensioning is a method of producing prestressed concrete structural elements by introducing internal forces (causing internal stresses) into concrete to counteract the external loads expected to be applied when the structural member is put to use or loaded.

Prestressed versus Post-Tensioned:

The internal forces referred to in the previous section are applied to the structural element by tensioning high strength steel tendons. The tensioning process can be done before or after the concrete is placed in the forms. When the tendons are tensioned before the concrete is placed the process is called pre-tensioning. Conversely, when the tendons are tensioned after the concrete is placed the process is called post-tensioning.

Slab tendon passing over bundled tendons in a P-T beam

The Prestressing Process:

Prestressing is typically done at a manufacturing plant using special casting beds with steel bulkheads restraining the steel as it is tensioned. The concrete is placed around the pre-tensioned steel and allowed to set up and harden. After the concrete hardens, the tensioned steel is cut loose and imparts compressive stresses into the concrete elements and the element is transported to the site.

The Post-Tensioning Process:

Post-tensioning is performed at the actual project site and, for the most part, uses the same formwork required for non-prestressed concrete. The prestressing steel used is located inside a duct or sheath allowing it to be placed within the formwork at the same time as the typical reinforcing steel. Concrete is placed in the forms and allowed to harden. After the concrete reaches a specific compressive strength, then tension is applied to the steel. Placing the steel within a sheathing or duct allows it to move freely inside the concrete during the tensioning process. The prestress steel is draped in such a manner allowing it to be tensioned against the hardened concrete instead of using cumbersome steel bulkheads. Draping the prestressing steel is extremely advantageous in that it induces internal compressive forces to help counteract tensile forces caused by external loads, as well as creating an uplift force midway between supports at the place it is needed the most.

Think about it; as the draped prestressing steel is tensioned, its natural tendency is to become straight. As it tries to straighten out, it bears on the surrounding concrete and exerts forces counteracting the effects of gravity (tendency to move downward) on the structural system.

Materials and Equipment Used in Post-Tensioning:

Following are some elements that make up a post-tensioning system:

Tendon being "jacked" to induce tension

Tendon – one or more pieces of prestressing steel coated with grease inside a protective duct or sheathing. The ducting or sheathing provides a protective layer against the effects of corrosion.

Multi-Strand Tendon – a tendon containing several pieces of prestressing strands within the sheathing.

Monostrand Tendon – a tendon containing one prestressing strand within the sheathing.

Unbonded Tendon – when grease is used in the sheathing to allow the prestressing steel to move freely within the sheathing.

Bonded Tendon – when a grout is injected into the sheathing, thus bonding the steel to the sheathing.

Hydraulic Stressing Jack – mechanism used to apply tension to prestressing steel.

Anchors – mechanisms used to provide a permanent mechanical connection keeping the steel in tension, and subsequently the concrete in compression.

Advantages of Post-Tension and Prestressing:

- Reduction of concrete materials since smaller concrete sizes can be used (1 LEED point potential).
- Reduction in foundation cost due to less concrete weight (1 LEED point potential).
- Reduction in amount of mild reinforcing material (1 LEED point potential).
- Reduction in building height due to shallower members yielding a smaller shadow and potentially addition levels (1 LEED point potential).
- Increase in span lengths creating more clear space; thus allowing more architectural freedoms.
- Reduction in number of concrete cracks.
- LEED points for inherent thermal mass, use of recycled concrete, recycled reinforcing steel, and other avenues to gain LEED points.

If you would like an electronic version of our Technical Bulletins instead of a mailed paper copy, please email Christa at christa@smandf.com.

Resource:
Post-Tension Magazine, March 2008 issue.
For more information explore www.ptconcrete.com.

SPEIGHT, MARSHALL & FRANCIS, P.C.
2125 McComas Way, Suite 103
Virginia Beach, Virginia 23456
a-team@smandf.com
(757) 427-1020
(757) 427-5919