CHAPTER THREE

ERECTION OF PRECAST CONCRETE BEAMS AND GIRDERS

CONTENTS

As you will remember from Part 1, Chapter 1, there are two main types of precast beams: Prestressed or Post-tensioned; however, sometimes both types are used in the same beam. Their method of fabrication is discussed in detail in Part 1, Chapter 1 along with a description of the different shapes they come in: AASHTO, Florida I-Beam, Bulb-T, U-Beam and Double-Tee. Both Prestressed and Post-tensioned beams are fabricated and prestressed at a precast plant, but Post-tensioned girders are also post-tensioned together at the project because spans are so long that more than one girder segment is required to complete a span. The Department conducts quality assurance inspections at the precast plant unless the plant is located out-of-state in which case the inspections are provided by a testing lab approved by, and under contract to, the Department. The Department plant Inspector makes sure that beams are constructed according to the contract documents and the Producer stamps them, just before they are shipped from the plant, with the Producer's official approval stamp to indicate compliance with Department specifications. When the beams arrive at the construction site, your job will be to inspect them to be sure that there are no defects missed by the Producer, that no damage has occurred due to mishandling or improper storage and to make sure the beam has the Producer's approval stamp. Do not allow beams and girders to be used on the project if they have no approval stamp.

INSPECTING FOR DEFECTS BEFORE ERECTION

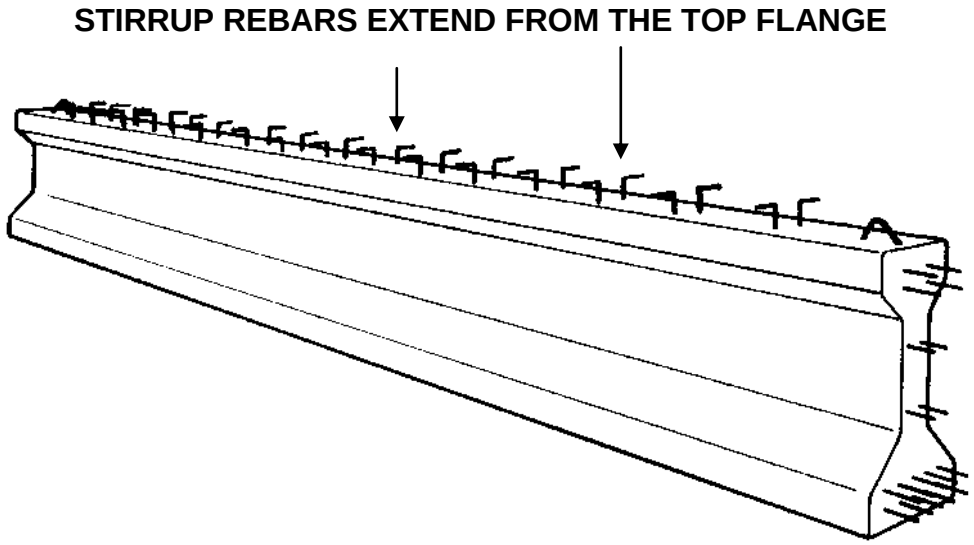
When the beams arrive at the project site, look for any cracks. Small hairline cracks are usually due to shrinkage and are not critical to the strength of the beams. However, large cracks may indicate that the beams were mishandled or that more serious structural defects exist. If you notice that a beam has significant chips, spalls, or fragments that have broken off, the beams were probably damaged during transport from the plant to the project site.

Also check the reinforcing steel that extends out of the top flange of the beam. These rebars, referred to as stirrups, will be used to tie the beams and the deck slab together, and serve the same purpose as the shear connectors on steel beams. Stirrups should not be broken or badly bent (see illustration, next page).
If you find any damage, notify your Project Administrator.

STORAGE

The Contractor must store prestressed concrete beams in an upright position. This is important because pretensioned cables are located in the bottoms of the beams. This makes a beam resistant to compressive stress in the top flange and tension stress in the bottom flange caused by the loads applied to the top of the beam.

If the beams tip over or are stored upside down, they will crack. This is because the prestress strands in a beam are designed to only work when the beam is in its permanent upright position with the top flange at the top. To design a beam that could be placed upside down or on its side would be excessively expensive and inefficient.



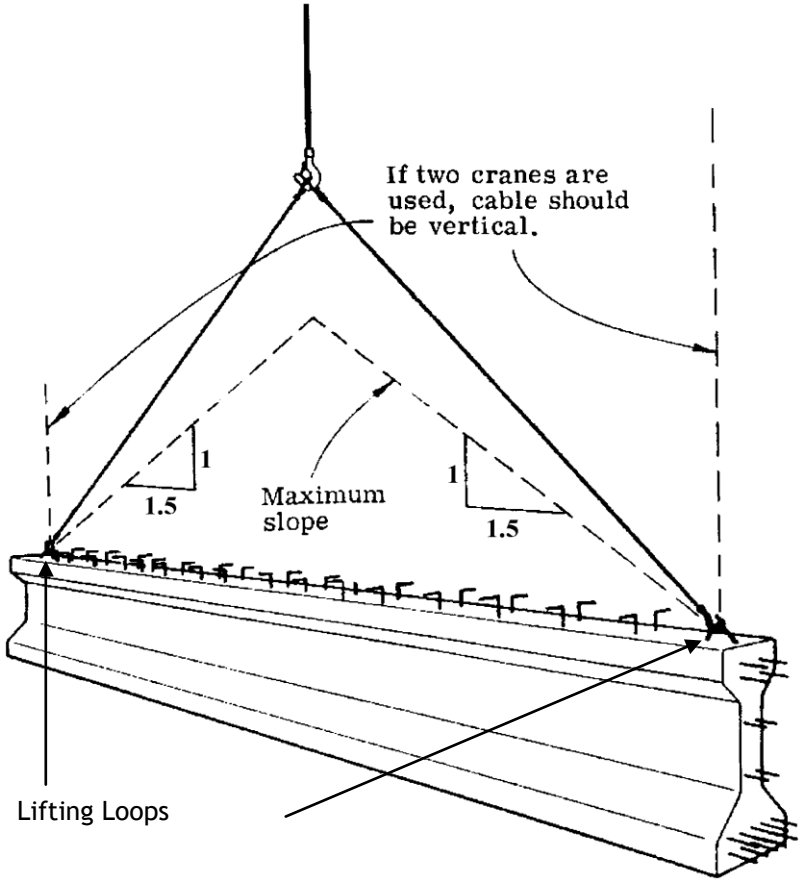
Beams should be stored off the ground. The supports used during storage, should be placed under the ends of the beam at approximately the same location, as will the permanent supports.

HANDLING

Beams should be picked up and supported only at the designated pick-up points, unless the plans state otherwise. These pick-up points are loops extending out of the tops of the beams (one near each end).

The pick up cable should maintain a safe slope. A safe maximum amount would be 1:1.5. If a flatter slope is used, the beam may be damaged. Contractors will sometimes use two cranes, which create no problems. If he uses only one crane, be sure that the cables are long enough. The cables also must be the same length, for proper balance.

The illustration to the right is for an AASHTO beam, so you will have to review the plans for the pickup point locations and lifting method for other beam shapes such as U-Beams or Double-Tees.



Q U I Z

1) Pieces broken off a concrete beam usually indicate that the beam was _____.

2) Concrete beams must be stored in an _____ position.

3) If the Contractor decides to use one crane to pick up a concrete beam, he must be sure the cables are _____ and _____.

4) Who will stamp the beams as approved before they arrive at the construction site?

5) Beams should be picked up only at designated _____.

ERECTION

PRESTRESSED BEAMS

Prestressed concrete beams are erected according to framing plans included in the plans and according to the shop drawings. Framing plans show a plan view of the beams with their markings. Concrete beams will have erection marks painted or stamped on them to show where each beam is to be placed. It is important for you to verify that the right beam is placed on the right pedestal and bearing. More often than not beams look identical; however, looks are deceiving since the rebars and prestress stands can be very different from beam to beam.

When prestressed beams are lifted into place and lowered onto their bearings, you must verify that the centerline of bearing of the beam coincides with the centerline of bearing for the bearing on the pier. U-Beams and Double-Tee beams often have multiple bearings and these can be more difficult to seat properly, so pay particular attention to whether or not these beams are in full contact with all bearings. The above issues and concerns apply as well to post-tensioned girders.

Beam Pedestals – Note the marks showing bearing and girder alignment

POST-TENSIONED GIRDERS [SP 462]

Since post-tensioned girders - which are usually Bulb-T girders - come to the project site in segments, their erection is far more complex than for prestressed beams. In the photograph on page 3-8, the erection of a three span post-tensioned bridge is underway. As can be seen, the three spans require five girder segments that are supported on two temporary steel pile bents. The first girder segments (pier segments) placed, are #2 and #4 followed by segments #1 and #5 (side segments) and finally segment #3 (center or "drop in" segment) is placed.

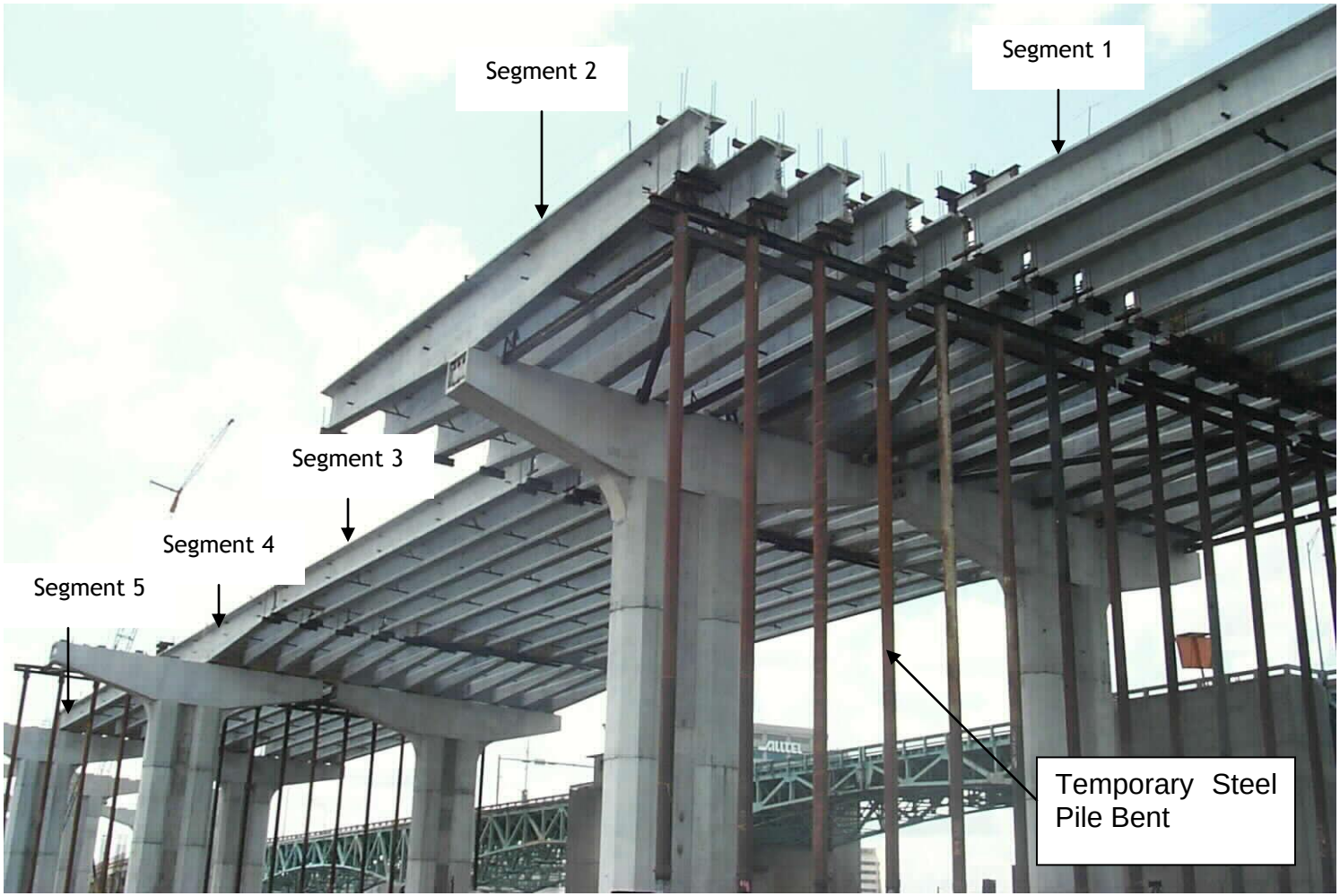
A pier segment is supported at its center by a permanent pier and at one end by the temporary bent. Its other end is unsupported and extends out over the water, which is called a cantilever. The side segments are supported on one end by a permanent pier and the other end is suspended from the pier segment by steel rods. Both ends of the drop in segment are suspended from the cantilever ends of the pier segments by steel rods. You should verify that the girder segments are sway braced adequately since they are very unstable by themselves and that bracing is installed immediately after segment placement. Verification of the suspension

hardware at segment ends is also important and you should review the shop drawings for the details as well as consulting with the Project Administrator.

Once the segments are in their permanent positions, the open joints between the segments are fitted with post-tensioning ducts and other reinforcement. The joints are then filled with concrete, which permanently connect the girder segments. When the joint concrete is adequately cured, the post-tensioning tendons (groups of steel strands or cables) are threaded through ducts that were cast into the girders at the precast plant. Each tendon runs through all five segments and is stretched or tensioned with a hydraulic jack and the ends are anchored while still stretched. The anchors are located at the outside ends of the side girder segments. When the jack is released, the stretched tendon tries to return to its original un-stretched length, but cannot, because it is anchored to the girder ends and; therefore, highly squeezes or compresses the girder. The compression force the tendon applies to the girder is what holds the segments together and prevents the girder from bending excessively under vehicle loads.

During the post-tensioning phase of erection, you must be involved in assuring that the ducts are properly cleaned prior to the threading of the tendons, that tendons are free of corrosion and other surface contaminants, and that the tendons are stressed properly. You must consult with the Project Administrator about the complex procedures and record keeping involved in proper tendon stressing. You will be required to keep records of tendon elongation, which is the distance a tendon stretches during jacking. You will also be involved in verifying that duct and tendon materials and post-tensioning hardware are certified as required by the specification.

Erection of a Concrete Precast Post-tensioned Girder



Soon after the tendons are anchored, the tendon ducts are filled with grout. This is done by pumping the grout under pressure through a pipe connected to the duct. You will need to make sure the contractor is mixing the grout properly, is using an approved grout, that the correct amount of grout discharges at vents along the duct and that CTQP Qualified Grouting Technicians (foreman must be Level II, workers Level I) are performing the grouting. This assures that the duct is completely full and that tendons are completely encased in grout. The grouting process is very important because the grout protects the tendon from corrosion and poor grouting can cause accelerated deterioration of the tendon. The specification requires that grouting be completed within a specific time limit (usually a maximum of 14 days after the tendons are installed.) You must make sure that the Contractor complies with this limit. If grouting is delayed the tendon can begin to corrode since it is unprotected.

Finally, after grouting is complete, the anchorage areas must be properly sealed to prevent corrosion of the steel in the anchorages. The plans will indicate how this is to be done and it is also very critical that anchorages be properly protected from corrosion. For detailed information about proper grouting methods and procedures refer to the State of Florida DOT training manual, Grouting of Bridge Post-Tensioning Tendons.

The temporary bents must remain in place until the deck is constructed and fully cured and after other post-tensioning tendons are installed from the deck and that also go through the girders.

DIAPHRAGM CONSTRUCTION [SS 400]

After the concrete beams are erected, forms for diaphragms are built and concrete is placed in the forms. The diaphragms will stabilize the beams prior to completion of the deck and will prevent the beams from swaying sideways due to lateral forces applied to the beams such as high wind.

On the same plan sheet as the framing plan, you will find instructions for when and where the diaphragms should be constructed. You will also find more information about diaphragms by consulting the deck plan sheets that are included in the plans. All specification requirements that apply to cast-in-place concrete (SS 346) apply to the diaphragms, so you will need to do your inspection with this in mind.

Q U I Z

1) During erection, how does the Contractor tell which beams go where?

2) True or false: beams that are the same size and length have the same load carrying capacity.

3) Other than using the right girder in the right position, what is the most important item you must check about the placement of beams and girders?

4) What do you need to verify in order to ensure that girders are stable prior to deck construction?

5) Is it acceptable for the surface of tendons to be rusty before they are threaded into the bridge?

6) What materials involved in the post-tensioning of the bridge must you check? _____, _____,_____.

7) Tendons must be grouted within ____days of their being installed.

8) Diaphragms stabilize beams prior to deck construction and prevent them from _____ permanently

Chapters One, Two and Three had a lot of information in them. To check yourself, go back and try a couple of the quizzes. If you miss many questions, go back and review these sections. If you do well, take a break before going on to Chapter Four.

ANSWERS TO QUESTIONS

Page 3-5, General and Handling

1) damaged during transport from the plant to the project site

2) upright

3) long enough, the same length

4) Producer

5) pick-up points

Page 3-10 Erection and Diaphragms

1) Each beam is marked for correct location as shown on the framing plan.

2) false, rebars and prestress steel can vary a great deal for a given size and length beam

3) The centerline of bearing for the beam must coincide with the centerline of the bearing on the pier.

4) bracing

5) no

6) ducts, tendon steel and other hardware

7) 14

8) swaying