Inspection & Sampling Procedure for Prestressed Structural Members Manual

Table of Contents

Chapter Five – Concrete Placement

Chapter Six – Weather Influence

Chapter Seven – Inspection of Completed Structural Members

Chapter Eight- Handling, Storage, and Transportation of Structural Members

Chapter Nine – Acceptance and Release for Shipment

Chapter Ten – SiteManager

Appendix A

1 Introduction

Lines of Authority and Communication

Safety

Safety Measures During Prestressing
Safety Measures During Movement of Structural Members

Equipment

Plans and Specifications

INDOT Technician Requirements

Terminology

CHAPTER ONE: *INTRODUCTION*

The primary purpose of this manual is to establish a uniform policy of inspection procedures and standards for the inspection of precast prestressed structural member fabrication. Also included in this manual is an example of the typical documentation required for these activities. The objective is to ensure that the fabricated precast prestressed structural member has been produced in accordance with INDOT plans and specifications.

Technicians are assigned to Precast Prestressed Fabrication Shops for the purpose of Quality Assurance (QA) inspection, and are the contacts between INDOT and the Fabricator. QA fabrication inspection requires close attention to details and procedures required by INDOT to verify that the work performed by the Fabricator is of the quality required by the contract.

The actual construction of a precast prestressed concrete structural member begins when the final approved shop drawings are sent to the shop fabrication floor and continues through fabrication until the structural members are finally put to use. The Fabricator performs Quality Control (QC) and is responsible for the completion of a structural member in accordance with the design drawings and the approved shop drawings. The Technician is responsible for the QA portion of the work. Shop practices and procedures differ with each Fabricator and with each crew within each fabrication plant. INDOT does not specify the procedures of each Fabricator; however, all procedures and workmanship are required to be in accordance with the specifications and details on the plans.

Specifications for precast prestressed concrete structural members are included in Section **707** of the Standard Specifications.

LINES OF AUTHORITY AND COMMUNICATION

The Technician has the authority, using the plans, Standard Specifications, and the contract Special Provisions to make decisions on acceptance or rejection of materials and members produced from these materials. Solutions to any discrepancies or disagreements with the Fabricator, which the Technician feels is beyond his authority to make, should immediately be referred to the District Testing Engineer (DTE).

The Technician has the responsibility to use the plans, Standard Drawings and Specifications, and the contract Special Provisions to verify that all materials are within INDOT current specifications. When there is a defect, the DTE will request a repair procedure from the Fabricator.

When necessary, the Division of Construction Management is available to review and discuss situations that cannot be resolved between the Fabricator, the Technician, and the DTE. These situations are required to be reported by the DTE.

If the Fabricator proposes changes that differ from the plans, the Technician will contact the INDOT Fabrication Supervisor and the Supervisor will contact the DTE and PE for approval of any changes.

The chart in Figure 1-1 indicates the relationship between INDOT and the parties involved in the project. A solid line represents a direct relationship or direct contract between the parties. A dashed line represents a working relationship between INDOT and that party; however, there is no direct contract between them. All formal changes are required to be made through the Prime Contractor.

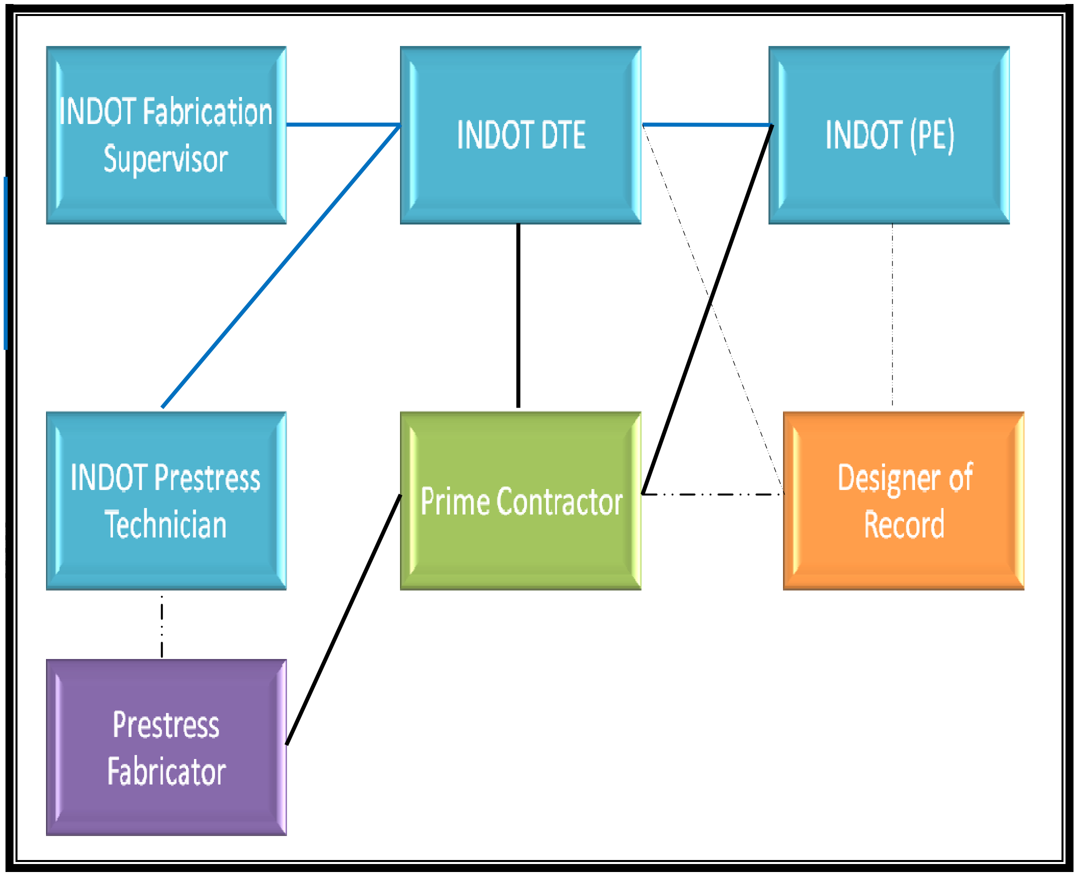

Figure 1-1. Line of Communication

Refer to Chapter 7 for more information in regards to what correspondences are needed in regards to changes in design or materials produced out of compliance with specifications.

SAFETY

Safety is of great importance to the Technician when working in the fabrication facility. At no time should the Technician be put in a potentially dangerous location or position in the fabrication facility. The Fabricator and Technician are required to work closely together to identify and correct any potentially dangerous situations. The Technician is required to follow all safety rules and regulations of the fabricating facility and INDOT including wearing all required Personal Protective Equipment (PPE). INDOT will supply the Technician with the necessary PPE. Consultant Technicians will provide their own PPE.

SAFETY MEASURES DURING PRESTRESSING

The specifications require the Fabricator to provide all safeguards, safety devices, and protection equipment necessary to protect personnel. This protection consists of a screen of heavy plywood, wire mesh, or a combination of both, or of other suitable materials, placed in front of the strand anchorage. The barrier is required to be of adequate width and height and of sufficient strength to withstand a strand that breaks or becomes suddenly released when under tension. This requirement is particularly important during tensioning of the strands. Breakage of the strands is more likely to occur during rather than after tensioning. A tensioned casting bed is considered as potentially dangerous. After a strand breaks, the cable and strand vise will project back with considerable force. The Technician is required to avoid careless or unnecessary exposure to injury such as standing directly in line with a tensioned strand, leaning over a tensioned strand, or placing their face or hands in close proximity to a tensioned strand. If in the opinion of the Technician the safety precautions are inadequate, the DTE is informed immediately.

In many Fabrication plants, the prestressing operation is done inside of a closed structure such as a bunker plate (Figure 1-2). This operation may be safely viewed from the control panel located outside the structure. The Technician is required to stand outside of the bunker when strands are being stressed.

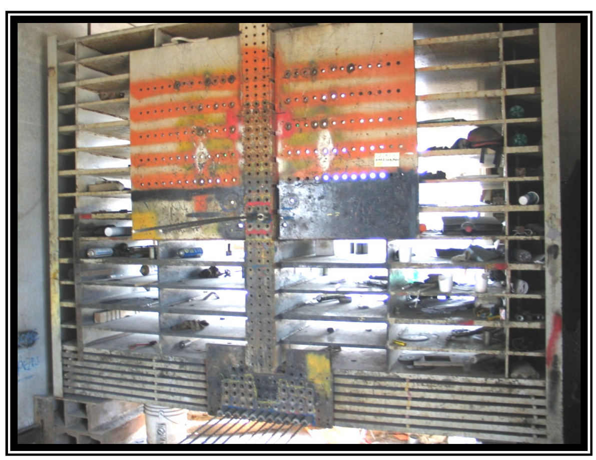

Figure 1-2. Bunker Plate

Other prestressing beds have a steel screen (Figure 1-3) behind the hydraulic jack that is stressing the strands. Personnel are not allowed to stand between the screen and the hydraulic jack stressing the strands.

Figure 1-3. Steel Screen

SAFETY MEASURES DURING MOVEMENT OF STRUCTURAL MEMBERS

Structural members are moved in the yard for various reasons to include loading the members on trucks for transportation to the project or to rearrange the members in the yard to make room for additional storage of other members. During the movement of the members, the Technician will not be in the vicinity of the straddle cranes that are moving the member. Occasionally structural members have been in storage for an extended period of time and the lift loops may have deteriorated. Also, the wooden battens used to support the member may have rotted and no longer are capable of supporting the member. The structural member illustrated in Figure 1-4 tipped over due to the rotten wooden battens collapsing.

Figure 1-4. Bulb Tee Beam Tipped Over

EQUIPMENT

INDOT will supply the Technician with the inspection equipment to perform all of the necessary duties. Consultant Technicians will provide their own inspection equipment. If there are discrepancies with the test results obtained by the Fabricator, the Technician will provide to the Fabricator the equipment calibration records. The Technician will also obtain the calibration records of the equipment used by the Fabricator. The Technician will keep the inspection equipment in calibration at all times. Most calibrations are done on a semi-annual or annual basis by the District Testing Lab or other companies.

PLANS AND SPECIFICATIONS

A thorough knowledge of the plans and specifications is essential before the Technician begins work on each contract. Prestressed materials are exposed to much higher stress values than found in ordinary work. The higher stress values necessitate close attention to specified requirements or the prestress work will not produce the desired results. Every requirement on the plans or in the specifications is important.

The Technician is given a stamped "Approved" set of shop drawings from the DTE along with any Special Provisions for the contract. These drawings are stamped approved by Central Office Division of Structural Engineering or their designated representative. Fabrication shall not begin until the Fabricator and Technician have an approved set of shop drawings. A transmittal letter that lists each approved drawing and any revisions to the drawings is required to accompany the shop drawings.

The District Office will provide the Technician with a Contract Information Book (CIB) with all revisions, and a set of design drawings for the contract. The Technician will compare the design drawings to the shop drawings for any discrepancies. If the Technician does find any discrepancies between the design drawings and the Fabricator shop drawings, the discrepancies will immediately be reported to the DTE. The design plans hold over approved shop drawings (Section 105.04). Shop drawings are not listed in 105.04 because they are not provided by INDOT. Any Special Provisions hold over plans, Supplemental Specifications, and the Standard Specifications. Special Provisions will be found in the CIB.

The design drawings, CIB, and INDOT approved shop drawings are available electronically from the INDOT website and the Department Y drive. If drawings cannot be found, contact the DTE.

INDOT TECHNICIAN REQUIREMENTS

The INDOT Technician is required to have a thorough knowledge of the following to perform the duties at a precast prestressed concrete plant:

INDOT Standard Specifications and Contract Special Provisions
INDOT Frequency Manual
Shop Drawings
INDOT Design Drawings

The INDOT Technician is required to be a Qualified Technician for the following test methods:

AASHTO T 22 ....Compressive Strength
AASHTO T 23 ....Making and Curing Specimens
AASHTO T 119 ....Slump
AASHTO T 121 .... Unit Weight and Relative Yield
AASHTO T 152 .... Air Test
AASHTO T 255…………………. Moisture Content of Aggregates
AASHTO R 60 ....Sampling Fresh Concrete
*ASTM C 173 ....Volumetric Air Test
ITM 207 ....Sampling Aggregates
ITM 403 .... Water/Cementitious Ratio
*only if lightweight or slag aggregate is used

TERMINOLOGY

AASHTO – American Association of State Highway and Transportation Officials

Absorption - The amount of water absorbed under specific conditions, usually expressed as a percentage of the dry weight of the material; the process by which the water is absorbed.

Accelerator - An admixture which, when added to concrete, mortar, or grout, increases the rate of hydration of hydraulic cement, shortens the time of set, or increases the rate of hardening or strength development.

ACI - American Concrete Institute

Admixture - A material other than water, aggregates, and portland cement (including air-entraining portland cement, and portland blast furnace slag cement) that is used as an ingredient of concrete and is added to the batch before and during the mixing operation

Agitating Truck - A vehicle in which freshly mixed concrete can be conveyed from the point of mixing to that of placing; while being agitated, the truck body may either be stationary and contain an agitator or may be a drum rotated continuously so as to agitate the contents

Air Content - The amount of air in mortar or concrete, exclusive of pore space in the aggregate particles, usually expressed as a percentage of total volume of mortar or concrete

Air-Entraining Admixture - An addition for concrete which causes air, usually in small quantity, to be incorporated in the form of minute bubbles in the concrete during mixing, usually to increase its workability and frost resistance. An entrapped air void is characteristically 1 mm or more in width and irregular in shape whereas an entrained air void is typically between 10 and 1000 µm in diameter and spherical or nearly so

Air-Entrainment - The inclusion of air in the form of minute bubbles during the mixing of concrete or mortar

Alkali-Silica Reaction - The reaction between the alkalies (sodium and potassium) in portland cement binder and certain siliceous rocks or minerals, such as opaline chert, strained quartz, and acisic volcanic glass, present in some aggregates; the products of the reaction may cause abnormal expansion and cracking of concrete in service

Approved Concrete Plant – A concrete plant that meets the requirements of ITM 405

ASTM – American Society for Testing and Materials

Bulk Specific Gravity - The ratio of the weight in air of a given volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of an equal volume of distilled water at the same temperature

Bulk Specific Gravity (Saturated Surface Dry (SSD)) – The ratio of the weight of a volume of a material including the weight of water within the pores in the material (but excluding the voids between particles) at a stated temperature, to the weight of an equal volume of distilled water at a stated temperature

Camber – a slight convexity, arching, or curvature of a beam or girder for the purpose of compensating for the deflection when loads are applied

Cement, Blended - A hydraulic cement consisting essentially of an intimate and uniform blend of granulated blast-furnace slag and hydrated lime; or an intimate and uniform blend of portland cement and granulated blast-furnace slag cement and pozzolan, produced by intergrinding Portland cement clinker with the other materials or by blending Portland cement with the other materials, or a combination of intergrinding and blending

Cement, High Early-Strength - Cement characterized by producing earlier strength in mortar or concrete than regular cement, referred to in as Type III.

Cementitious Materials - Substances that have hydraulic cementing properties (set and harden in the presence of water); includes ground, granulated blast-furnace slag, natural cement, hydraulic hydrated lime, and combinations of these and other materials

Central Office – INDOT Office located at 100 N Senate Ave in the Indiana Government Center North Building in Indianapolis, Indiana

Certified Aggregate Producer – A Plant/redistribution Terminal that meets the requirements of ITM 211, continues to be under the same ownership, and is approved by INDOT

Certified Precast Prestressed Concrete Producer **-** Producer that meets the requirements of ITM 814

CIB **–** Contract Information Book

Coarse Aggregate - Aggregate that has a minimum of 20 percent retained on the No. 4 (4.75 mm) sieve

Compressive Strength - The measured resistance of a concrete or mortar specimen to axial loading; expressed as pounds per square inch (psi) of cross-sectional area

Contractor – The individual, partnership, firm, corporation, or combination of same contracting with or desiring to contract with the Department for performance of prescribed work

Curing - The maintenance of a satisfactory moisture content and temperature in concrete during its early stages so that desired properties may develop

Designer of Record **–** The person who designed and stamped the contract plans

Department (*Indiana Department of Transportation (INDOT)* - The agency as constituted under the laws of Indiana for the administration of highway work

DTE – District Testing Engineer

District Office – INDOT Office located within one of the six Districts

Engineer – The Chief Engineer of the Department acting directly or through the duly authorized representatives

Entrained Air - Round, uniformly distributed, microscopic, non-coalescing air bubbles entrained by the use of air-entraining agents; usually less than 1 mm (.04 in.) in size

Entrapped Air - air in concrete that is not purposely entrained. Entrapped air is generally considered to be large voids (larger than .04 in.)

Fabrication Supervisor – INDOT District Testing employee that monitors all testing and quality operations during the production of precast prestressed structural members. This position may also serve as the Technician.

Fabricator – Individual or firm that has subcontracted with the Prime Contractor to produce structural members for the contract

Fine Aggregate - Aggregate that is 100 percent passing the 3/8 in. (9.5 mm) sieve and a minimum of 80 percent passing the No. 4 (4.75 mm) sieve

Fly Ash - The finely divided residue resulting from the combustion of ground or powdered coal and which is transported from the fire box through the boiler by flu gasses; used as mineral admixture in concrete mixtures

Frequency Manual – A document issued by the Department which is titled Manual for Frequency of Sampling and Testing and Basis for Use of Materials. The number of samples and tests, the basis for approval, the basis for use, and similar requirements for furnished materials are specified in the document.

Hardening - When portland cement is mixed with enough water to form a paste, the compounds of the cement react with water to form cementitious products that adhere to each other and to the intermixed sand and stone particles and become very hard. As long as moisture is present, the reaction may continue for years, adding continually to the strength of the mixture.

Heat of Hydration - Heat evolved by chemical reactions of a substance with water, such as that evolved during the setting and hardening of portland cement

High Early-Strength Concrete - Concrete that, through the use of high-early-strength cement or admixtures, is capable of attaining specified strength at an earlier age than normal concrete

Honeycomb - Concrete that, due to lace of the proper amount of fines or vibration, contains abundant interconnected large voids or cavities; concrete that contains honeycombs was improperly consolidated.

Hydration - The chemical reaction between cement and water which causes concrete to harden

Independent Assurance Technician (IAT) – The District Testing Engineer representative responsible for monitoring the Acceptance Technician to make checks on the reliability of the results obtained in acceptance sampling, sample reduction, and testing. The Independent Assurance Technician will not conduct any contract acceptance testing.

Indiana Test Method (ITM) – Written documentation of various test procedures, general testing instructions, programs, and protocols which are used by the Department and not covered by ASTM, AASHTO, or other national Standard Specifications

Maximum Particle Size - The sieve on which 100 percent of the material will pass

Nominal Maximum Particle Size - The smallest sieve opening through which the entire amount of the aggregate is permitted to pass

Office of Materials Management (OMM) – INDOT Office located at 120 S. Shortridge Road in Indianapolis, Indiana

PCC - Portland Cement Concrete

Personal Protective Equipment (PPE) - Items such as ear plugs, gloves, safety glasses, hard hat, vest, etc intended to provide protection to the user

Portland Cement - A commercial product which when mixed with water alone or in combination with sand, stone, or similar materials, has the property of combining with water, slowly, to form a hard solid mass. Physically, portland cement is a finely pulverized clinker produced by burning mixtures containing lime, iron, alumina, and silica at high temperature and in definite proportions, and then intergrinding gypsum to give the properties desired.

Pozzolan - A siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties

psi – pound per square inch (lb/in^2)

Quality Assurance (QA) – Planned and systematic actions by an owner or his representative to provide confidence that a product or facility meet applicable standards of good practice. This involves continued evaluation of design, plan and specification development, contract advertisement and award, construction and maintenance, and the interaction of these activities.

Quality Control (QC) – Actions taken by a Producer or Contractor to provide control over what is being done and what is being provided so that the applicable standards of good practice for the work are followed.

Quality Control Plan (QCP) - A document written by the Contractor that is product-specific and includes the policies and procedures used by the Contractor

Qualified Technician **–** An individual that has successfully completed the written and proficiency requirements of the Indiana Department of Transportation Qualified Laboratory and Technician Program

Retardation - Reduction in the rate of hardening or strength development of fresh concrete, mortar, or grout; i.e., an increase in the time required to reach initial and final set

Saturated Surface-Dry - Condition of an aggregate particle or other porous solid when the permeable voids are filled with water but there is no water on the exposed surface

Scaling - Flaking or peeling away of the near-surface portion of hydraulic cement concrete or mortar

Shrinkage Crack - Crack from restraint of volume reduction due to shrinkage or temperature contraction; usually occurring within the first few days after placement.

Slump - A measure of consistency of freshly mixed concrete, equal to the subsidence measured to the nearest 1/4-in. of the molded specimen immediately after removal of the slump cone

Specific Gravity - The ratio of the weight in air of a given volume of material at a stated temperature to the weight in air of an equal volume of distilled water at the same temperature

Technician – The authorized representative of the Engineer responsible for Quality Assurance. This person is responsible for observing and documenting the operations of the Fabricator and may be either a Department employee or a Consultant.

Water / Cementitious Materials Ratio – The ratio of the amount of water, exclusive only of that absorbed by the aggregates, to the amount of portland cement and the other cementitious material (fly ash, pozzolan, etc.) in a concrete or mortar mixture; preferably stated as a decimal by weight

Water-Reducing Admixture - A material that either increases slump of freshly mixed mortar or concrete without increasing water content or maintains a workability with a reduced amount of water, the effect being due to factors other than air entrainment; also know as water reducer

Water-Reducing Admixture (High Range) - A water-reducing admixture capable of producing large water or great flowability without causing undue set retardation or entrainment of air in mortar or concrete

Workability - The property of freshly mixed concrete or mortar which determines the ease and homogeneity with which concrete may be mixed, placed, compacted, and finished

Yield - The volume of fresh concrete produced from a known quantity of ingredients; the total weight of ingredients divided by the unit weight of the freshly mixed concrete

2 Notification and Fabrication

Notification

Prefabrication Meeting

Office

CHAPTER TWO:
NOTIFICATION AND FABRICATION

NOTIFICATION

The Contractor or the Fabricator is required to give the DTE written notice in advance of the precast prestressed structural member fabrication start date. This notice shall state the name and location of the Fabricator for the contract. A copy of this notice is given to the Technician so that the Technician may contact the Fabricator and request a prefabrication meeting, if necessary. Typically this meeting is only required if something out of the ordinary is required by the contract. Examples of items requiring a prefabrication meeting include a trial batch, use of light weight concrete, or Special Provisions that require discussion. The DTE and Technician will decide if a prefabrication meeting is necessary The prefabrication meeting is held before the fabrication start date.

PREFABRICATION MEETING

The time and location of the prefabrication meeting is mutually agreed upon by the Fabricator and the Technician. This meeting will take place at the fabrication plant. If the Fabricator requests this meeting to be held at a location other than the plant, the Technician is required to agree on the meeting location. The Technician will make an agenda for the meeting that will include items concerning what is expected of the Fabricator and to establish lines of communication between the Fabricator and the Technician. Addressing these items ahead of the fabrication process will help the Technician and Fabricator avoid disagreements as to what is expected and how any discrepancies are handled. The Technician will notify the DTE of the time and place of the meeting and the DTE will attend, if available.

After the Technician has made an agenda for the prefabrication meeting, the Technician will review the agenda with the DTE and make any changes. The Technician will give a copy of the agenda to the Fabricator prior to the prefabrication meeting. The Technician will also obtain a stamped approved set of the Fabricators shop drawings prior to the meeting. These drawings are not obtained from the Fabricator. The DTE will provide instructions for the Technician to download the approved shop drawings, design drawings, and other required materials from the INDOT website. A copy of the proposal and any contract revisions will also be downloaded to check for any Special Provisions that may apply. Advance notification of the meeting will allow the Fabricator time to prepare responses and paperwork that will expedite the meeting.

The Technician will take notes at the prefabrication meeting. A copy of these notes will be made available to all individuals in attendance within five days of the date of the meeting. Personnel in attendance at these meetings will be the Technician, the DTE, the Design Engineer, the Fabricator QC manager, the Fabricator Engineering Manager, and the Fabricator Shop Superintendent. Occasionally, the Prime Contractor will have a representative at the meeting. Either before or after the prefabrication meeting, the Technician will tour the fabrication facility with a representative of the Fabricator.

OFFICE

Some contracts may provide office space for the Technician. A type A field office in accordance with **707.03** is required to be supplied when office space is a provision of the contract. The Technician will review the office facilities provided before the prefabrication meeting to verify that all specification requirements are met. Any issues with the facilities provided will be discussed and resolved at the meeting. The office provided shall have high speed internet access.

3 Materials

Reinforcing Bars

Prestressing Strand

Concrete

Cement and Pozzolans

Aggregates

Admixtures

Mixing and Curing Water

Concrete Plant

Mix Designs

Elastomeric Bearing Pads

CHAPTER THREE: *MATERIALS*

REINFORCING BARS

Reinforcing bars are required to be supplied from a source listed on the Department Approved List of Certified Uncoated Reinforcing Bar Manufacturers and WWR Fabricators and/or Certified Reinforcing Bar and WWR Epoxy Coaters. The most recent listings may be located at the following websites:

http://www.in.gov/indot/div/mt/appmat/pubs/apl08.pdf

http://www.in.gov/indot/div/mt/appmat/pubs/apl07.pdf

If the Fabricator plans to use ties to keep the reinforcing bars in position prior to and during the placement of concrete, the reinforcing is required to meet ASTM A 615 or A 706 standards.

The Technician will obtain verification samples at the jobsite for testing as detailed in the Frequency Manual.

PRESTRESSING STRAND

Typically, prestressing strands consist of uncoated seven-wire stress-relieved strands meeting the requirements of ASTM A 416 for the size and grade specified or as shown on the approved shop drawings (Section **910.01 (b)**). The Technician is required to verify that a Type A certification covering the strand is received from the manufacturer before the strand is used in the work. Section **916** contains examples of the various required certification forms. The certification shall indicate the modulus of elasticity of the strand and the area of the strand used to calculate the modulus of elasticity. The DTE will provide the most current ASTM A 416 standard to the Technician so that the laboratory report may be compared to the current strand requirements.

CONCRETE

Sections **707.04 (c)** and **707.04 (d)** include the requirements for the concrete used in the precast prestressed structural members. The water-cementitious ratio of the concrete at the time of placement is required to be 0.420 or less.

CEMENT AND POZZOLANS

Cement and pozzolans are required to be stored in a clean, dry, place and protected from moisture until used. Cement or pozzolans which have become partially set or contain lumps are not used. Silica fume is sometimes added in high strength applications. The approved sources of cement and pozzolans may be located at the following website:

http://www.in.gov/indot/div/mt/appmat/pubs/apl02.pdf

AGGREGATES

Fine and coarse aggregates used in precast prestressed structural members are not required to be produced by a Certified Aggregate Producer Program (Section **904.01**). ITM 203 requires that sources supplying stone for precast prestressed concrete members have ledge samples obtained. This is not a requirement for aggregate sources supplying aggregates for precast concrete.

The coarse aggregate is required to be Class A or higher, Size No. 91 (Section **904.03**).

Lightweight coarse aggregates are sometimes incorporated into precast prestress structural members. This concrete may be referred to as lightweight concrete. The lightweight aggregates are typically used when the girder is very long. A Special Provision will be included in the contract document to detail the requirements for the use of this aggregate. The aggregate the Fabricator proposes to use is required to have aggregate quality tests conducted in accordance with ITM 203.

Fine aggregate is required to be natural sand, size No. 23, or crushed limestone, dolomite, gravel, or ACBF.

If aggregates are supplied from a CAPP source and are of the specified quality, no further testing will be required. If the aggregates are not supplied from a CAPP source and there is a concern with the quality or gradation of the aggregate, a point-of-use sample may be obtained in accordance with the Office of Materials Management Directive No. 202. The approved sources of aggregates may be located at the following website:

http://www.in.gov/indot/div/mt/appmat/pubs/apl03.pdf

ADMIXTURES

Portland cement concrete admixtures are required to be supplied from a source listed on the Department Approved List of PCC Admixtures and Admixture Systems. Admixtures Type A, D, F, or G may be used in accordance with Section **707.04 (c).** High range water reducing (HRWR) and high range water reducing retarding (HRWRR) admixture systems may also be used. Admixtures Type B, C, or E may only be used when approved in writing. The concrete is required to be air entrained and meet the requirements of Section **702.05.** The approved sources of admixtures and admixture systems may be located at the following website:

http://www.in.gov/indot/div/mt/appmat/pubs/apl22.pdf

MIXING AND CURING WATER

Water proposed for use in mixing or curing is required to be in accordance with **913.01**.

CONCRETE PLANT

If the Fabricator produces the concrete, the Technician is required to inspect the storage, mixing, and transportation of the materials in the concrete. The materials are required to be stored, produced, and transported in accordance with Section **702**. The Technician is required to perform the inspection of the plant in accordance with ITM 405, Portland Cement Concrete Plant Inspection.

MIX DESIGNS

All mix designs are reviewed annually and approved by the Technician. If the Technician has a problem or question, the DTE will be contacted. The mix designs may be adjusted daily for fluctuations in aggregate moistures. A change in the cement source, pozzolan source, admixture type or source, and /or aggregate source will require the Fabricator to submit a new mix design. Some Fabricators use different mixes according to expected curing times. For example, a Fabricator may have a mix design with less cement than their "standard" mix that is used on a Friday when the members are required to cure all weekend in the forms. This practice is acceptable.

The standard mixes that most Fabricators use may be approved without a trial batch. However, some Special Provisions, such as for lightweight concrete, require a mix design to have a trial batch. The mix design is required to be approved by the DTE prior to the trial batch. All tests from the trial batch are required to meet the requirements of the Special Provisions and Section **707.04 (c)** before a mix design is approved for use. Compressive strength of the concrete is required to be in accordance with **707.04 (c)** or the required 28 day strength from the shop drawings, whichever is greatest.

The design Water/Cementitious Ratio (W/C) normally is set below the maximum allowable amount to account for variations in the materials used to determine this value. Good Quality Control by the Fabricator allows the W/C to be set closer to the maximum allowable amount.

ELASTOMERIC BEARING PADS

Elastomeric Bearing Pads include plain bearings that consist of elastomer material only and laminated bearings that consist of layers of elastomer material restrained at their interfaces by bonded laminates. The grade of the material is required to be as shown on the plans. The number, types, and sizes of elastomeric bearing pads are required to be as specified or as shown on the plans or approved shop drawings.

Not all bridges have elastomeric bearing pads. The plans are required to be checked to verify if bearing pads are required. If bearing pads are required, verify that the Fabricator has submitted a sample for testing to the Office of Materials Management in accordance with the Frequency Manual.

4 Casting Bed

Movement of Anchorage Abutments

Elongation of Abutment Anchoring Bolt

CHAPTER FOUR:
CASTING BED

The Technician is required to check the casting beds periodically for deviations from a plane surface. Any deviations sufficient to cause irregularities in the bearing areas of the member, or other irregularities that may approach or exceed the established tolerances are required to be corrected.

CONCRETE FORMS

Precast prestressed structural members are generally manufactured in steel forms. The interior of the forms are thoroughly cleaned after each use and are required to be treated with an approved formulated form coating prior to placing concrete. Some concrete will remain on the bottom flanges of the forms after removal of the structure member which may appear as an irregularity on the next beam. The tops of the forms are also required to be kept clean of any possible contaminates during the pour. Form coating materials are required to be free from lubricating oils, fuel oils, kerosene and other ingredients which cause discoloration of the finished concrete and are required to be applied before any reinforcing bars or prestressing strands are placed in the forms. Since the integrity of all pretension members is based on the development of uniformly high bond on all strands and reinforcing, the necessity of clean strands and reinforcing is important. Form ties, if used, should be of either the threaded type or snap-off type so that no form wire or metal pieces are left at the surface of the finished concrete.

Voids in the structure members may be formed by any material. Materials, such as polystyrene, are required to be firmly anchored to prevent floating or movement during the placement and compaction of the concrete. Improper location of the voids will change the structural properties of the member and may easily result in a weak member. Void tubes may be held in position by the use of metal fittings (saddles or chairs) placed permanently on top or by the use of tie wires and spacer templates. The spacer templates are required to be removed after the tubes are securely fastened by tie wires or immediately after placing the concrete and before the concrete has set. Spacer templates or other positioning devices that may have a tendency to induce cracking in the finished structure member if left in place, are required to be removed before, during, or immediately after the concrete is placed. Other methods of satisfactorily holding the tubes in place may be used. Any method to position and hold void tubes in the correct location is required to not affect the vertical or horizontal alignment of the prestressing strands.

When two or more sections of void tubes (cylindrical or rectangular) are used to make up a required length, the ends are effectively taped together. Forms for void tubes damaged during storing, exposure to the elements, or handling are not used. Cylindrical void tubes are placed longitudinally side by side. The usual dimensions

for these tubes are 10 ½ in. outside diameter for standard 17 in. structural member depth and 12 ½ in. outside diameter for standard 21 in. structural member depth. If cylindrical void tubes are positioned before the start of concreting operations, adequate precautions are required to be taken to insure that no movement occurs during placement and consolidation of the concrete.

Rectangular void tubes are required to be of the sizes specified on the Standard Drawings or approved Shop Drawings and the interior corners are required to be chamfered as specified or approved. The void tubes are placed after the concrete is struck off accurately to the thickness of the bottom slab to eliminate the possibility of void spaces beneath the tubes.

All necessary provisions to ensure the proper positioning of the voids in the finished member is the responsibility of the Fabricator. In addition to other checks, the Technician is required to verify that the tubes are placed correctly and remain in the correct position. The Technician also is required to check the location, position, and condition of the void drains. The voids are to be vented during the curing period.

Any and all voids are subject to a position check after the structural members have been constructed. Any structural member with a void out of position in excess of the specified tolerances may be rejected.

REINFORCING

Reinforcing bars, wire reinforcement, and prestressing strands are required to be stored under cover and protected at all times from damage.

Reinforcement required to be bent shall be accurately cold bent in a bending machine to the shapes shown on the plans. Reinforcing bars with cracks or splits are required to be rejected. All dimensions shown on the plans for spacing of reinforcing bars apply to centers of bars unless otherwise noted. Reinforcing bars are accurately placed and firmly anchored to retain their position as shown on the plans during concrete placement. Distances from the forms are maintained by means of chairs, ties, hangers, or other approved supports. All reinforcement is required to be rigidly wired or securely fastened at sufficient intervals to hold the reinforcement in place. Welding reinforcing bars is not allowed.

Layers of bars are required to be separated by approved spacers. Reinforcing bars are separated from horizontal surfaces by being suspended or supported on approved metal chairs and spacers. For the steel reinforcement near the header in Figure 4-1, the reinforcing bars are spaced closely together near the ends of the member. The chairs maintain the proper spacing between the rebar and the forms when the bed is closed and the concrete is poured. The stirrups are placed around the prestressing strand. The strands in the vertical position are the lifting loops.

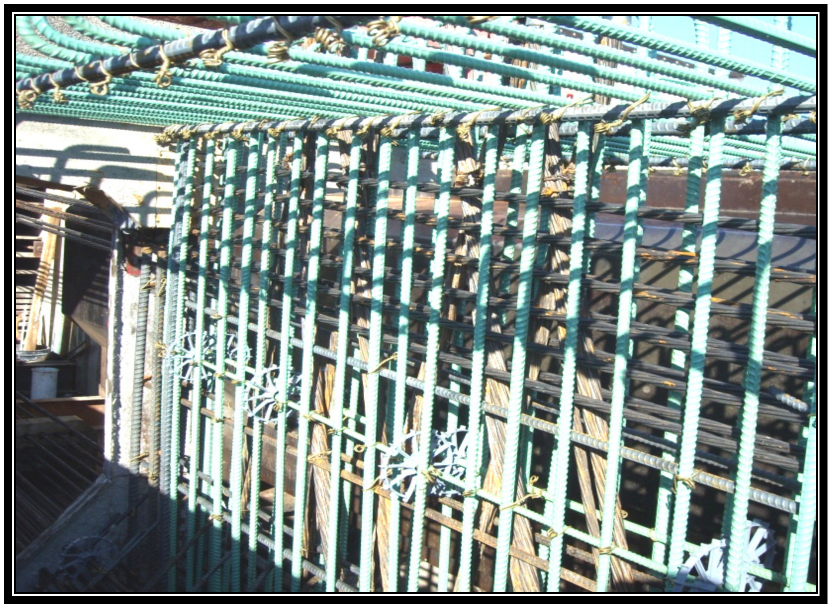

Figure 4-1. Metal Chairs and Spacers

Metal supports and spacers are of such shape that they may easily be encased in concrete, and that portion of the support and spacer in contact with the forms is required to be non-corrosive and non-staining material. The supports and spacers types are approved by the Engineer. Vertical stirrups always pass around main tension members and are required to be securely attached. The use of pebbles, broken stone or bricks, metal pipe, wooden blocks or other similar devices for holding reinforcement or strands in position is not permitted.

After being placed, all reinforcement is inspected and approved before the concrete is placed. The positions of the bars, both during and after the placement of the concrete, may not be altered.

SPLICES

All reinforcing bars are required to be furnished in the full lengths indicated on the shop plans unless splices are indicated. No other splicing is allowed, except with written permission of the Engineer.

For lapped splices (Figure 4-2), reinforcing bars are required to be placed in contact and rigidly clamped or wired in a manner approved by the Engineer. Unless otherwise shown on the drawings, reinforcing bars are to be lapped at 32 times the bar diameter to make a splice. If possible, splices are required to be staggered and well distributed, or located at points of low tensile stress. Splices are not permitted at points where the section does not provide a distance of at least 2 in. between the splices and the nearest adjacent bar or surface of the concrete unless indicated otherwise on the design or approved shop drawings. Laps are required to be in accordance with **703.06**.

Figure 4-2. #6 Reinforcing Bar lapped, spliced, and tied into place along the top of the structural member

PRESTRESSING

Prestressing strands are carefully handled at all times to prevent kinks, nicks, bends, or other defects. The use of prestressing strands with these defects is not permitted. Tensioned strands are subject to relaxation if subjected to excessive temperatures such as those produced by torches, welding equipment, or sparks and are required to be protected accordingly. The strands are required to be the type, size and number specified and be located and spaced as shown on the detail design or shop drawings. Each reel of strand is labeled (Figure 4-3).

Figure 4-3. Reels of Strand

ELONGATION

In all methods of tensioning, the stress induced in the prestressing strands is required to be measured both by gauges and by elongation of the tendons or strands (Figure 4-4).

Figure 4-4. Elongated Strands

The elongation for the gauge length of the strand is computed accurately using the actual cross-sectional area and modulus of elasticity of the strand from the laboratory report and the design load for each strand from the plans. The computed elongation and the design load are adjusted to compensate for any operational losses or thermal corrections. Form IC 737 (Appendix A), is used for computing the elongation. The strands are tensioned to the adjusted design load.

The actual elongation obtained on each strand is checked against the adjusted computed elongation and is required to be within the allowable tolerance of five percent. The strands are required to be held securely in place and, where necessary, galvanized chairs or other approved methods are used to prevent sag of the strands and to assure the thickness of the concrete beneath the strands is as shown on the drawings.

Draped strands, when specified, are required to be deflected at the third points (Figure 4-5) or at the locations shown on the detail design drawings or approved shop drawings. Strands are securely held in place at all points of change in slope with a roller device that minimizes friction during tensioning.

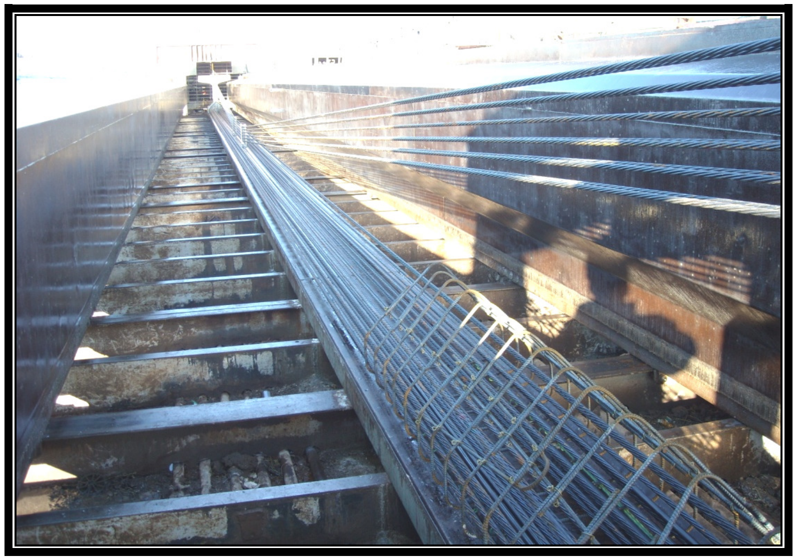

Figure 4-5: Tensioned Straight Strands and Deflected Strands

Pre-tensioning may be done by prestressing one strand or by tensioning two or more strands simultaneously. An orderly procedure of stringing and tensioning the strands is important for easy record keeping.

PRESTRESSING SYSTEM

The prestressing system (Figure 4-6) used by the Fabricator is equipped with accurately calibrated gauges for registering the loads produced. A record of the force applied to each prestressing strand and the identification of the prestressing strand and unit to which the record applies is made. All readings are placed on form IC 736 (Appendix A). Pressure gauges, load cells, dynamometers, or other devices may be used. All devices for measuring the stressing load are required to have a reading accuracy within two percent. All gauges are required to be calibrated annually by an approved laboratory. If during the progress of the work any gauging system appears to be giving erratic results, the jack and the gauges are required to be re-calibrated. The laboratory shall furnish a calibration curve for each device indicating errors or adjustments necessary over the entire span of the gauge. Gauges are required to have a reading dial of not less than 8 in. in diameter and digital readouts, if used, should be easily read.

Figure 4-6: Prestressing System

Each gauge is capable of reading loads directly in pounds or is accompanied by a chart from which the dial reading may be converted to pounds. Calibration of gauges is required to be done with the gauges on the jacking system to be used in the prestressing operations. The load shall be acting on the ram of the jack and in the same direction as the actual tensioning operation. The gauges are required to have a full pressure capacity of approximately twice the working pressure. Unless calibration data clearly establishes accuracy over a greater range, the loads to be gauged are required to be not less than 1/4 or more than 3/4 the total graduated capacity of the dials. A tensioning system using hydraulic gauges shall have appropriate by-pass piping valves and fittings, such that the gauge point remains steady and does not fluctuate until the jacking load is released from the strand. Gauges shall be mounted at near working eye level and within 6 ft of the operator to insure accurate and consistent readings.

INITIAL TENSIONING OF STRAIGHT STRANDS

The purpose of the initial tensioning is to take up the slack in the strands so that elongation measurements may be made during final tensioning. After the prestressing strands have been positioned, a minimum initial tensioning force of 1000 lb is required to be applied to each strand to be tensioned to equalize the stresses in the strands. This may be increased if necessary; however, the tensioning force shall not exceed a value of 5000 lb. The magnitude of the initial tensioning force is the minimum force necessary to equalize the stresses and eliminate slack in the strands. The standard method used to apply the initial tensioning force is a single strand tensioning jack which is the same jack used for single strand tensioning. The jack is required to be equipped with a gauging system that registers the initial tension force. The length of the casting bed and the number and size of the strands tensioned determines the magnitude of this force. Elongation measurements are not used to determine the initial tensioning force. Properly calibrated load cells may be used for this purpose.

The initial tensioning sequence for a group of strands is required to be such that the indicated tensile force is uniformly distributed in the strand throughout the length. The strand being tensioned may not be restrained by exterior forces. Where the strand passes through the stirrups, spirals, or headers, care is necessary to prevent binding that would result in substantial restraint. Avoiding entanglement of the strands during tensioning may be accomplished by having a definite sequence of laying and tensioning. In most cases, the laying of the strands shall progress from the bottom row of the strand group to the top row. The initial tensioning is done in the reverse order.

When single strand jacking is used, the jacking ram has a tendency to rotate due to the unwinding action of the strand. This rotation is required to be minimized as considerable losses in the strand tension may occur if unwinding in excess of one turn is permitted.

INITIAL TENSIONING OF DRAPED STRANDS

Draped pre-tensioned strands are tensioned entirely by jacking with the strands held in their draped position by means of rollers (Figure 4-7) or other approved methods during the jacking operation. The low-friction free turning rollers are required to be used at all hold-up and hold-down points where there is a change in slope of the strand trajectory. The roller devices that hold up the strand are located outside of the headers and may be adjusted vertically to correspond with the dimensions specified on the plans. The tensioning of draped strands applied by jacking is done by the same procedures and is required to conform to the same requirements as the tensioning for straight strands. Any other method used for tensioning draped strands is required to be indicated on the shop drawings and approved by the Designer of Record.

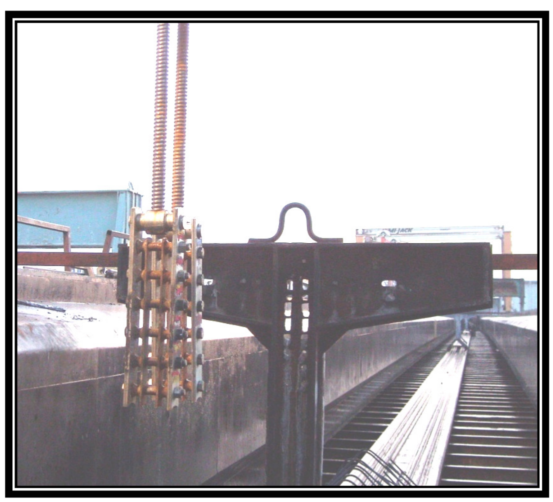

Figure 4-7. Rollers

Draped strands are pulled through the abutment plate on one end of the casting bed. Once the strand is properly spaced through the hold-down and hold-up points, chucks (Figure 4-8) are put into place and then prestressing may begin.

Figure 4-8. Strand Chucks

The required procedure for tensioning draped strands in the deflected position by single strand jacking is as follows:

1) Apply the initial tensioning load to the strand

2) Mark the strand for elongation measurement

3) Apply the full tension load as determined by the jack gauge, not by elongation

4) Measure the elongation and determine the remaining elongation required for full tension based on computed elongation

5) Apply the full tension load to the other end of the strand and measure the elongation at that end. The sum of the two elongation measurements from each end is required to be within the allowable tolerance of 5 percent.

   The strand may be tensioned simultaneously at each end to the full tension load and the elongation measured at each end. The sum of the two elongation measurements are required to be within the allowable tolerance.

Single strand tensioning of the strands in the draped position by jacking the strands from only one end is permissible for shorter beds provided the strand elongation obtained is within the allowable tolerances and the required load on each strand is not exceeded.

Friction at each of the positioning devices resists some of the forces exerted in pulling the strands. The load actually applied to the strand, therefore, is decreased at each successive point of deflection away from the sources of pull. When several members are to be cast on the same bed and tensioning is performed from both ends involving a large number of positioning devices, the loss of stress in the strand away from the source or sources of pull may be excessive. This is evident by undue disagreement between the load determined by the elongation measurement and that indicated by the gauges. When this situation occurs, the number of points of deflection is required to be reduced sufficiently so that the friction losses do not influence the tensioning beyond the five percent allowable tolerance.

The lengths of the strands to be used in calculating elongations will be the actual length of the strand along the trajectory between the fixed anchorage and the referenced point at the jacking end of the strand.

UP-LIFT AND HOLD-DOWN DEVICES

Up-lift and hold-down devices (Figure 4-9) are attached in such a manner to maintain the specified center to center spacing of strands in both the vertical and horizontal directions. Provisions are made for the opening left by the removal of the restraining device to be grouted. Using aluminum sleeves or approved fiber sleeves for the hold-down bolts is satisfactory (Figure 4-10).

Figure 4-9. Hold – Down Device

Figure 4-10. Aluminum Sleeves

STRAND SPLICES

The splicing of straight strands in accordance with AASHTO M 203 is permitted. Splice locations may not fall within the concrete member. Splices are preferred to be located on the end opposite the hydraulic jack referred to as the "dead" end. Spliced strands are required to have the same “twist” or “lap”. For single strand tensioning, slippage of the splices is considered in computing the elongation.

When tensioning multiple strands, either all of the strands or not more than 10 percent are required to be spliced since correction for excessive slippage of individual strands cannot be made. If all of the strands are spliced, the average splice slippage is considered in computing the elongation. Splices may only be made between the beams and not in the middle. If 10 percent or less of the strands are spliced, no slippage allowance is required. Splicing is not permitted on draped strands.

While prestressing operations are in progress, the Technician is required to check the gauges indicating the tension load and check the elongation to assure that the strand is not fowling or unwinding beyond the strand vise. The Technician also checks for slippage in the strand vises and in the strand splices and for any movement of the anchorages or abutments. Section **707** designates the number of permissible wire breaks. Any permissible wire breaks which may occur are located and the ends securely tied to the strand with wire. A strand with a broken wire is tensioned to the same elongation as strands with no broken wires, but not to the same load. The elongation is obtained with approximately 86 percent of the load required for whole strands.

MEASURING ELONGATION

The degree of accuracy necessary in reading the elongation depends on the magnitude of elongation obtained, which in turn depends upon the length of strand tensioned. Measurements to the nearest 1/8 in. are satisfactory for casting beds of 150 ft or longer and measurements to the nearest 1/16 in. are satisfactory for casting beds shorter than 150 ft.

There may be differences between the adjusted computed elongation and the actual measured elongation. The allowable difference may be up to 15 percent. In the event of a difference in excess of this amount, the entire operation is required to be carefully checked and the source of error determined and corrected before proceeding further.

After the initial tensioning force has been applied to the strand, reference points for measuring the elongation due to additional forces are required to be established. The location of the reference points will vary slightly with the different methods of tensioning strands and with the physical characteristics of the equipment used. The adjusted computed elongation and the plus and minus tolerance limits of 5 percent are accurately determined from these reference points. The actual elongation obtained is then checked against the allowable tolerances.

Calculations for elongation and jacking pressures are required to include the appropriate allowances for thermal corrections, friction, and all possible slippage and relaxation of the anchorages.

Example Computations for Elongation

Assume the problem is to tension 46, 7/16 in. stress relieved strands to a total tension of 19,100 lb for each of four beams 80 ft long. The casting bed has a length of 350.5 ft from the strand anchorage to the reference point for tensioning.

$$\text{Elongation (inches)} = \frac{PL}{AE}$$

P = tension forces in pounds

L = distance in inches from anchorage to reference point

A = cross-sectional area of strand in square inches

E = modulus of elasticity of prestressing strand assumed as 27,500,000 lb/sq. in.*

* This value is an average modulus of elasticity applied to the stress range between the initial tensioning and 70 percent of ultimate strength. Where the modulus of elasticity established by the strand manufacturer or the stress range is appreciably different from the example shown, the value of the modulus is more accurately established and approved by the Office of Structural Services.

P = 19,100 lb (total) – 1,500 lb (initial) = 17,600 lb (net)

$L = 350.5 \text{ ft.} \times \frac{12 \text{ in.}}{\text{ft}} = 4{,}206 \text{ in.}$

A = 0.109 sq. in. = area of one 7/16 in. strand

$E = 27{,}500{,}000 \text{ lb/in}^2$

$$\text{Elongation} = \frac{17{,}600 \times 4{,}206}{0.109 \times 27{,}500{,}000} = 24.70 \text{ in. (computed elongation)}$$

Assume 0.25 in. slippage in strand anchorages. Total elongation required after initial tensioning to prestress strand to 19,100 lb is:

24.70 in. + 0.25 in. = 24.95 in.

TEMPERATURE VARIATIONS

Changes in the temperature of the strands after tensioning will often result in stress changes in the strands. When strands are stressed in a cold atmosphere and warm concrete is placed around the strand there is a reduction in the tension due to the thermal expansion of the strand. The reverse is true if the strands are stressed on a very warm day and the temperature of the concrete is cooler than the temperature of the strands when tensioned.

When the temperature of the strands being tensioned is 25°F or more below or above the temperature of the placed concrete, the strand elongation and load computations are required to take into account the difference between the temperature of the strands when tensioned and the temperature of the concrete when placed. The Fabricator is required to follow Section **707.07** when required overstressing would exceed 75 percent of the ultimate strength of the strand. The Engineer is informed of this procedure. The amount of strand under tension not subjected to elevated temperatures while the concrete is undergoing the initial set is considered in the computations. Predicting the temperature of fresh concrete with sufficient accuracy to calculate the temperature change expected in the reinforcing at the time the concrete is placed is normally possible.

EXAMPLE COMPUTATIONS FOR TEMPERATURE CORRECTION

Prestressing on a Cold Day

Assume for the previous example of elongation computations that the strands are stressed at an air temperature of 25° F and that the concrete at placement was expected to have a temperature of 75° F

C = Thermal coefficient of expansion of steel = 0.0000065 in/in/deg

$L_{concrete}$ = Length of strand incased in concrete (add length of beams in the bed) is 3840 in.

T_1 = 75°F (expected temperature of concrete at time of placement)

T_2 = 25°F (temperature at which the 4,206 inch strand was tensioned)

Elongation = 24.70 in. (from previous example problem)

Total Elongation (length change) in strand due to higher concrete temperature:

Total Elongation = Elongation + C x ($L_{concrete}$) x ($T_1 - T_2$)

Total Elongation = 24.70 + 0.0000065 x (3840 in) x (75° F – 25° F) = 1.25 in.

Total Elongation = 24.70 in. + 1.25 in. = 25.95 in.

Assume 0.25 in. slippage in strand anchors

Total Elongation = 25.95 in. + 0.25 ins. = 26.20 in.

When strands are stressed in a cold atmosphere and warm concrete is placed around the strands, there will be a reduction in the tension due to the thermal expansion of the reinforcing.

Prestressing on a Hot Day

Similar corrections are made if prestressing is done on a hot day. The temperature of the steel beds may be approximately 110°F on a warm day while the concrete temperature may be approximately 70°F. The resulting reduction in the temperature results in an increase of tensile stresses in the prestressing strands.

C = Thermal coefficient of expansion of steel = 0.0000065 in/in/deg

$L_{concrete}$ = Length of strand incased in concrete (add length of beams in the bed) is 3840 in.

T_1 = 110°F (temperature at which the 4,206 in. strand was tensioned)

T_2 = 25°F (expected temperature of concrete at time of placement)

Elongation = 24.70 in. (from previous example problem)

Total elongation (length change) in strand due to lower concrete temperature:

Total Elongation = C x ($L_{concrete}$) x ($T_1 - T_2$)

Total Elongation = 0.0000065 x (3840 in.) x (110° F – 70° F) = 1.00 in.

Total Elongation = 24.70 in. – 1.00 in = 23.70 in.

Assume 0.25 in. slippage in strand anchors

Total Elongation = 23.70 in. + 0.25 in (for slippage) = 23.95 in.When strands are stressed in a warm atmosphere and cooler concrete is placed around the strands there will be an increase in the tension due to the thermal shrinkage of the reinforcing.

SLIPPAGE OF STRAND ANCHORS

One of the most frequent causes of discrepancies between calculated and measured elongations is slippage of the gripping devices at either or both ends of the bed. In multiple strand tensioning, one or more grips may slip considerably and not be detected by elongation or load measurement.

One method of detecting slippage is to mark each strand with a crayon or soapstone at a uniform distance of 1/2 in. to 1 in. from where the strand emerges from the gripping device. Movement of the mark shows the slippage. The slippage of the strand in the gripping device at the jacking end of the strand is easily detected after anchoring by determining the loss in measured elongation.

In normal operation, most grips in common use slip from 1/8 in. to 1/4 in. depending on the type and condition of the grips. This means that a correction of as much as 1/2 in. may be necessary in the calculations for elongation. Slight errors in corrections for grip slip are much less significant on the long beds than on short beds. For example, if the anticipated correction is 1/4 in and the slip is actually 1/2 in., an elongation of 50 percent will be in error less than one percent. However, if the total elongation is 4 in., the 1/4 in. error in anticipated grip slip results in a 6 percent error in total elongation.

Another problem is slow, gradual slippage in gripping devices from the time the initial tensioning is done until the concrete around the prestressing elements has set. The Technician is required to watch for this unusual condition.

MOVEMENT OF ANCHORAGE ABUTMENTS

For each pre-tensioning operation, the yield, deflection, or movement of the anchorage abutments is required to be determined. The value of this measured movement will reasonably compare with the assumed value in the elongation calculations. The significance of the discrepancy between the assumed and measured abutment movement is dependent upon the distance between the anchoring abutments. Usually if the combined movements exceed 1/16 in. per 100 ft of strand length, the need for applying corrections to the measured elongation and applied loads is required. The DTE is required to be consulted for these corrections.

ELONGATION OF ABUTMENT ANCHORING BOLTS

If anchor bolts used in the abutment anchoring system experience tensile stresses during prestressing, the elongation of these bolts is required to be considered in the elongation calculations. After the full tensile load has been applied to these bolts, the actual elongation is measured and compared with the theoretical elongation. The significance of differences in these values is dependent upon the length of the prestressing bed. The DTE is required to be consulted for these corrections.

5 Concrete Placement

CHAPTER FIVE:
CONCRETE PLACEMENT

Concrete used to produce precast prestressed structural members is required to be batched in an approved plant meeting the requirements of ITM 405. A Quality Control Plan (QCP) is prepared by the vendor in accordance with ITM 803. This plan is approved by the DTE before production begins.

TESTING

All QC concrete testing is performed by a Technician employed by the Fabricator. All concrete testing for structural members will be monitored by a Qualified Technician employed by INDOT. This is the QA oversight. If, as directed by the DTE, the Qualified Technician employed by INDOT cannot be present for the compression testing to verify the minimum strength for prestress release has been achieved, the Fabricator may proceed with the compressive strength testing. The Fabricator is required to complete the Certification of Compliance for Release of Prestress Force (Appendix A) and provide this document to the Qualified Technician. When the above procedure is used, INDOT is required to obtain test cylinders to perform verification compressive strength testing. The frequency of verification testing is determined by the DTE. The INDOT Technician is required to notify the Fabricator that additional compressive strength cylinders are required at the time the beam is cast.

The Fabricator Technician may be either Certified or Qualified. Certification may be obtained from a trade organization such as American Concrete Institute (ACI), Precast/Prestressed Concrete Institute (PCI), or through INDOT. Qualification is obtained through the Independent Assurance Program. A Qualified Technician is required to pass a written exam and demonstrate proficiency for each individual test that is performed. The written test and demonstration of proficiency are given by an Independent Assurance Technician (IAT) located in each INDOT District. Required tests include the air content, compressive strength, making and curing specimens, sampling concrete, slump, yield, moisture content of aggregate, sampling aggregates, and water/cementitious ratio. Fabricator Technicians are required to demonstrate proficiency to the IAT every year. All Certified and Qualified Technicians are entered into the SiteManager log of Technicians.

ENTRAINED AIR

Concrete used in precast prestressed structural members is required to be air entrained. Air entraining and other types of concrete admixtures are maintained on an Approved List by the Office of Materials Management.

Air content is determined by AASHTO T 152 or ASTM C 173 for lightweight concrete. Air content tests are made in accordance with the requirements of the Manual for Frequency Manual or as directed by the Fabrication Supervisor. The results of all tests are shared between INDOT and the Fabricator. Tests for entrained air are required to be made on concrete containing the same materials and using the same type mixer and mixing procedure used for the structural member. The air test is taken as close as possible to the work location.

The air content is required to be 6.5% ± 1.5%. If the air content tests are not consistently within specification requirements, additional air content tests are required to be performed and recorded until the air content is consistent. Hot temperatures, new admixtures, and the first batch of the day may sometimes attribute to the air content not being within the specification requirements.

SLUMP

The concrete is required to be workable and of the desired consistency. The slump test is a measure of this workability and consistency and is required to be conducted in accordance with Section **505.01**. Acceptable slump ranges are designated in Section **707.04**. Slump tests are made in accordance with the requirements of the Frequency Manual or as directed by the Fabrication Supervisor.

STRENGTH

Precast members that are not prestressed are required to have a minimum compressive strength of 4500 psi in 28 days in accordance with Section **707.04**. All tests are monitored by the INDOT Technician and the results will be readily available.

WATER / CEMENTITIOUS RATIO

The maximum water cementitious ratio is required to comply with Section **707** and ITM 403. The total of Portland cement and other cementitious material may not exceed 800 lbs/cu.yd.

MIXING

Concrete materials are required to be stored, produced, and transported under applicable provisions of Section **702.07** and **702.09**.

Concrete for structural members is usually mixed on-site in a stationary mixer, truck mounted mixer, or a combination of the two. Ready-mixed concrete from an approved plant is also acceptable if not more than 30 minutes elapses from the time mixing water is added and the mix is deposited in the forms.

The batch-mixer is required to be approved by the Engineer and meet the following:

1) Provide a uniform distribution of the materials

2) Operate at the rated capacity or less

3) Be equipped with a mechanical means to prevent the addition of materials once mixing is started

4) Contents of drum are entirely emptied before the next batch is started

PLACING

Concrete is required to be placed in a continuous operation in accordance with Sections **707.06** and **702.20** to produce a monolithic structural member free of any cold joints, areas of segregation, honeycomb, or planes of separation between layers.

Concrete is placed in the forms in such a manner that the concrete does not free fall more than 5 ft and that no segregation occurs. The concrete is placed in uniform layers and thoroughly compacted during and immediately after placing, and vibrated (Figure 5-1).

Figure 5-1. Vibrating the Concrete

Section **707.04(a)** allows a tight coat of concrete grout on reinforcing bars to extend a maximum of 1/2 in. from the top of the structural member. All loose and flaky material is required to be removed from the reinforcing bars. Plastic bags are often used to prevent excess concrete from drying on the reinforcing bar during concrete placement (Figure 5-2).

Figure 5-2. Plastic Bags on Reinforcing Bars

Hangers (Figure 5-3) and clips are supplied by the Contractor for false work. The Contractor provides the location and spacing of the hardware if the locations are not shown on the shop drawings.

Figure 5-3. Placing Hangers

Floating or screeding the top of the concrete is done to obtain a smooth finish (Figure 5-4). Shop drawings will indicate the amount and frequency of the transverse scoring. Excess concrete on the tops of the forms is required to be removed.

Figure 5-4. Concrete Finish

In the event that there is a significant time delay between lifts, the Technician is required to check the concrete in the bed. The vibrators are required to easily penetrate and consolidate the concrete. Extra work is required between the lifts to ensure proper consolidation of the subsequent lifts. The Technician is also required to record the time that the trucks arrive at the bed.

CONCRETE COMPRESSIVE TEST SPECIMENS

During placement of the concrete, the Technician monitors the making of concrete compressive test specimens. These specimens are made in accordance with Section **707.04(c) 3**, and the Frequency Manual designates the number of compressive test specimens that are required. A cylinder set consists of at least three cylinders obtained from three separate batches or loads of concrete used in casting a structural member. This cylinder set is required when at least three or more loads of concrete are needed for each member. When only one to two loads are required for each member, at least one cylinder is required for each load. When the pour is large, testing the first load of concrete is necessary and cylinders are required to be made from this load.

Compressive test specimens are made in accordance with AASHTO T 23. The cylinders are required to be 6 in. in diameter and 12 in. in height and cured at the same location and in the same manner as the structural member (Figure 5-5). Special care is taken to not disturb the concrete cylinders during the initial set of the concrete. Cylinders are placed on or near the casting bed so that the concrete is not disturbed by nearby vibrators or workers.

Figure 5-5. Curing Concrete Specimens

Concrete test specimen tags are required to indicate the contract number, job number, beam identification, location of the test in the beam, the date poured, and the initials of the Technician (Figure 5-6).

Figure 5-6. Concrete Specimen Tags

CURING

Curing may be done by accelerated curing or by wet curing in accordance with Section **707.07** and AASHTO T 23 (10.2). For accelerated curing in accordance with Section **707.07 (b)**, low pressure steam is usually used; however, radiant heat may be used. The casting bed for any unit cured with steam is required to be completely enclosed by a suitable type of housing and tightly constructed to minimize heat and moisture loss.

Water curing methods, such as covering the top of the freshly set concrete with wet burlap (Figure 5-7), are used from the time the concrete is placed. Tarps (Figure 5-8) are placed over the forms after the burlap is placed.

Figure 5-7. Wet Curing with Burlap

Figure 5-8. Wet Curing with Tarps

Curing is maintained until the concrete meets the minimum required strength for detensioning. In discontinuing the steam application, the air temperature inside the enclosure is required to decrease at a rate not to exceed 50°F per hour until a temperature has reached at least 40°F above the temperature of the air which the concrete is exposed. Recording thermometers are required to be provided by the Fabricator and are used to check these temperature requirements. The temperature of the concrete shall not exceed 158°F.

DE-TENSIONING

The inspection of the finished product starts with the de-tensioning operation. This occurs after the strands have been stressed, the conventional reinforcement has been placed, the forms have been positioned, all hardware and accessories have been installed, and the concrete placed and cured. Forms which may restrict either horizontal or vertical movement of prestressed members are stripped, or at least loosened, prior to de-tensioning.

Unless otherwise specified on the detail plans or approved shop drawings, the minimum compressive strength of the concrete at the time of the prestressing is required to be at least 4000 psi. This value is determined from compressive test specimens made at the time the beam was cast. If the concrete has been steam cured, the prestressing operation is required to be done while the concrete is still warm and moist.

The prestressing of the concrete beam requires cutting or releasing of the tensioned strands outside the ends of the beam which transfers the tension load in the strand from the anchoring abutments to the concrete beam. The top strand is required to detensioned first (Figure 5- 9).

Figure 5-9. Detensioning Top Strand

The bottom strand is then detensioned symmetrically about the center line (Figure 5-10). Each end of the strands is cut in the same manner at the same time. Specific details of the detensioning sequence are listed on the shop drawings.

Figure 5-10. Detensioning Bottom Strand

Concrete changes in dimension because of temperature change and shrinkage. The temperature of structural members is required to be held reasonably constant during the curing period, especially during the latter half of the curing period. If the concrete is permitted to dry and cool for any length of time prior to prestressing, dimensional changes take place which may cause cracks or undesirable stresses in the concrete due to restraint caused by the prestressing strands. This is especially true if hold-downs are used to deflect strands. Therefore, de-tensioning is done immediately following the curing period and when test cylinder strengths indicate that the required minimum compressive strength has been obtained. Prestressing forces are never applied to a member until the required minimum compressive strength of the concrete has been obtained. In all de-tensioning operations, the prestressing forces are required to be kept symmetrical about the vertical axis of the member and be applied in such a manner to prevent any sudden or shock loading.

MULTIPLE STRAND RELEASE

The strands may be released simultaneously by hydraulic jacking. With this method, the total force is taken from the header by the jack and gradually released. Some sliding of the members on the bed may occur. The amount of sliding is proportional to the exposed lengths of the stressed strands between members and between the last member and the fixed end. To minimize sliding, these lengths are held to a practical minimum. Structural members stressed by this method are required to be free from all restrictive movement, other than sliding friction on the bed.

SINGLE STRAND RELEASE

Single strands may be released by heating and gradually parting the strands. Heating is done on each strand simultaneously at both ends of the prestressing bed and preferably at all spaces between the ends of adjacent members. Where spaces between the ends of adjacent members are short, simultaneous heating at all spaces between members may not be required; however, any allowance is required to be in accordance with the approved sequence. For release of the strands to occur gradually, the ends are not quickly cut and are heated until the metal gradually loses strength. Heating is done with a large low-oxygen flame that is applied along the strands at 2 in. to 5 in. in width. Strands are heated in such a manner that failure of the first wire in each strand occurs after the torch has been applied for approximately 5 seconds or preferably longer.

Symmetry of release is required to be observed at each beam end. Strands are cut one at a time on opposite sides of the center line so the sequence used keeps the stresses nearly symmetrical about the axis of the structural members.

DRAPED PRE-TENSIONED STRANDS

Unless the plans or specification indicate otherwise, draped pre-tensioned strands are required to be de-tensioned using the following procedure:

1) Release the tension in the draped strands at the ends of the structural members by heating each strand until failure. The draped strands are heated to failure at each uplifted point in accordance with the approved sequence or as shown on the shop drawings.

2) All hold-down devices for the draped strands are released and the hold-down bolts within the members removed

3) If any straight pre-tensioned strands are located within the members, the straight strands are de-tensioned after the draped strands have been de-tensioned. Straight strands may be de-tensioned by either the single-strand or multiple strand release method.

4) Procedures for transfer of prestressing forces to structural members with deflected pre-tensioned strands are followed.

REMOVAL OF FORMS

In accordance with Section **707.07**, side forms may be removed when there will be no distortion, slump, or misalignment of the concrete. The side forms are removed with a crane after all of the bolts for the inserts have been removed. The beam is then lifted from the bed by the crane (Figure 5-11) and transported to the storage area.

Figure 5-11. Beam Removal

SEALING OF SURFACES

The outside vertical faces of fascia girders and the exposed face and top of the curb section are finished in accordance with Section **702.21**. The tops of all beams and the outside faces of the fascia beams are sealed with an approved concrete sealer in accordance with Sections **707.06** and **709** (Figure 5-12).

The list of approved Proprietary Portland Cement Concrete Sealers may be obtained from the following:

http://www.in.gov/indot/div/mt/appmat/pubs/apl29.pdf

Figure 5-12. Sealing Beams

The concrete surface is required to be at least 28 days old. If the beams are shipped prior to 28 days, the beams are required to be sealed at the job-site. The Technician will inform the PE at the job-site of this sealing requirement by e-mail as well as noting the need for sealing on the Yellow Shipping Cards.

The sealer and ambient and surface temperatures at the time of sealing are required to be between 40°F and 100°F. Silane sealers may not be applied if the ambient temperature is expected to drop below 40°F in the next 12 h.

If rain has occurred, the concrete surfaces are dried at least 48 h before sealing. Sealers are not applied if standing water is visible. Silane sealers require at least 4 h to dry in 70°F weather at 50% humidity. Drying times are longer in cooler or more humid conditions. If rain is expected before the drying time is completed, the structural beams are required to be covered appropriately.

6 Weather Influence

Cold Weather Fabrication

Hot Weather Fabrication

CHAPTER SIX: *WEATHER INFLUENCE*

COLD WEATHER FABRICATION

Structural members poured in cold weather are required to meet the requirements for cold weather structural concrete detailed in Sections **707.07** and **702.11**. When concrete is placed at or below 35°F, the water and or aggregates may be heated to no more than 150°F. Forms may be covered with tarps and the area within and around the forms may be heated to above 35°F by means of steam, radiant heat, or forced air. Concrete is required to be delivered immediately after the removal of the tarps. The tarps are replaced as soon as possible after placing of the concrete. The temperature of the heated concrete is required to be between 50°F and 90°F when heated water or aggregates are used. The use of calcium chloride to accelerate hardening of the concrete is not permitted under any circumstances.

HOT WEATHER FABRICATION

When structural members are fabricated during hot weather, the steel form work may become very hot. The forms may be cooled by means of spraying with a fine mist of water and/or using reflective tarps. Any concrete deposited on the tops of the forms is required to be scraped off the top flanges before the concrete begins to cure. "Hot spots" (Figure 6-1) form on the underside of the top flanges when splatters of concrete remain on top of the hot steel forms before the concrete fills the remainder of the form. Figure 6-2 is a close-up picture of a hot spot.

Figure 6-1. Top Flange Hot Spots

Figure 6-2. Hot Spot

There is a correlation between hot weather and decreasing amounts of entrained air retained in the concrete. Additional air tests may be required to ensure the air content is within specification requirements.

If the temperatures are too high and concrete cannot be produced at a temperature of 90°F or lower at the time of placement, the Fabricator is required to wait until the ambient temperatures are cooler. Usually, the material component that retains the most heat is the cement. If the cement is already too hot before being incorporated into the concrete, the concrete will likely exceed the maximum allowable temperature of 90°F.

When temperatures are beginning to approach the hot extremes of the specification requirements, the thermometers may need to be re-calibrated at higher temperatures.

7 Inspection of Completed Structural Members

CHAPTER SEVEN: *INSPECTION OF COMPLETED STRUCTURAL MEMBERS*

CHECKING DIMENSIONS

After the side forms are stripped and the surfaces of the structural member have been examined for defective concrete, the Technician is required to check the completed structural member. The dimensions, including camber, horizontal alignment (sweep), and plumb are checked against the requirements on the approved shop drawings and/or INDOT standards to determine if the structural member is within the allowable tolerances. The tolerances are shown on INDOT Standard Drawings 707- BPBF-01 to BPBF-04.

Structural members with dimensions falling outside the specified tolerances are required to be rejected unless approved measures to correct the deficiency are completed. The QCP is required to contain provisions for corrective measures for an out of tolerance structural member. A written corrective action plan shall be presented to the Engineer for approval. Length measurements that are slightly outside the tolerance limit, especially in the case of structural members of considerable length, are subject to review. The temperature of the concrete at the time the measurements are made will have some influence on the length; however, the influence of the temperature on other measurements may be considered negligible. Grinding of beams to allow measurements to fall within the specified tolerance may be permitted only with the written approval of the Engineer. The limits of tolerance do not necessarily represent acceptable fabrication but are the limits at which fabrication may become unacceptable. The Fabricator is required to work at a level of quality that is well within the tolerance limits. The Technician is required to inform the Fabricator of dimensions that approach the tolerance limits so that the proper adjustments may be made in future fabrication of members.

CHECKING CAMBER

The camber of each structural member is checked after the strands are released. Since there is a possibility of a change in camber occurring for members in storage, the camber of each member is also required to be checked just prior to shipping.

The camber may be checked with a surveyor level by determining the elevation of marked points on top of the member at the ends and the mid-point before and after the strands are released (Figures 7-1 and 7-2). The camber may also be checked by marking a point on the floor or bed at mid-section of the member and placing a reference mark the same distance above this point on the side of deck beams or on the lower flange of I-beams. The distance between the two marks is measured before and after the release of the strands. Either of the methods outlined above is

done just prior to and after releasing the strands and while the member is still on the casting bed.

Figure 7-1. Checking Camber at the End of the Beam

Figure 7-2. Checking Camber at the Mid-Point of the Beam

Another method of checking the camber that may be done at any time the member is accessible is by means of a wire or line. The procedure is as follows:

1) Place a straight edge transversely under the beam at the ends and mid-point

2) Measure the same distance at the three points vertically above the straight edge and place a mark on the side or flange of the member

3) Stretch a wire or line tightly between the marks at the ends of the member and record the distance between the wire or line and the mark at the mid-point of the member

Care is taken to assure that there is a minimum amount of sag in the wire or line. Any sag not compensated for is included as camber in the member. Tests may be conducted in advance to determine the maximum length for which this compensation would be sufficiently accurate. The pull or tension necessary for various lengths of wire or line to reduce the sag to a minimum may be determined and the sag measured at mid-point with a surveyor level or other suitable means. When checking for camber, the pull or tension for a certain length wire or line is used and the sag deducted from the mid-point measurement. The remaining measurement is the amount of camber in the beam. The variation of camber is required to be more than that allowed in the plans or standard drawings 707-BPBF-01 thru 04. If the camber is outside the allowable tolerances or is already at the erection camber at the time of release, the DTE, PE, and Contractor are immediately notified.

The shipping camber is recorded on Form IT 573 (Yellow Card) and IC 735 (Appendix A).

CHECKING PLUMB

The plumb or vertical alignment of the beams is checked after the strands are released. Since there is a possibility of a change in plumb occurring while a member is in storage, the Technician is required to check the plumb of each member just prior to shipping. The Technician should note that many beams have top and bottom flanges of different widths. Checking plumb is generally done by placing a carpenter level against the end of the beam and observing the vertical centerline of the beam section in relation to true vertical.

DEFECTS

The Technician will contact the DTE for determination of the final disposition of the structural member when a minor or major defect in the structural member is observed. All communications between the Fabricator, Prime Contractor, PE/S, DTE, and Technician may be done by means of written or electronic notification. Acceptance or rejection of the structural member will be done by the DTE. The

District Field Engineer in the Division of Construction Management or the Office of Materials Management may be contacted if there are any questions concerning the quality of the structural member.

MINOR DEFECTS

If the defects are cosmetic or minor in nature that will not affect the structural capacity or structural integrity of the member, the DTE will request a written repair procedure from the Fabricator. The Fabricator shall send the repair procedure to the Prime Contractor and the DTE. Examples of minor defects in structural members include minor honeycombs, bug holes, minor cracks, or spalling (Figures 7-3 & 7-4). If the repair procedure is acceptable, the DTE will inform the Fabricator and the Prime Contractor that the structural member may be repaired in accordance with the approved repair procedure. The structural member repairs are done in the presence of the Fabrication Inspector. Once repaired, the structural member will be accepted. A Disposition of Rejected Materials form (TD 305) will not be issued.

Figure 7-3. Top Corner Spalling

Figure 7-4. Bulb Tee Spalling on Top Corner

INSPECTION AND REPAIR OF SURFACES

Immediately after the removal of the forms, the concrete surfaces are inspected for honeycomb, voids, or other defects. Members having honeycombs or voids in or near the bottom of a member bearing area, or surrounding or exposing strands of reinforcing bars or prestressing strands, are generally rejected. Minor honeycombs or voids not affecting the strength of a structural member may be repaired when approved by the DTE. The method of repair is required to be submitted in writing. After the defective concrete has been removed, the area is examined by the DTE. Repairs are required to be made in the presence of the Technician.

All repairs are required to be rubbed even with adjoining surfaces. Any evidence of plastering over an area or repairing a defective area without approval of the DTE is sufficient cause for rejection of the member. The depressions left in the bottom of pre-tensioned members with draped strands after removal of the hold-down bolts are required to be cleaned of oil or grease and the surface roughened or keyed. The bottom and sides of the depression are completely coated with an approved bonding compound, and the depression filled with a preapproved patch. Unless these precautions are taken, the grout will most likely fall out due to the flexure of the structural member.

CRACKS

Structural members are required to be free from cracks and other defects. However, cracks occur and past studies have revealed that some cracks are entirely superficial. These cracks are usually small in number, on the top surface, are not extending down the sides or into the body of the member, and do not have a detrimental effect on the quality of the structural member (Figure 7-2). In such instances, some leeway may be permitted. Good references concerning superficial cracks are ACI Committee 224 Report entitled "Control of Cracking in Concrete Structures" and the PCI Manual for the Evaluation And Repair of Precast, Prestressed Concrete Bridge Products.

Figure7-2. Minor Crack

Cracks constitute potential locations for the start of disintegration of the concrete and no members with cracks, however small, are accepted unless the cracks are effectively sealed against the entrance of water with a suitable epoxy resin.

Cracks on the top surface of members are required to be grooved to a depth of 1/4 in. to hold the sealing material. Cracks on the sides of members, which are only hair-line width, may be painted with the sealing material. End cracks are required to be sealed before the ends are given the required coatings of asphalt paint.

Each instance of crack occurrence is considered individually. When there is a possibility that a member with cracks may be acceptable, the extent and magnitude of the crack or cracks is determined before the decision for acceptance may be made. The method used to determine the extent and magnitude of the cracks is required to not reduce the structural capacity of the member. Whenever the Technician has any doubt about the acceptability of a member, the DTE is contacted.

MAJOR DEFECTS

If the DTE believes the defects could affect the structural capacity or structural integrity of the member, the DTE will issue a TD 305 and send copies to the Prime Contractor, Fabricator, and PE/S. Examples of major defects in structural members include stirrups not extending high enough above the top of the beam, fewer than the required number of strands extending from the end of the beam, or wrong reinforcing bars used in the beam.

The Prime Contractor is responsible for consulting with the Fabricator concerning the acceptance or rejection of the structural member. The procedures shall be as follows:

1) If the Prime Contractor elects not to have INDOT pursue an investigation, the DTE will notify the Fabricator that the structural member is unacceptable and a new structural member will be required.

2) If the Prime Contractor elects to have INDOT pursue an investigation of the structural member, a written repair procedure is required by the Fabricator. Copies of the repair procedure are sent by the Fabricator to the Prime Contractor, PE/S, and the DTE.

3) The DTE will forward the repair procedure to the Designer of Record for an investigation.

4) The Designer of Record will review the repair procedure and make a recommendation to the DTE for acceptance of the repair procedure to the structural member or rejection of the structural member. The expenses incurred by the Designer of Record to evaluate the structural member will be submitted to the DTE.

5) If the Designer of Record does not accept the recommendation for repair of the structural member, the DTE will document on the TD 305 that the structural member is unacceptable and a new structural member will be required.

6) If the Designer of Record accepts the recommendation for repair of the structural member, the DTE will document the required repairs on the TD 305.

7) The DTE will issue the final recommendation and may either concur with the Designer of Record recommendation or provide another recommendation. The DTE will complete the TD 305 with the appropriate recommendation and send a copy to the Prime Contractor, Fabricator, PE/S, INDOT Inspector and the Office of Materials Manageent of the final decision regarding the acceptance or rejection of the structural member.

8) The costs for the evaluation of the structural member will be assessed to the Prime Contractor by means of the TD 305. These costs will include the DTE expenses for the time and travel to inspect the structural member, the Designer of Record expenses to evaluate the structural member, the Fabricator Inspector expenses for the time to monitor the repair, and any other incurred expenses. An additional penalty may be assessed for structural members that do not meet the specification requirements and have defects that are determined to not affect the structural capacity or structural integrity of the member. A minimum of $1000.00 or the actual cost of the investigation if more than $1000.00 will be assessed.

9) The Prime Contractor may appeal the decision of the DTE by sending a notification to appeal to the DTE within 15 days from the date of the notification of the failure. The basis of appeal in detail is required to be included in the notification. The DTE will review the appeal and send the decision to the Prime Contractor.

REJECTION OF STRUCTURAL MEMBER

If the defects are significant, the quality of the structural member does not meet specification requirements, and the DTE decides that the structural member cannot be modified to meet the specification requirements, the DTE may reject the structural member by sending a notification to the Fabricator. A TD 305 will not be issued. The Fabricator may appeal the failed materials decision by sending a notification to appeal to the DTE within 15 days from the date of the notification of the failure. The basis of appeal in detail is required to be included in the notification. The DTE will review the appeal and send the decision to the Fabricator.

8 Handling, Storage, and Transportation of Structural Members

CHAPTER EIGHT:
HANDLING, STORAGE, AND TRANSPORTATION OF STRUCTURAL MEMBERS

The handling, storage, and transportation of structural members is described in Section **707.08**. Members damaged by improper handling, storing, or transportation are replaced at the expense of the Contractor.

HANDLING

The method of handling of structural members is indicated on the shop drawing and is approved prior to use. To avoid damage to the members during handling, the members are required to be in an upright position at all times. The members are lifted by the inserts or other approved devices for that purpose and are supported as indicated below when in storage and during transportation to the construction site.

STORAGE

In storage, the structural member is fully supported across the width of the structural member on battens and are stored in a level position to prevent twisting (Figure 8-1). Supports for cantilever beams are as shown on the plans. Due to storage limitations, structural members may be stacked. If stacked, structural members are supported as described in Section **707.08**. Structural members may not be stacked more than three members high.

Figure 8-1. Structural Member Storage

TRANSPORTATION

During transportation, the structural members are supported with truck bolsters or battens (Figure 8-2). The ends of beams are not allowed to extend more than the depth of the beam and not more than 3 ft 6 in.

Figure 8-2. Structural Member Transportation

9 Acceptance and Release for Shipment

Breaking Test Specimens

Stockpiled Material

Acceptance Forms

Transportation

CHAPTER NINE: *ACCEPTANCE AND RELEASE FOR SHIPMENT*

If all other requirements have been met and the structural member meets the minimum 28 day compressive strength requirements, the structural member may be accepted for shipment. If the Contractor elects to ship a structural member prior to 28 days, sufficient test specimens are required to be made to assure adequate 28 day compressive strength. If all other requirements have been met and a member fails to meet the minimum 28 day compressive strength requirement, the member is rejected. The compressive strength is determined by breaking test cylinders made at the time the member was cast. These cylinders are required to be cured in the identical manner as the member was cured. The average of three test cylinders from one cylinder set is used. Coring the structural member to obtain a test specimen is not allowed.

BREAKING TEST SPECIMENS

Because testing at elevated temperatures may have an adverse effect on the strength of the concrete, cylinders removed directly from steam curing are cooled to ambient temperature prior to testing. The test cylinders are tested in accordance with AASHTO T 22.

STOCKPILED MATERIAL

Once all structural members have been sealed and all certifications and ship loose materials accounted for, the members may be stored. The Contractor may request payment for stockpiled materials in accordance with Section **111.03 (b)**. Notification is sent to the PE/PS that the members are stockpiled and have met the testing requirements.

ACCEPTANCE FORMS

The Technician is required to complete the acceptance forms IT-573 (Yellow Card), IC 734, IC 735, IC 736, and IC 737 (Appendix A).

IT 573 (YELLOW CARD)

The primary purpose of form IT 573 is to assure the PE/S that the member has been inspected, tested, and accepted prior to shipment. For each member accepted for shipment, the Technician is required to complete one copy of form IT 573 (Figure 9-1) and send this form to the PE/S at the time of shipment. The camber of each member measured just prior to shipping is recorded on Form IT 573. The date poured, date sealed, and date each member is shipped is also

recorded on this form. If the member is shipped before 28 days and/or without being sealed, this information is noted on the form. The number of each accepted member is also reported on the form. The original IT 573 is shipped with the structural member. A copy of each IT 573 is made and placed in the contract file and e-mailed by the Fabricator Supervisor to the PE/S.

Form BM-573

Fabricator No. L/D/M 9999

Contract No. I R - 9 9 9 9 9

SiteMgr Report No. R 1 2 (Yr.) 5 (District) 4 7 3 5 (Submitter) 9 9 9 9 9 (Sequence)

INDIANA
DEPARTMENT OF TRANSPORTATION
Division of Materials and Tests

No. 4 7 3 5 9 9 9 9

Material: 9 4 9 9 **54" Hybrid Bulb Tee**

SiteMgr. Material Code: 7 0 7 M 0 0 0 2 0

Producer: 8 5 0 2 **Prestress Services Industries**

Location: **5501 Briar Hill Road, Lexington, KY 40516**

Date Poured: **September 9, 1999** Beam ID: **MK999-9**

Date Shipped **October 10, 1999** Camber: **2"** **3 1/4"**

Date Sealed At Job Site or 10/9/99 Release Ship

This material has been
INSPECTED
prior to shipment, but may be registered at any time before use, and rejected if unsatisfactory

Signed: *Fabrication Supervisor Signature*

Figure 9-1. Sample IT-573 (Yellow Card)

IC 734

After the structural member for each bed or pour has been inspected and the specified 28 day compressive strength has been obtained, form IC 734 is required to be completed. All members constructed for a specific contract are reported on form IC 734 whether or not the member has been accepted. If any member is rejected, the reason for the rejection is noted under the "Remarks" section.

Form IC 734 is distributed with the following certifications and documents:

1) Type A Certification for the seven wire strand

2) Type B Certification for Elastomeric Bearings, Laboratory Report for Elastomeric Bearings (which is the Basis-For-Use for this item) and Mill Certifications for Elastomeric Bearings

3) Receipts of concrete materials used for that contract

4) Letter from the Fabricator detailing the concrete sealer from the Approved List that was used to seal the structural members

5) Documents for the steel diaphragm connectors/angles which includes high strength bolts, nuts, and washers. Other documents for rotational capacity, the mill report, and galvanization are also attached, when applicable.

6) Certifications for any other materials when required by the specifications or Special Provisions

7) All correspondence received and submitted pertaining to the structural members

8) All reports detailing repairs done to any of the members

Forms IC 734 and IC 735 are attached in SiteManager with all required certifications. An e-mail is sent to the PE/S and DTE with the IC 735 attached, indicating that the entries in SiteManager with the attachments are complete. The SiteManager report number is included in the correspondence. One copy with the certifications and additional documentation is retained in the file of the Technician.

The Fabrication Supervisor has blank copies of all of the forms. The excel spreadsheet contains formulas in certain cells in the form. The cells with formulas are highlighted and will automatically calculate the necessary values when the other information is entered. The Fabrication Supervisor will format the spreadsheet with information relative to each plant.

IC 737

Before tensioning begins, form IC 737 is completed which details stressing materials and computations. A copy of this form is placed in the file of the Technician.

IC 736

As members are being stressed, the resulting data is recorded on form IC 736. This form summarizes the actual jacking measurements for each structural member. A copy of this form is placed in the file of the Technician.

IC 735

When structural members are ready to be shipped, the camber, sweep, and plumb are required to be measured again. At this point, form IC 735 is completed. This form summarizes all inspection data and includes the Yellow Card number and the date shipped. The IC 735 is filed in SiteManager and a copy placed in the file of the Technician.

POUR SHEET

The form for tracking information during the concrete pour until the 28 day cylinder breaks are made and the structural members are sealed is designated on the Pour Sheet. A Pour Sheet is used for each concrete pour, and the information added to forms IC 734 and IC 735.

10 SiteManager

CHAPTER TEN: SITEMANAGER DATA ENTRY FOR MATERIAL 707M00020

SiteManager Panel

From the SiteManager Main Panel (Figure 10-1), select the "Materials Management (+)" icon:

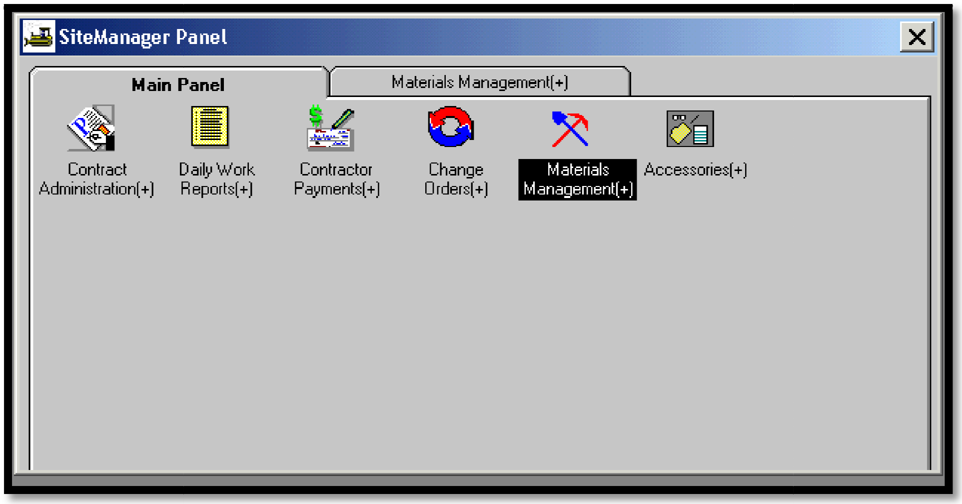

Figure 10-1. Site Manager Main Panel

From Materials Management Tab (Figure 10-2), select the "Sampling and Testing (+)" icon.

Figure 10-2. Materials Management

From the Sampling and Testing Tab (Figure 10-3), select the "Sample Information" icon.

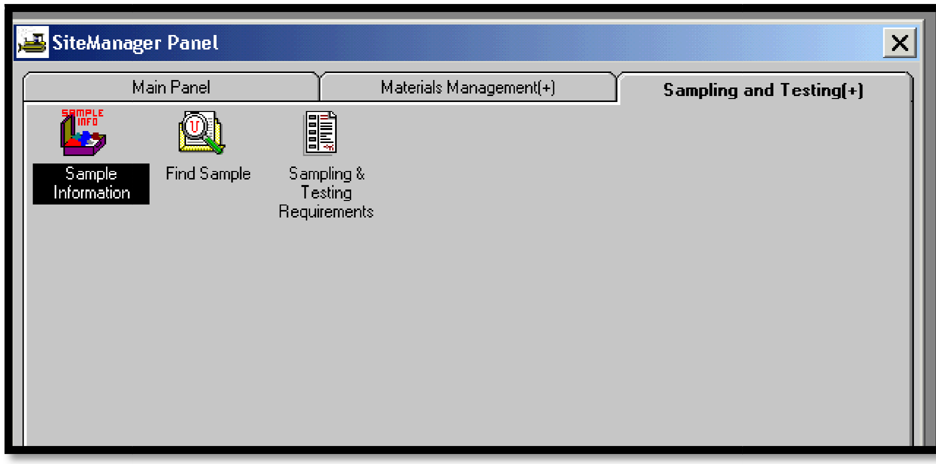

Figure 10-3. Sampling and Testing

From the Maintain Sample Information Panel (Figure 10-4), enter all information required for the material records for the structural members for each project on a contract that are completed. There may be more than one project on a contract. In this case, a new Sample ID shall be created for each project.

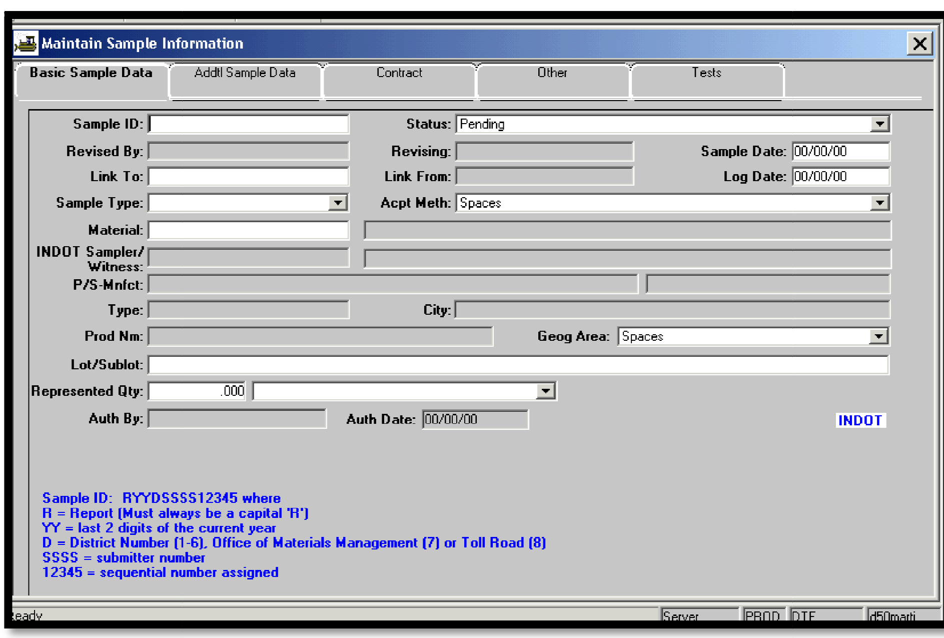

Figure 10-4. Maintain Sample Information

The sample ID number will be designated by either the Structural Fabrication Supervisor or the Technician. This number is defined in the blue font at the bottom of the Maintain Sample Information Panel and designated as follows:

R = Report (must capitalize "R")

YY = last two digits of the current year

D = District Number (1-6), Office of Materials Management (7), or Toll Road (8)

SSSS = Submitter Number assigned to the Technician for Site Manager Data entries

12354 = Sequential Number assigned by the Structural Fabrication Supervisor or the Technician.

For each sample ID, five tabs are filled in to completion along with the necessary attachments. The tabs include: the Basic Sample Data tab, the Addtl Sample Data tab, the Contract tab, the Other tab, and the Tests tab. The attachments are added with the yellow attachment icon. The means of filling in the information is described as follows:

BASIC SAMPLE DATA TAB

For the Basic Sample Data Tab (Figure 10-5), SiteManager will automatically generate some of the information as other fields are completed. The fields that the Technician is required to complete are: Sample ID, Status, Sample Date, Log Date, Link To (if necessary), Sample Type, Acpt Meth, Material, INDOT Sampler/Witness, P/S-Mnfct, Geog Area, Lot/Sublot, and Represented Qty.

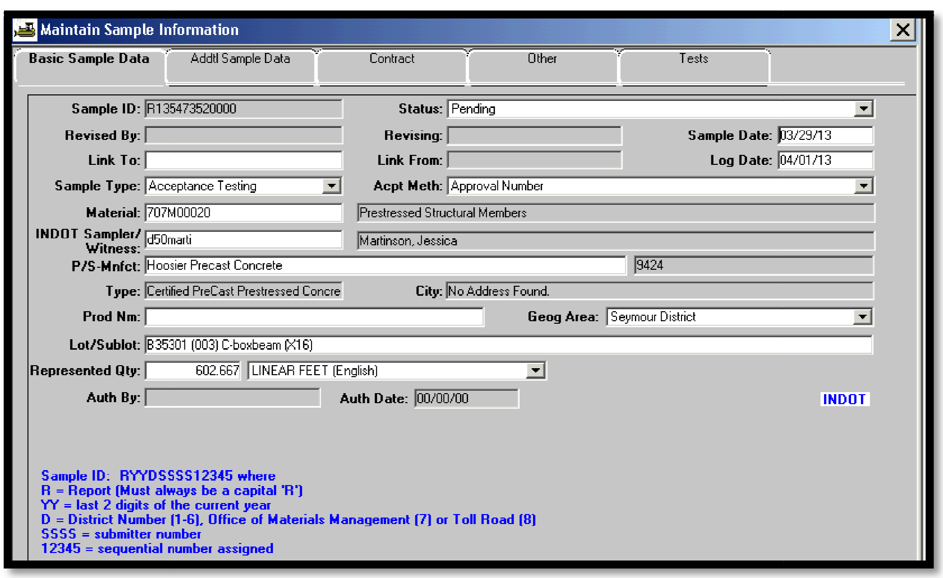

Figure 10-5. Sample Data Tab – Status Pending

Entries on this form include the following:

Status - "Pending" shall be the status until the PE/PS authorizes the entry and changes the status to "Complete". If the material has failed the testing requirements, the status will be designated "Fail". The Structural Fabrication Supervisor will complete any failed materials entries.

Sample Date - The sample date will be either the date the beams for a completed project are stockpiled or shipped to the project site depending on the dates available at the time of SiteManager data entry.

Link To – this entry is used to link the Sample ID to another Sample ID. This is necessary if there is a failed material or if there are data entry errors that need corrected. "Link To" and "Link From" will usually be left blank.

Sample Type - "Acceptance Testing" will always be the "Sample Type" for Material Code 707M00020.

Acpt Meth - "Approval Number" will always be the "Acceptance Method" for Material Code 707M00020.

Material - 707M00020 is the material code for Prestressed Concrete Members. The number will be typed in exactly. The Technician may also right click on the blank white space, select "search", and select the correct "Material Code" from the list. The Material Name will be generated in the gray box to the right of the Material Code.

INDOT/Sampler Witness - The Technician that has inspected the project. If there are multiple witnesses, use the ID of the person that witnessed the majority of the work, the ID for the Technician entering the data, or the ID of the Structural Fabrication Supervisor.

P/S-Mnfc - The Producer/Supplier – Manufacturer is the name of the Fabricator Plant where the prestressed structural members were fabricated. This entry is required to be typed in exactly. The Technician may also right click on the blank white space, select "search", and select the correct Fabricator & Plant from the list. The Fabricator approval number will appear in the gray box to the right.

Prod Nm – Prod Nm shall be left blank

Geog Area – The Geographic Area refers to the District or Lab that is responsible for testing the material

Type - Type identifies the type of Producer/Supplier – Manufacturer. This entry; is filled in automatically when the P/S-Mnfc is selected.

City - The city where the plant is located. The city name is generated automatically.

Prod Nm - Product Number will be left blank for Material Code 707M00020

Lot/Sublot - The quantity and type of structural members will be entered here

Represented Qty - The total amount of structural members measured in Linear Feet (or Meters for Metric). The amount totaled from the shop drawings will match the Pay Item quantity on the Contract. If the total quantity does not match, contact the Structural Fabrication Supervisor.

Auth By - The PE/PS will authorize the Material Entry for the contract once the beams have been set

Auth Date - The date the PE/PS authorizes the SiteManager Entry

ADDITIONAL SAMPLE DATA TAB

The Additional Sample Data Tab is filled in as shown in Figure 10-6. Most of the fields are left blank.

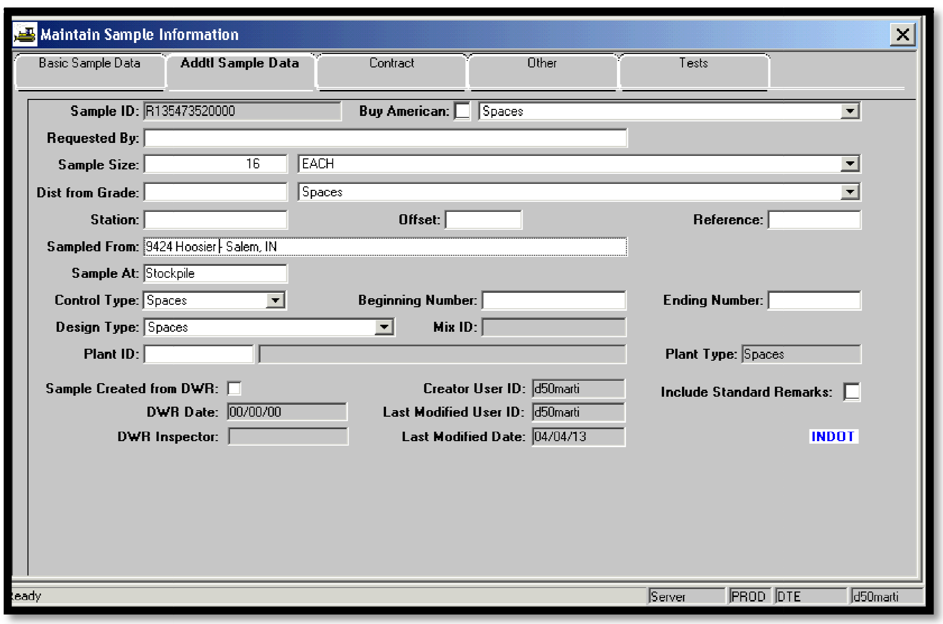

Figure 10-6. Addtl Sample Data Tab

The fields that are required to be completed for Material Code 707M00020 are the Sample Size, Sampled From, Sampled At, and Plant ID fields as follows:

Sample Size - The sample size is the Number of structural members with the units "EACH"

Sampled From - The name of the plant where the structural members were fabricated will be entered in the field. The Sample From field is not specific on the text entered.

Sample At - The sample is stockpiled until shipped to the project site. Enter “Stockpile”

Plant ID - This field is specific to the text entered. Right click, select search, and select the appropriate plant ID, or leave the field blank if there are none.

CONTRACT TAB

As seen in Figure 10-7, the Contract Tab links the sample ID to the contract. To add a contract, click on the white piece of paper icon at the top or press “Ctrl + N”. A Select Contract Material Information screen will appear as seen in Figure 10-8.

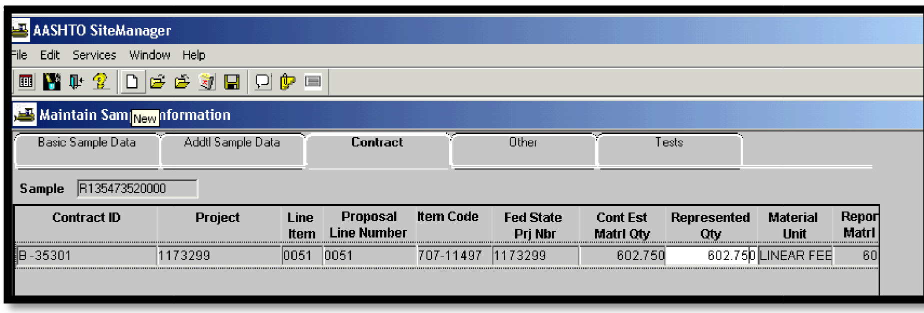

Figure 10-7. Contract Tab

Right click on the blank Contract Id space and select “search”. The search window will then appear as seen in Figure 10-8. Select the appropriate Contract ID. If the contract ID cannot be found, contact the Structural Fabrication Supervisor.

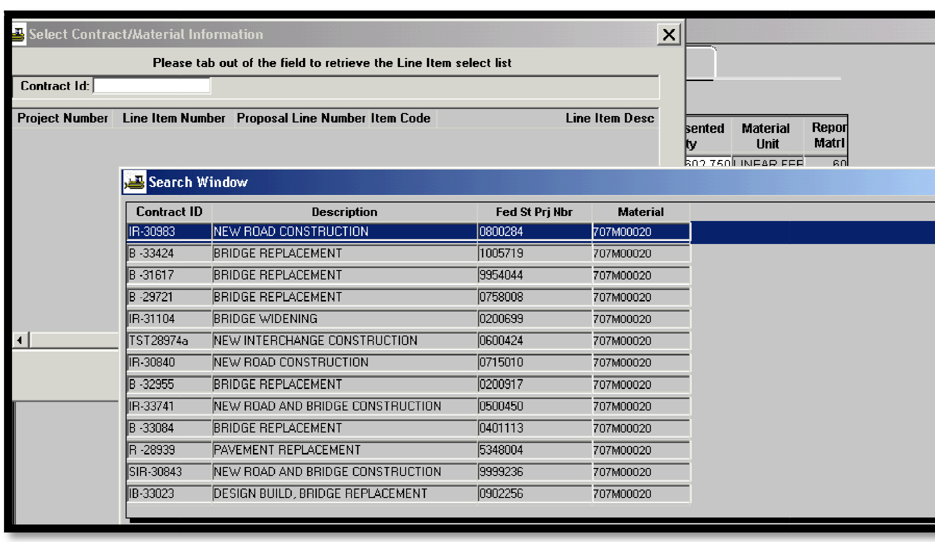

Figure 10-8. Contract Tab - Add Contract

OTHER TAB

The Other Tab is shown in Figure 10-9. "Ctrl+N" will create a new entity record. From the drop down list, select "Effective Date (mm/dd/yy)". The effective date is the date that the Specifications for that project took effect. All projects using the 2012 specifications will have an effective date of 09/01/11. All projects using the 2014 specs will have an effective date of 09/01/13.

The effective date is the only information entered on the Other Tab.

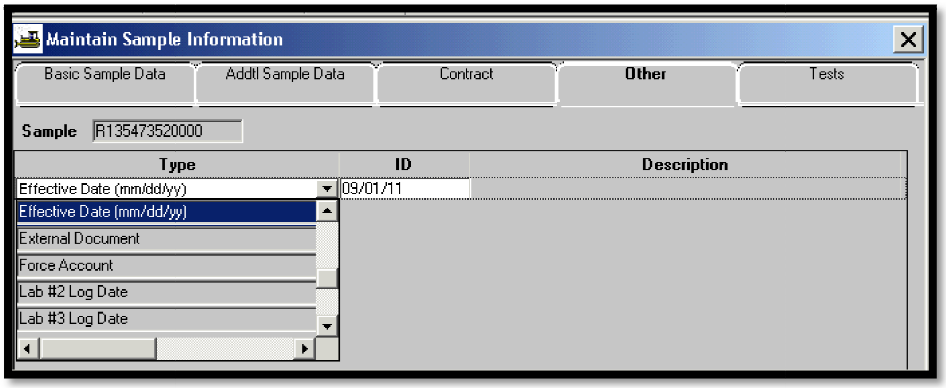

Figure 10-9. Other Tab

TEST TAB

The Tests Tab (Figure 10-10) is where the test information is entered that will meet the requirements of the Contract Check List. Refer to the Frequency Manual for the number of required tests.

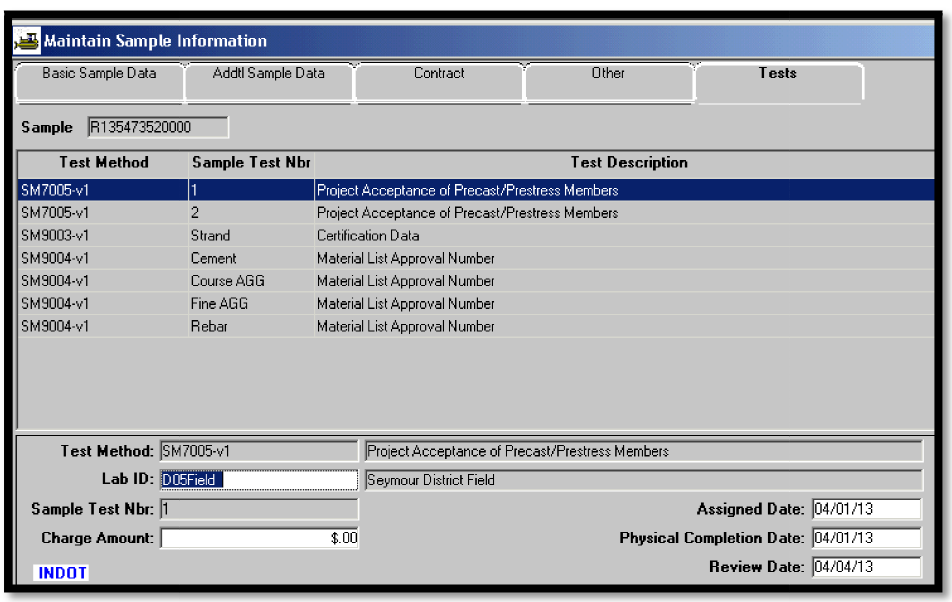

Figure 10-10. Tests Tab

Material Code 707M00020 requires the following:

SM7005-v1 – Project Acceptance of Precast/Prestress Members. The template allows for 12 members. Projects with more than 12 members will need multiple SM7005-v1 Test Methods entered.

SM9003-v1 - Certification Data (Type A certification) is required for the Strand

SM9004-v1 – Material List Approval Number is required for Rebar, Cement, Course Aggregates, and Fine Aggregates

Type "Ctrl +N" to generate a new Test Template from the Test Tab. This will create a new entry where the fields will be filled in as follows:

Test Method: right click on the blank field, select "search" and select the appropriate Test Method. The test method may be typed in manually; however, the test method is required to match the text exactly.

Lab ID: right click on the blank field, select "search" and select the appropriate Lab ID number for the Technician lab or District. The Lab ID may be typed in manually; however, the Lab ID is required to match the text exactly.

Sample Test Nbr: The sample test number will identify what the test method is for

TEST METHOD DATA ENTRY

As illustrated in Figure 10-11, highlight the test method that the data is to be entered for. Then Enter/View Test Data by typing "Ctrl+Shift+V", or select Services from the top, and then select "Enter/View Test Data".

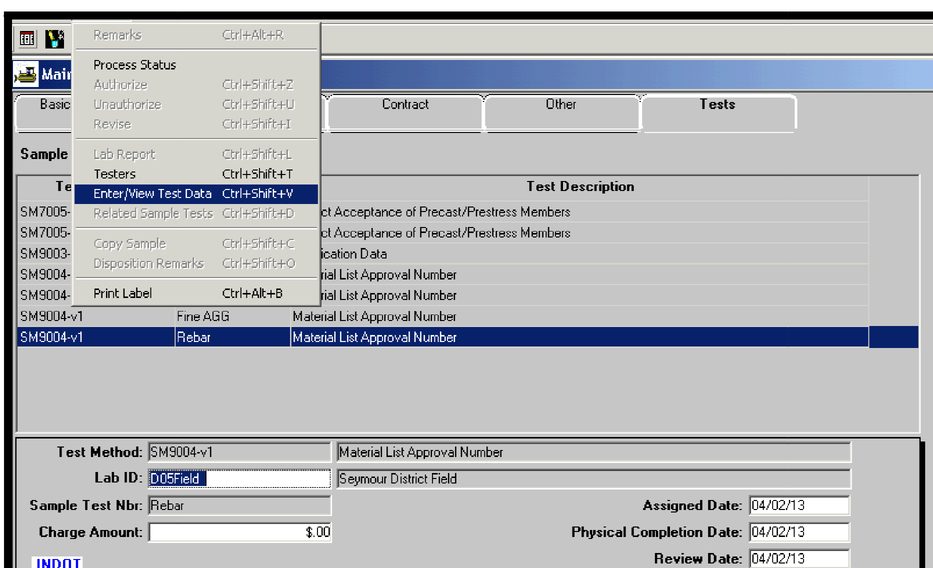

Figure 10-11. Services - Enter/View Test Data

Figure 10-12 illustrates the test template for the Material List Approval Number. The approval numbers may be found on the Approved Materials Lists on the INDOT website. If the approval numbers cannot be found, contact the Structural Fabrication Supervisor.

Although each Material Test Template will vary for each entry, they are accessed in the same manner.

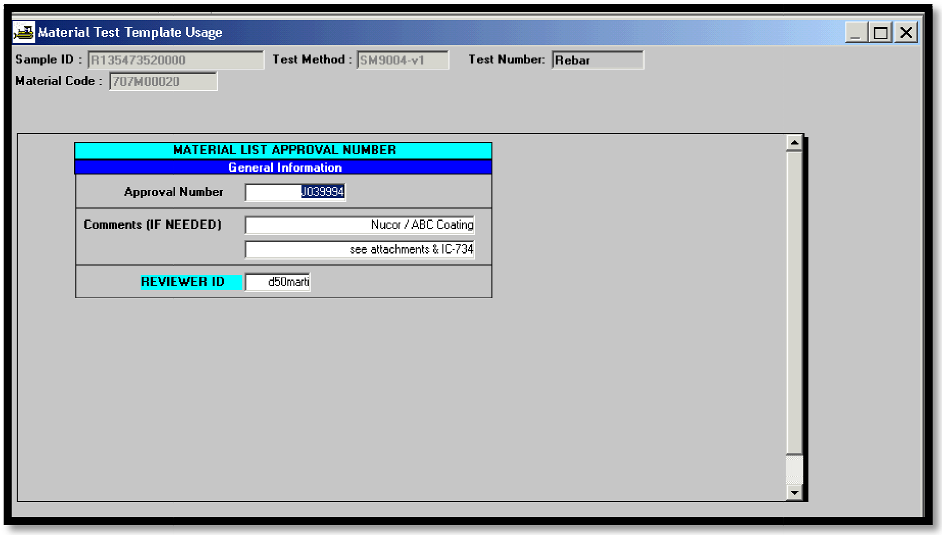

Figure 10-12. Material Test Template for Material List Approval Number

ADDING ATTACHMENTS

Attachments that will need to be added are:

1. IC-734
2. IC-735
3. Type A Certification for the Strand
4. Rebar Mill Certifications and Epoxy Coatings
5. Correspondence(s) in regards to beam repairs and acceptance
6. Other certifications or relevant material supplied by the Fabricator or INDOT personnel

To add an attachment (Figure 10-13), go back to the basic sample data tab. From the icons at the top of the screen, locate the yellow polygon icon. This icon will read “Attachments”. Click on the yellow icon, and the Attachments toolbar will appear. Locate the icon that reads “New OLE” (OLE = Object Linking and Embedding) and click on this icon. After the attachments have been saved, the yellow icon will have a paper clip attached.

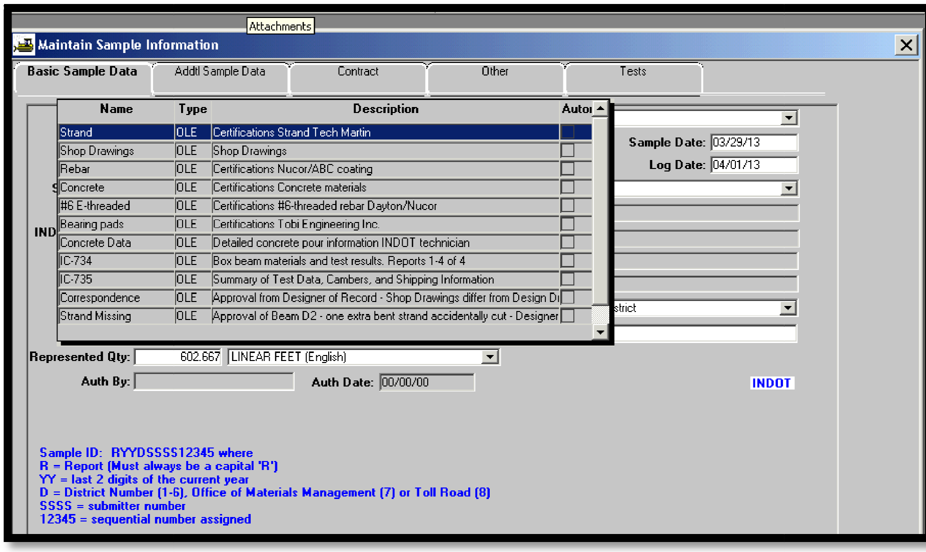

Figure 10-13. Adding Attachments

Select the New OLE icon (Figure 10-14). An "Insert Object" window will appear. Click on the "Create From File" Tab, then select "Browse". Then browse to wherever the desired file has been saved and click "open". (Note; Linking and embedding objects will take time. A direct Internet connection to the state network is recommended, whenever possible, instead of using Windows Explorer through Citrix to connect to files on the network drives.)

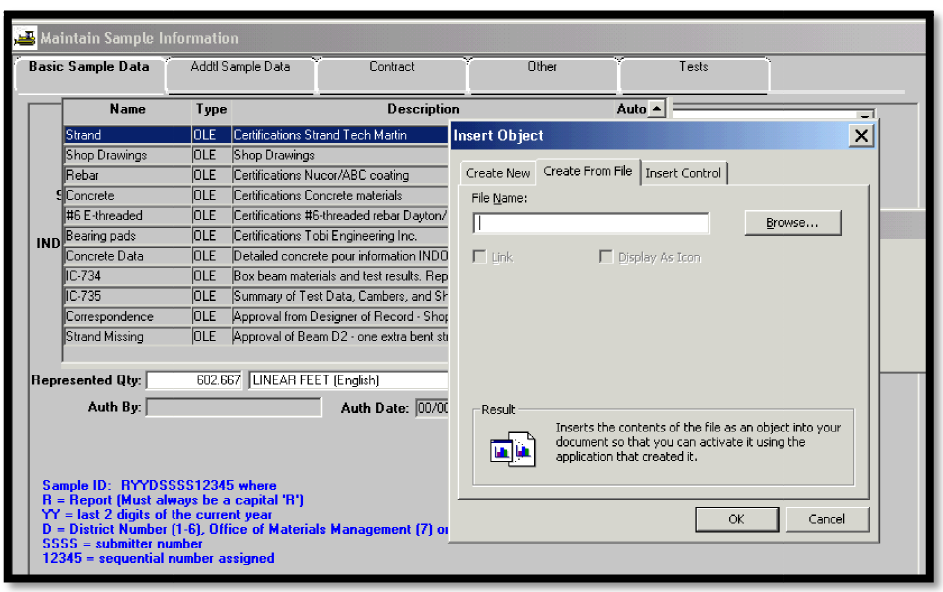

Figure 10-14. OLE (Object Linking and Embedding)

Name the OLE attachment (Figure 10-15). SiteManager will allow up to 15 characters. In the Description Area, type a brief description of what the document is. Under “Attachment Security”, select “Add All”. Then select “Add” from the very bottom of the screen to add the file. Repeat this process for all the files that are required to be added. Once the files have been added, the files are required to be saved. Type “Ctrl+S” or click on the floppy disc icon at the top of the screen to save the files. The files may be saved individually or all at once. Remember that saving the files will take from 5 seconds to 30 minutes, depending on the size of the files and how busy the server is at that moment.

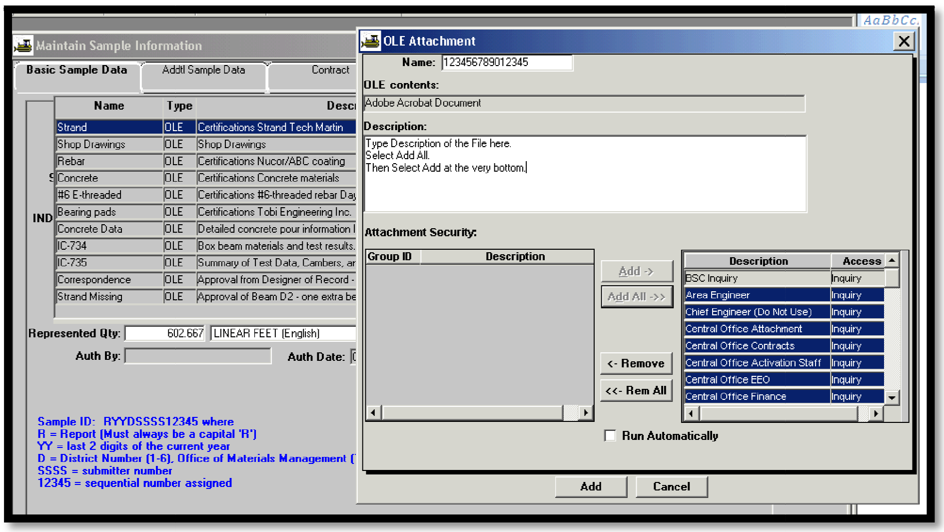

Figure 10-15. Name OLE Attachment

REVIEW AND COMPLETION OF SITE MANAGER DATA ENTRY

Once all of the information has been entered into SiteManager, the Structural Fabrication Supervisor will review the information for accuracy and completion. The Structural Fabrication Supervisor will then notify the PE on the contract and the DTE by e-mail and/or telephone.

FIND SAMPLES

A SiteManager user may wish to obtain material information for a specific contract; however, the Sample ID may not be known. Samples may be found with other known fields (Figure 10-16). The following information may be helpful:

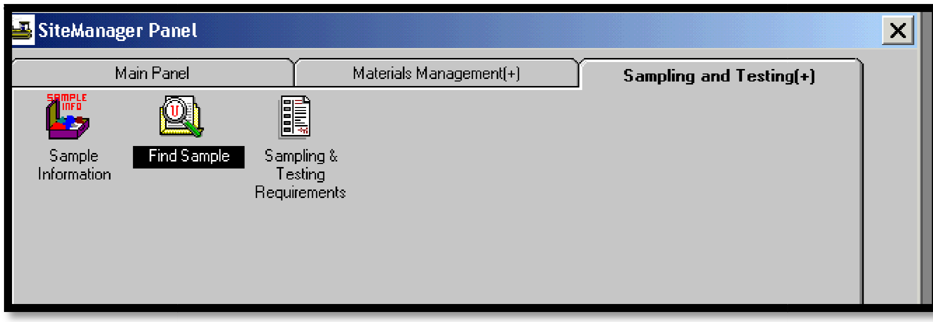

Figure 10-16. Find Sample

From the Main Panel, select Materials Management, Sampling and Testing, and then Find Sample (Figure 10-17).

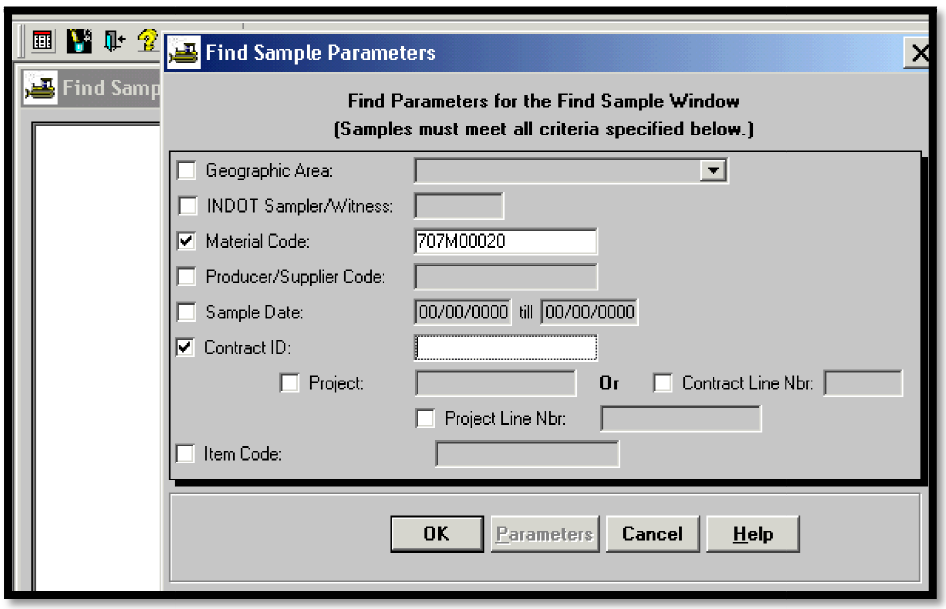

Figure 10-17. Find Sample Parameters

Check the square boxes of known information to the left. The fields with information entered are required to match the existing data exactly. Right click on a field and select search to find the desired Material Code and Contract ID.

Contract ID (Figure 10-18) will require a space in front of the dash for contracts containing only one alpha character. Contracts with two alpha characters do not require any spaces. The simplest method for entering contract ID may be to use the search method.

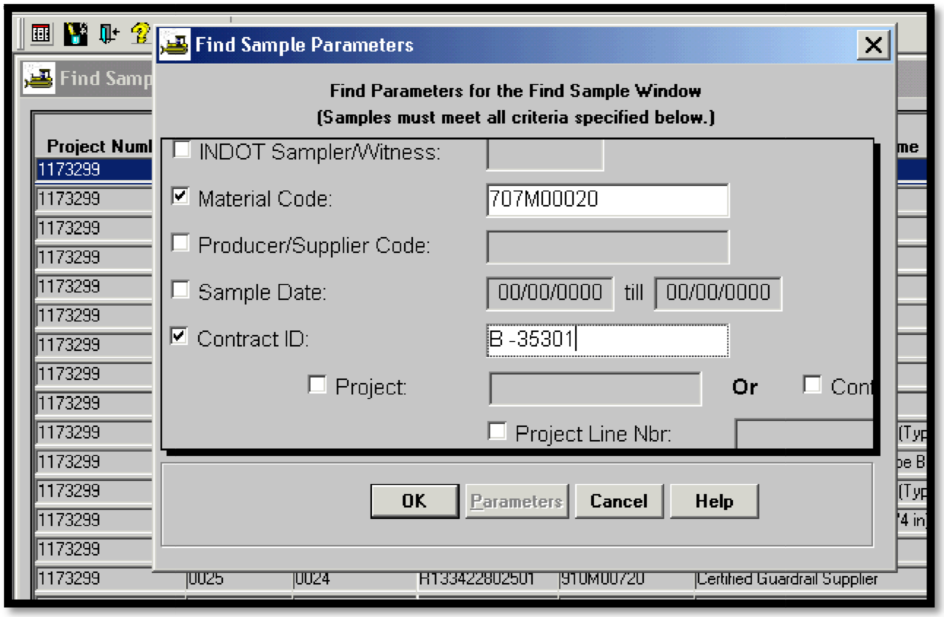

Figure 10-18. Enter Contract ID

Figure 10-19 illustrates the samples containing the information that has been entered. Scroll the page to the right to observe more information.

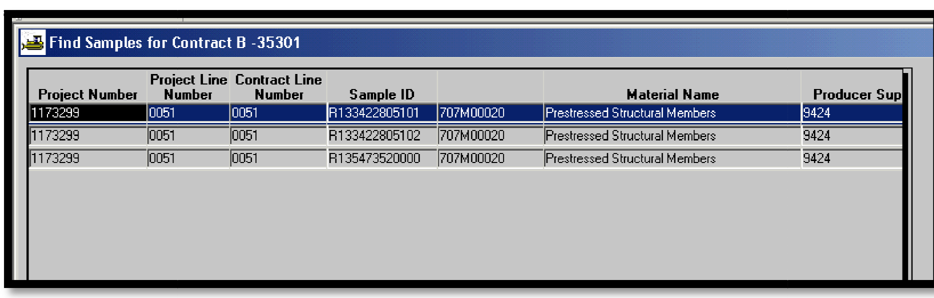

Figure 10-19. Samples Found

Once the proper Sample ID has been identified from the given information, the Sample ID may be copied and pasted into the Sample ID location (Figure 10-20). An alternate procedure would be to return to the Sample Information Panel (Figures 10-3 and 10-4), and enter the Sample ID. This procedure will open up the sample.

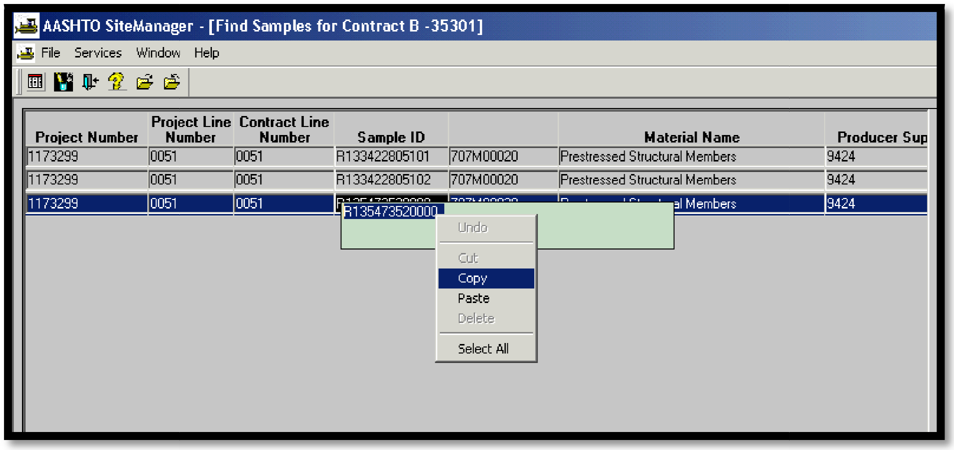

Figure 10-20. Identify Sample ID

Appendix A