# PORTLAND CEMENT CONCRETE PAVING

# FIELD INSPECTION 2014

TECHNICAL TRAINING & CERTIFICATION PROGRAM

IOWA DOT
SMARTER | SIMPLER | CUSTOMER DRIVEN

**HIGHWAY DIVISION**
**CONSTRUCTION OFFICE**

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# CHAPTER 1
# INTRODUCTION

# Chapter 1 Introduction

This training manual has been prepared to provide guidance and instruction to inspectors involved in the construction of Portland cement concrete (PCC) pavements. The important tasks involved in this work are explained and proper procedures are described. The material is targeted for those who have not had experience in PCC paving construction.

This manual is intended for use in any of three ways:

- a text for a training class
- a self-training manual
- a reference to be used in the field

The manual is intended to help the inspector learn the various aspects of what is involved in a PCC paving operation and also to become familiar with the duties that are a part of PCC paving inspection responsibilities.

At the beginning of each section, references, when applicable, are given to:

- Iowa Department of Transportation Standard Specification with the Specification Article listed
- Materials Instructional Memorandums (I.M.)
- Standard Road Plans
- Construction Manual Chapters

These references will enable the inspector to refer to those documents for more detailed information. The actual documents are not included in this material because they are continually being updated. Different versions may be applicable to different projects being constructed in the same construction season. The project letting date will determine which Specification Article, I.M., Standard Road Plan, or Construction Manual Chapter is applicable.

The manual is arranged to allow space for pictures adjacent to the text. This space may also be used to make notes for future reference

### *A. Technical Assistance*

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**Inspection worksheets available online at**:
http://www.iowadot.gov/construction/contract_admin.html

**Specifications, Materials IMs, Road Standards, and Construction Manual available online at:**
http://www.iowadot.gov/erl/index.html

**Iowa DOT standard forms available online at:**
https://forms.iowadot.gov/BrowseForms.aspx

# CHAPTER 2
# CONCRETE

# Chapter 2 Concrete

Concrete consists of three basic components-aggregates (both sand and rock), cement, and water. When mixed together, a chemical reaction occurs between the cement and water which eventually causes the mixture to harden and form concrete. Concrete is one of the most versatile construction materials and has tremendous compressive strength. It is widely used for both pavements and structures.

Concrete used today is much more complicated than the three basic components. Many other materials are included in a concrete mixture. Each is used for a specific purpose and is included to improve the concrete. In the following sections, the ingredients commonly use for a concrete paving mixture will be discussed in some detail in order to provide basic information as to what they are and what their intended purpose is.

**Figure 2-1 Basic components in concrete**

After the components are mixed and become concrete, there are many properties that will determine concrete quality as well as its ability to perform as it was intended and designed.

One thing that seems to be a universal misunderstanding is the misuse of the terms cement and concrete.

- **Cement** is the fine gray powder that holds the aggregates together.

**Figure 2-2 Cement**

- **Concrete** is a mass of sand and rock bound together by cement.

**Figure 2-3 Concrete**

## *A. Concrete Materials*

Concrete can be made from the three basic ingredients, but there are other materials and properties that must be considered when designing a concrete mixture. It is important to understand all of the materials and their properties because they can significantly affect the properties of the concrete mixture which may affect the construction process.

### 1. Aggregates

**Sections 4109, 4110, 4112, 4115, and 4117**
**I.M. T-203**

The aggregates in a concrete mixture make up the largest portion of the volume of the concrete; often about two thirds. The aggregates in standard Iowa DOT mixtures are made up of two parts, the fine aggregate, which is the sand, and the coarse aggregate, which is normally the gravel or crushed stone. The use of a third aggregate as a midsize aggregate is being used more often when the contractor is allowed to design the concrete mixture. The combination of the third aggregate, along with the coarse and fine aggregates, normally produces stronger concrete while utilizing less cement. This often results in more workable concrete for machine placement with less shrinkage.

There are two important aspects of aggregates. One is the gradation and the other is the durability.

#### a. Gradation

**Section 4109**

A concrete mix basically consists of sand and rock of various sizes glued together with a mixture of cement and water. The gradation of the aggregate, or distribution of particle sizes, should meet the specifications outlined in Sections 4109 through 4117. Quality Management Concrete (QM-C) specifications allow the contractor to determine the gradation of the combined aggregates in the concrete mixture.

Many properties of a concrete mixture can be improved by utilizing a well graded, combined gradation. This approach to mixture design strives for the aggregates to have somewhat equal proportions of the various aggregate sizes. To the extent that this can be accomplished with the materials available for a project, a number of concrete properties can be improved:

- Reduced cement content for equal strength
- Improved workability and finishing
- Reduced tendency for the coarse aggregate to separate from the sand-cement mortar (segregation).

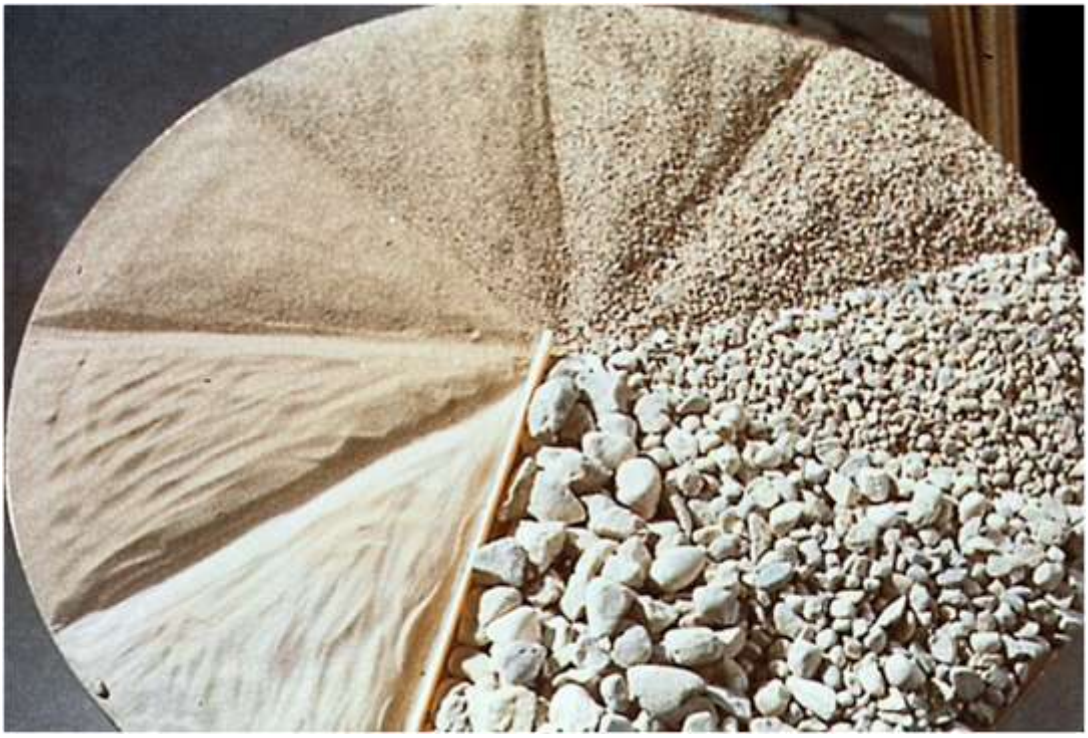


**Figure 2-4 Well graded mixes have somewhat equal proportions of aggregate sizes**

### b. Durability

Durability is the other aspect of aggregates that must be considered in concrete production. How the aggregate performs over time often determines how long the pavement will last.

The Materials Office has geologists who evaluate aggregate sources. They evaluate them in a number of ways and then approve them with an assigned durability rating.

The geologists monitor the performance of the aggregates based on service records of existing pavements. They also perform physical and chemical tests. Based on aggregate performance and testing results, they maintain a classification system for aggregates that are allowed in concrete pavements and structures.

This information is contained in IM T-203. This classification needs to be checked prior to construction to assure that the proposed aggregate sources are approved sources and they are from the proper durability classification.

## 2. Cement

**Section 4101, IM 401**

Portland cement is the most important and the most expensive component in a concrete mixture. It is the glue that holds the aggregates together and is the primary ingredient that will determine the strength of the concrete.

The process used to make cement is not critical to understanding how it works or what it's properties are, but, it is worthwhile to know that cement is made up of limestone, clay, and iron ore. These materials are combined and heated to very high temperatures to form clinker. The clinker is ground with gypsum into a fine powder.

**Figure 2-5 Limestone, clay, and iron ore heated to form clinker**

**Figure 2-6 Clinker is ground with gypsum to produce Portland cement**

Strength is developed through a process called hydration. This is an exothermic reaction meaning heat is produced and released. This begins when the cement particles come in contact with water, and it continues as long as water is present. The hydration process creates small needle-like crystals on the surface of the cement particle. The crystals grow and attach to each other or to the surface of the aggregates and form a gel-like mass.

Because they continue to grow as long as water is present, it is important to retain the water in the concrete as long as possible. This is why curing is so important.

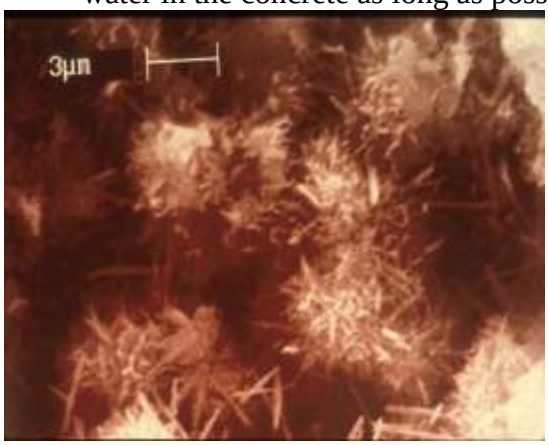



**Figure 2-7 Hydrated cement grains**

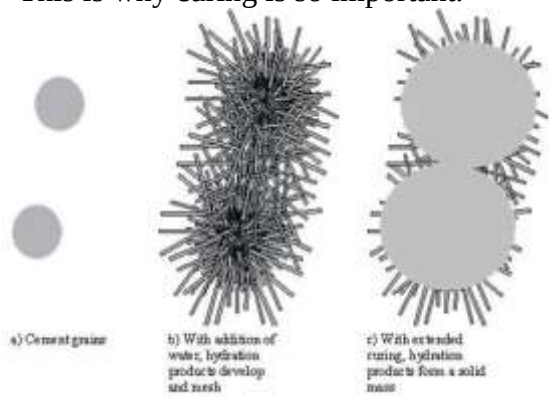



**Figure 2-8 Cement hydration crystals**

Section 4101 describes the requirements for cements. Today we use not only pure cements but also blended cements in concrete for paving. Blended cements are products that consist of both Portland cement and a supplemental cementitious material. Both pure cement and blended cements are used in concrete mixtures and either is considered as cement when figuring cement content for a standard concrete mixture.

In Iowa the vast majority of concrete for all uses contains supplementary cementitious materials. These are substituted for cement in the concrete mixture and serve a number of useful purposes. Two types are commonly used in concrete paving:

a. Fly ash
b. Ground granulated blast furnace slag

## a. Fly Ash

**Section 4108, IM 491.17**

Fly ash is a common mineral admixture used in most concrete paving mixtures. It is a pozzolanic material that is a by-product of the burning of finely ground coal in electricity generating power plants. It is a very fine, powdery material, predominately silica, with particles almost totally spherical in shape.

**Figure 2-9 Electricity generating power plant**

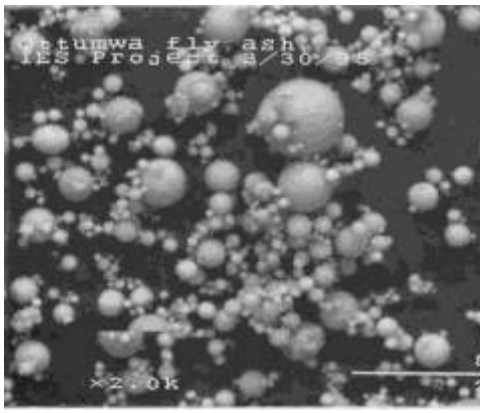



**Figure 2-10 Fly ash is spherical in shape**

Fly ash is known as a pozzolan. Pozzolans are finely divided, siliceous or aluminosiliceous materials that react with water and calcium hydroxide released by Portland cement hydration to form cementing compounds.

Fly ash is used in concrete to enhance a number of properties of the concrete. It also results in a more economical mix since the price of fly ash is roughly a third of the cost of the cement it replaces. Some of the benefits that can often be achieved by using fly ash in concrete include:

- Increased long term strength
- Increased workability
- Reduced heat of hydration
- Reduced permeability
- Reduced cost

The small size allows the particle to take up space that otherwise would be filled with water and thereby leads to increased strength. The spherical shape of the fly ash particle helps make the mix more workable.

Two Types of fly ash are specified in Section 4108: Class C fly ash and Class F fly ash. The approved sources of each are listed in I.M. 491.17.

Class C fly ashes generally increase compressive strength at all ages and Class F fly ashes only after 7 to 28 days. In conventional mix designs, both types of fly ash normally retard the setting time of concrete although some Class C ashes have very little retardation effect.

Class C fly ashes have both pozzolanic and cementitious properties, and Class F fly ashes have only pozzolanic properties.

Generally one type of ash is predominantly available in various regions of the country. In Iowa, Class C ash is commonly used

### b. Ground Granulated Blast Furnace Slag (GGBFS)

**Section 4108, IM 491.14**

Ground granulated blast furnace slag (GGBFS) is a mineral admixture that is popular in Iowa. It is a by-product of steel production. GGBFS is made from slag floating on top of an iron blast furnace. The slag is tapped off and quenched in water to produce a glassy sand-like material. This material is then ground to a fine white powder.

**Figure 2-11 Slag is a by-product of steel production**

**Figure 2-12 Slag is ground to a fine white powder**

Like fly ash, GGBFS adds a number of very positive properties to concrete:

- Increased workability
- Increased strength
- Decreased permeability
- Increased sulfate resistance
- Decreased alkali aggregate reaction potential

GGBFS is commonly blended or interground with cement to form IS(X) cement where the X represents the percentage of GGBFS in the cement. For instance, blended cement with 25% GGBFS replacement would be denoted as a IS(25). GGBFS can also be added in the mixing process.

Combinations of Class C or F fly ash along with GGBFS can be used in a concrete mixture. These types of mixes including two supplementary cementitious materials along with Portland cement are called ternary mixes.

## 3. Water

**Section 4102**

The water used in batching concrete can come from almost any source. Each source must be tested and approved if it is not potable. Often lakes or streams are used because they

are close to the project. This water must meet hardness, alkalinity, and acidity requirements.

Workability issues arise during very hot weather. High temperature of the water can contribute to this problem. There is no restriction on the water temperature but warm water will add to the temperature of the concrete. High concrete temperatures can lead to placement and durability problems.

## 4. Admixtures

**Section 4103, IM 403**

Admixtures are those ingredients in concrete, other than portland cement, pozzolans, water, or aggregates, that are added to the mixture, normally immediately before or during mixing. Admixtures can be classified by function and include:

- Air Entraining admixtures
- High/Mid Range Water Reducing admixtures
- Retarding admixtures
- Accelerating admixtures

Accelerators and high or mid range water reducers are not commonly used in paving. Calcium Chloride is the most widely used accelerator and is used in patching work.

The effectiveness of an admixture depends upon such factors as type, brand, and amount of cement, water content, aggregate shape, gradation, and proportions, mixing time, slump, and concrete and air temperatures.

Desirable characteristics of concrete include being workable, finishable, strong, durable, and wear resistant. These qualities can often be obtained easily and economically by the selection of suitable materials rather than by resorting to admixtures (except air-entraining admixtures when needed).

The major reasons for using admixtures are:

- To reduce the cost of concrete construction
- To achieve certain properties in concrete more effectively than by other means
- To ensure the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions
- To overcome certain emergencies during concreting operation

Despite the above considerations, no admixture of any type or amount should be considered a substitute for good concreting practice.

### a. Air Entraining

Air-entraining admixtures are used to purposely entrain microscopic air bubbles in concrete. One primary purpose of air-entrainment is to improve the durability of concrete exposed to moisture during cycles of freezing and thawing.

**Figure 2-13 Minute bubbles entrained in concrete**

Entrained air also greatly improves concrete's resistance to surface scaling caused by chemical deicers. Another major benefit is to improve the workability of fresh concrete. Segregation and bleeding are also reduced or eliminated.

Air-entrained concrete contains minute air bubbles that are distributed uniformly throughout the cement paste. An air-entraining admixture is added directly to the concrete materials either before or during mixing.

Today, air is entrained in concrete by using one of two types of products:

- Neutralized Salt of Pine Wood Resins (normally called Vinsol resins)
- Synthetic Detergents

**NOTE:** While entrained air imparts many beneficial properties in a concrete mixture, there is a cost. For every 1% increase in entrained air content in a concrete mixture there is approximately a 5% decrease in compressive strength.

### b. Water Reducer

A water reducer is a substance that changes the electrical charges on cement particles. This disperses the particles that naturally agglomerate. When this happens, water particles that had been trapped by these particles are released. This is the same process used by anti-static laundry products.

Water-reducing admixtures are used to reduce the quantity of mixing water required to produce concrete of a certain slump, reduce water/cement ratio, or increase slump.

Typical water reducers reduce the water content by approximately 7% to 10%. High-range water reducers reduce water content by 12% to 30%. Adding a water-reducing admixture to a mix without reducing the water content can produce a mixture with a much higher slump.

The rate of slump loss, however, is not reduced and in most cases is increased. Rapid slump loss can occur and results in reduced workability and less time to place concrete.

An increase in strength is generally obtained with water-reducing admixtures as the water/cement ratio is reduced.

Many water-reducing admixtures can also retard the setting time of concrete. Some are modified to give varying degrees of retardation while others do not significantly affect the setting time. Some water-reducing admixtures such as lignosulfonates may also entrain some air in concrete.

The effectiveness of water reducers in concrete is a function of their chemical composition, concrete temperature, cement composition and fineness, cement content, and the presence of other admixtures. Some water reducers are more effective in lean mixtures and with cements of low alkali or low tricalcium aluminate contents.

### c. Retarders

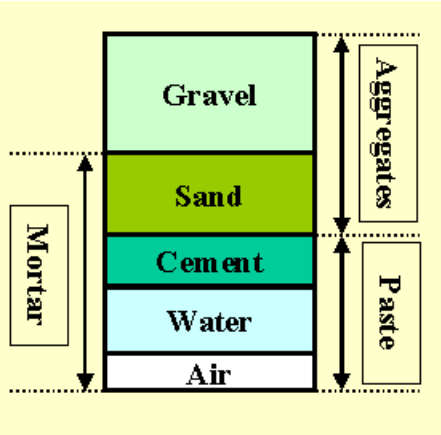
Retarding admixtures are used to retard the rate of setting of concrete. High temperatures of fresh concrete ($85^0$ F to $90^0$F and higher) are often the cause of an increased rate of hardening that makes placing and finishing difficult. Without a retarder, the primary method of counteracting this effect is to reduce the temperature of the concrete by cooling the mixing water or the aggregates. Retarders do not decrease the initial temperature of concrete.

Because most retarders also act as water reducers, they are frequently called water-reducing retarders. Retarders may also entrain some air in concrete.

## *B. Concrete Terms*

Concrete consists of three basic components - aggregate, cement, and water. However, typical concrete mixtures can be further broken down into five basic constituents consisting of cement, coarse aggregate, fine aggregate, water, and air (intermediate aggregate can also be included when talking about QM-C paving mixes). There are various terms that can be used to describe certain combinations of these constituents as follows:

**Aggregate:** Often refers to the coarse, intermediate, and fine aggregates
**Paste:** The cement, water and air
**Mortar:** The fine aggregate, cement, water, and air




It is important to learn and understand each of these terms and what they mean when working with concrete in order to avoid confusion when communicating with contractors, suppliers, and/or other inspection staff.

## *C. Concrete Properties*

There are several important properties of concrete that an inspector should know and understand. Some of these properties are measurable and used in the acceptance process while others are not measurable but are used in the decision making process during construction. Following is a brief description of each of these properties.

### 1. Strength

Strength is a very important property of concrete. Many factors affect strength. Some of those factors that affect strength must be considered when designing a concrete mixture while others must be considered and watched during construction.

Concrete strength is measured in a number of different ways. The two most commonly used for field applications in Iowa are compressive strength and flexural strength.

#### a. Compressive Strength

**IM 315**

Compressive strength is measured through the testing of cylinders or cores. This is used in commercial work and most commonly in structural applications. Although cylinders are cast during the construction of structures for highway construction, they are not normally used in pavement construction projects in Iowa. Cores are taken to determine the thickness of pavements, and in the past, those cores have been tested to establish concrete strength for pavement design proposes.

**Figure 2-14 Compression testing of cylinder**

## c. Flexural Strength

**IM 316 & IM 328**

Flexural strength is the traditional method used by the Iowa Department of Transportation to monitor the concrete strength of pavements and to determine opening time. It is measured using flexural beams cast as the pavement is constructed. Currently the flexural strength required for opening a pavement to traffic is based on the modulus of rupture of beams tested using center point loading.

**Figure 2-15 Center point flexural testing of beam**

Flexural beam strengths are also used when designing concrete pavements. These tests are different, though, from the flexural test done for other purposes because they are third point flexural tests. That means that they are tested with a different test device and in a different manner than those tested traditionally using center point loading. The values obtained from third point tests, as compared to center point tests, will often be smaller, commonly about 85% of the center point strength.

**Figure 2-16 Third point flexural testing of beam**

## 2. Air Content

**IM 318**

In most cases, the air system within the concrete will determine its ability to resist freeze/thaw deterioration. Therefore insuring adequate air content is of paramount importance. Normally air content is checked in the field using a pressure meter which is a test that determines the total air in the concrete. While this does not tell if the air system is adequate to protect the concrete, normally it is the best test available, and it is most commonly used.

**Figure 2-17 Pressure meter and tools to perform air test**

## 3. Slump

**IM 317**

Slump is an old test of concrete that was commonly used to give an indication of water content in the mixture. Most practitioners today would agree that the test no longer is a good indicator of water content because chemical admixtures commonly used in concrete will greatly affect slump, even with the same amount of water in the mix. Therefore slump has become a less used test and normally is used to indicate a change in the mix rather than an identifying measure of water content.

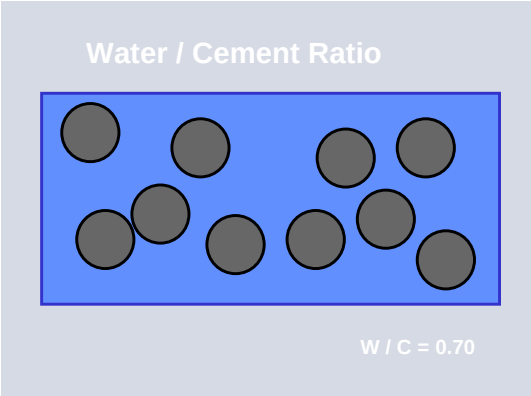
In Iowa, slump tests are not required for slip form paving.

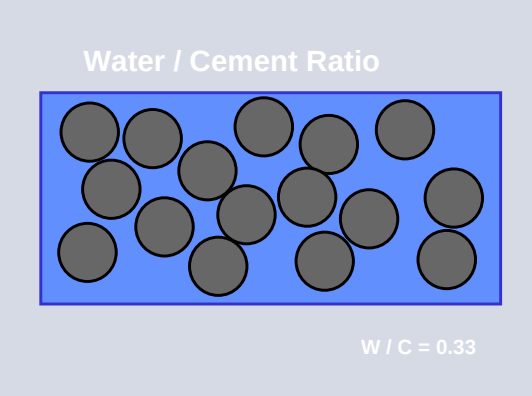
**Figure 2-18 Slump test**

## 4. Water/Cement Ratio

**IM 527**

Water cement ratio is an important property of concrete. The relationship of how much water is present in the mixture relative to the amount of cement will have a great effect on the ultimate strength of the concrete. The more water particles in the concrete, the farther apart the cement particles are held. The cement particle's ability to bind to each other and thereby produce strength in the concrete is then reduced.




Under the QM-C specification, the contractor will determine the basic water cement ratio (W/C) for the concrete mixture when it is designed. Then, during construction, the W/C ratio will be determined for the concrete being produced. This ratio will be plotted and tracked during the project.

## 5. Temperature

**Article 2301.03, S, IM 385**

The temperature of the concrete is important for a number of reasons. When the weather is cold, it is important that the concrete mix temperature be warm enough for the hydration process to take place. When the concrete is very hot, the mix can set too quickly and not allow time for proper placement or finishing. IM 385 gives the procedure for checking the temperature of plastic concrete.

**Note:** A good rule of thumb to follow when working with concrete is that the hydration reaction of cement doubles with an increase of 20 degrees F. Conversely the hydration reaction is cut in half with a decrease of 20 degrees F.

**Figure 2-19 Measuring temperature of fresh concrete**

The following table shows the effect of the materials on the temperature of the concrete.

| ***Change in Temperatures of Individual Components of a Typical Concrete Mix to Affect a 1$^o$ F Change in Concrete Temperature*** | | |
|---|---|---|
| Cement | Water | Aggregates (coarse and fine) |
| 9 $^o$ | 4 $^o$ | 1.6 $^o$ |

## 6. Unit Weight

**IM 340**

When a mixture is designed, normally the unit weight is one of the properties that is determined and becomes part of the parameters of the mixture. This information is then helpful to those in the field. When concrete is measured in the field, the unit weight will tell if the mixture produced is similar to the mix design.

Producers know exactly how much one cubic yard (or cubic meter) of each of their mixes weighs. This is called the ***unit weight of concrete.*** Unit weight is simply the weight of material that will fill one unit of volume. In the concrete industry, one unit of volume is usually either a cubic yard or a cubic meter.

Therefore, if a producer knows the exact weight of the materials that were batched into a truck, he can calculate exactly how much volume that concrete will fill when placed. This is the "weight versus volume" or "unit weight" relationship.

The unit weight calculation is:

***Unit Weight = Weight of Concrete / Volume of Concrete***

Under the QM-C Specification, unit weight is checked periodically during the paving operation. The contractor's QC/QA Plan will detail the frequency with which these tests will be conducted.

### 7. Workability

In concrete paving, workability is a characteristic of concrete that describes how well the concrete can be moved, molded, and shaped to the proper dimensions. It is impossible to describe this characteristic in words but it is variable between mixtures and can change with time within a given mixture.

There is no specification regarding workability. It is a characteristic of the concrete and is affected by water cement ratio, aggregate gradation, and characteristics of the cementitious materials.

The inspector should watch how the concrete moves though the paver and discuss the workability with the contractor and the mix designer. If difficulty in placement of the concrete arises, a change may be needed by the contractor in order to make the concrete more workable.

## *D. Concrete Mixes*

**Classes of Mix**

**IM 529**

The Iowa Department of Transportation has used a system of standard concrete mixtures for many years. There are many pavements in service around the state that were built using a standard mix. The standard mixture designs are grouped by strength and are called classes.

IM 529 lists the standard concrete mixes used by the Iowa department of Transportation. They are divided into classes of concrete mixes that are based on nominal strengths. Project plans will specify a class of concrete mixture to be used and the contractor is free to choose any one from those listed in IM 529 for that class of concrete.

Commonly a Class C concrete is specified for paving on primary roads and many secondary roads. Class A and Class B mixtures may be specified on secondary paving projects.

Today a number of PCC paving projects are let under the QM-C specification. This includes a provision for the contractor to develop the concrete mixture. On those projects, the standard mixtures are only used in hand work or in the event that something arises that is beyond the contractor's control.

# CHAPTER 3
# SUBGRADE & BASES

# Chapter 3 Subgrade and Bases

Sections 2107 and 2109 and Article 2301.03, B

When talking about pavement design in Iowa, the words base and subbase often are used to represent the lift of a selected material placed immediately beneath a pavement. The earth grade at the bottom of the pavement structure, whether modified by special treatment or not, is referred to as the subgrade.

All of these bases, regardless of placement methods, can be built to acceptable tolerances and provide the working platform necessary to:

- Enhance the performance of the finished product
- Minimize the loss of concrete
- Eliminate short core penalties
- Contribute to value added payment such as smoothness

## *A. Subgrade Treatment (Stabilization)*

While the bulk of general embankment fill consists of regular Class 10 soil, the upper material in the subgrade directly beneath the pavement structure (subbase, base, and pavement) is built of higher quality material. This higher quality material is referred to as "subgrade treatment". A subgrade treatment layer can be composed of higher quality materials that are imported on to the project or it can be created by improving the material that is already in place. The process of improving the material that is in place is often called 'stabilization'.

When necessary, subgrade treatment is used to provide uniform and better support for the subbase, base, and pavement. The type of subgrade treatment used depends on the type, the quality, and quantity of natural soils available on the project. The subgrade treatment material is much stronger than the regular Class 10. However, subgrade treatment should not be used to cover up unstable locations. Thus, it is critical to make sure that the lower Class 10 foundation soil is in reasonable condition before the subgrade treatment is placed, because it may not be economical to later remove the treatment material for repair of the lower foundation.

When available, designers will always recommend using on-site soils or borrow for the subgrade treatment. This is simply an economic decision since on site materials are typically on the order of five to ten times cheaper than other subgrade treatment options.

Following are some of the typical materials used as subgrade treatment:

### 1. Select Soil

Section 2102

The normal materials for select subgrade treatment are clay loam, loam, or sand. These materials are either granular (predominantly sand) or cohesive (a loam or clay loam

which is a good mixture of sand, silt, and clay). Because of the composition and gradation, the density and shear strength are much higher when they are properly compacted.

**Figure 3-1 Select sand**

At locations where modifications were done but stability is questionable, additional select should be considered. This is an economical way to improve stability.

If select sand is used for subgrade treatment, it is often specified in project plans that 3 inches of special backfill be incorporated into the surface. This increases strength and cohesion under construction traffic.

## 2. Special Backfill

Sections 2102 and 4132

Special backfill is a uniform mixture of coarse and fine particles of crushed concrete, crushed limestone, composite pavement, or a mixture of gravel, sand, soil; or a mixture of crushed limestone, gravel, sand, and soil. In other words, the special backfill could be a variety of different materials. The requirement for this material is that it has to meet a certain gradation. Since the materials vary, different behaviors should be expected. For example, a piece of rounded gravel is going to provide much less stability than a piece of crushed limeston. Special backfill has a relatively high content of fine particles which makes it a very stable material. On the other hand, it also makes it a non-drainable material. Because special backfill is typically a very stable material, it is often used to stabilize areas where a subgrade is soft and unstable.

## 3. Polymer Grid

Section 2113

Polymer grid is a high strength polymer material, which is called 'Subgrade Stabilization Material' in Iowa DOT specifications. It is often used in combination with special backfill as an alternative to select backfill. When on-site materials are not of sufficient quality to use in the upper part of the subgrade, polymer grid will then likely be used with special backfill material placed above it.

The open grid structure of polymer grid works best with aggregate base for the interlocking effect. A polymer grid is used by Soils Design for subgrade strength. Grids work because the material has a very high tensile strength which allows wheel loads to be spread over a much larger area rather than having localized punching failure, ruts, etc.

**Figure 3-2 Polymer grid used as subgrade treatment**

Polymer grid is also used to provide additional support at unstable locations of Class 10 foundation soils below the subgrade treatment. A polymer grid should be utilized when other methods have been tried but were not successful. Do not attempt to fix the polymer grid if the stability is not enough. The best thing to do is to add more special backfill on top.

A polymer grid should not be extended beyond the edge of the pavement; otherwise it will interfere with the longitudinal subdrain installation.

## 4. Fly Ash Stabilization

Fly ash has been used to stabilize wet or unstable foundation soils beneath the subgrade treatment. In some cases it has been used to stabilize a subgrade treatment of low quality.

Type C fly ash is self-cementing when hydrated, and can be mixed with soil to form a low-grade 'concrete' using soil as aggregate. Fly ash requires moisture for hydration, so addition of fly ash also removes water from wet unstable soils.

A typical mix ratio is 10 to 15% fly ash by dry weight of soil. Water may be added if needed. The mixture must be well pulverized and compacted near optimum moisture. Since setting begins soon after hydration, compaction is done soon after mixing to prevent breakdown of the curing soil-fly ash mixture by compaction equipment.

**Figure 3-3 Spreading fly ash**

**Figure 3-4 Adding water to fly ash**

**Figure 3-5 Mixing fly ash with soil**

**Figure 3-6 Compacting fly ash treated material**

## *B. Base and Subbase*

Sections 2109, 2111, 2115, 4121, 4123, & 4132

Most agencies specify trimming of the subgrade with electronically controlled trimmers to a specified tolerance prior to any subbase or base construction. The subbase (if specified) and base are then placed to uniform specified depths.

The subgrade is 'proof' rolled no more than one week prior to trimming. Proof rolling is very critical to make sure that the subgrade is strong enough to support the pavement structure. Soft or unstable areas must be reworked to obtain adequate stability. Refer to Section 2109.

After being rolled, the subgrade surface shall be at the required elevation.

## 1. Granular Subbase

Granular subbase will consist of a uniform mixture of granular material placed on a subgrade, uniformly moistened, shaped and compacted.

The main purpose of the granular subbase material is to provide drainage under the pavement. Since this material can have an open gradation, the maximum density often is not very high. In addition, this material is compacted with a maximum of three passes of a self-propelled, non-vibratory steel or pneumatic roller. The compacted density may be from 100 to 120 pcf. Percent voids can be as high as 40%. This is the reason why it is very permeable. Since it is used mainly for drainage, the structural support is also not very high.

**Figure 3-7 Placing granular subbase**

**Figure 3-8 Granular subbase in place**

Granular subbase is usually specified under Portland cement concrete (PCC) pavement which can provide the bridging support across the granular subbase layer. Since direct traffic loading on granular subbase can cause degredation of the material and loss of drainability, no construction traffic is allowed on top of the granular subbase layer.

During the trimming process, fines can separate from the larger particles and create thin layers of fines on the surface. Very dry material is most susceptible. This will also result in segregated granular subbase as the coarse fraction of the material is often loaded into a truck, hauled forward to the base placement area and placed back on the subgrade. The contractor needs to do all that's possible to minimize this problem.

**Figure 3-9 Variablity of granular subbase due to segregation during trimming**

**Figure 3-10 Fine material on the surface due to segregation**

One quick and easy way to check permeability is to fill a one-gallon milk jug with water. Pour this gallon of water from waist level down at one spot. If the water drains away, and there is no sign of any buildup after 30 seconds, the granular subbase layer is considered permeable.

## 2. Modified Subbase

Special backfill composed of sand and gravel, which is allowed in Section 4132 of Iowa DOT Standard Specifications, may not provide the strength needed to support construction traffic or equipment. A greater percentage of crushed particles and a denser gradation are needed for stability.

**Figure 3-11 Modified subbase**

Modified subbase is specified in Section 4123 in order to designate a material which will provide stronger support, especially for paving equipment for full-depth asphalt. The specification places a limit of 50% sand and uncrushed gravel content in the mix, as well as includes other specific gradation requirements.

The specification also adds a requirement that the subgrade be proof rolled by a legal axle load before placing the subbase.

## 3. Special Backfill

Special backfill is used mainly for stability/support. It is normally specified under asphalt cement concrete (ACC) pavement. Type A compaction is required for special backfill. Also, since special backfill is paid by the ton, the contractor usually uses a vibratory steel roller for compaction. This makes the special backfill very strong.

Construction traffic is allowed to run on special backfill. This is one of the reasons why special backfill is specified under ACC pavement so that the asphalt material can be delivered to the paver.

Special backfill is also used under PCC pavement when availability of select backfill is limited, such as in urban reconstruction projects.

Many times the question about drainability of the special backfill is asked. The answer is its permeability can vary because of the differing materials and gradation range allowed for special backfill by specification. It is generally less permeable than granular subbase, but more permeable than most Class 10 or select soil materials, except sand. As a general rule, it is considered permeable enough to require installation of continuous longitudinal subdrains when it is used.

Because requirements for granular subbase, modified subbase, and special backfill overlap, materials can be produced that meet the requirements for more than one base material.

**Figure 3-12 Material used as both special backfill and granular subbase**

# CHAPTER 4
# DESIGN

# Chapter 4 Design

In order to understand what is required to construct a project, an understanding of what information is specified on the plan and within the contract documents is essential. This chapter will present some of the important pieces of information that are contained on the project plans and road standards that will be necessary in order to define what work is to be accomplished.

## *A. Project Plans*

Project plans prepared by the Iowa Department of Transportation or by private consultants are arranged with a specified format. The following sections contain information that will be important when building a pavement project.

### 1. Title Sheet, Location Map, & Legend - A Sheets

These sheets provide information on the project location and length, vehicle counts, index of sheets, and beginning/ending stations of the project and divisions within the project.

### 2. Typical Cross Sections- B Sheets

These sheets provide dimensions and other information with cross section views. These views are typical for the locations listed in tabs. There can be several different typicals with each set of plans, which make the location information important to help decide which typical is used where. In a set of plans the typical sections include mainline pavement, superelevations, curbs, ramp grading and paving, and shoulder details. Also, it's important to look for any references to other plan sheets for special details.

### 3. Estimate of Quantities and General Information- C Sheets

These sheets give you the design quantities and additional information for the project. Many bid items have reference notes which further define the item. These are where the class of concrete, thickness of the pavement, and often the required durability class of the aggregate are given. Also included are general notes for the project and storm water pollution prevention requirements. A very important piece of information that is found here is the list of the applicable Road Standards.

### 4. Mainline Plan and Profile Sheets- D Sheets

These sheets give a plan and profile view of the entire project. They usually begin with the lowest station number and go to the highest station number. Note that profile elevations for top of slab at any given station are provided on these sheets. New and existing drainage features, entrances, and ditch cut information are also shown.

### 5. Side Road Plan and Profile Sheets- E Sheets

These show basically the same information for side roads as listed above for mainline.

### 6. Interchange Geometrics- K Sheets

These sheets show interchange staking, jointing, and edge profile information as well as centerlines and base lines in relationship to each other. Jointing at ramp intersections are also shown.

### 7. Intersection Geometrics- L Sheets

These sheets show intersection staking, jointing, and edge profile information along with pavement jointing details at side road intersections.

There is much more information included in a plan set beyond that shown above. The above information is just a selection of the most important information for PCC paving.

## *B. Joints*

**Articles 2301.03, N, O, and P Section 4151**
**Road Standard PV-101**

As cement hydrates, water is chemically combined with compounds in the cement particles. As this process continues, the space taken up by the water closes as the water leaves. This causes the concrete to shrink. When concrete is placed in large amounts, as in pavement, the volume change causes stresses. These stresses eventually will be greater than the tensile strength in the concrete and a crack in the concrete results. A joint is simply a designed crack.

A sawed joint provides a plane of weakness to allow the pavement to crack at designated locations. Controlled cracks are much easier to maintain than random cracks. By designing the pavement with joints, the natural cracks can occur without affecting the ridability and performance of the concrete pavement.

**Figure 4-1 - Joint sawed at top of pavement and crack below**

Section 4151 specifies the steel that is used in some joints. All bars used in pavement, either smooth dowels or deformed tie bars, are specified to have an epoxy coating. This helps to prevent the bars from corroding.

## 1. Joint Types

Many types of joints are used in a concrete paving project. The plans will specify where each type of joint will be used. The following is a discussion of the types of joints, the Road Standards where they are specified, and the types of saw cuts that are used to create the joint in the finished pavement.

### a. Transverse Contraction Joints

**PV-101**

Transverse contraction joints are constructed laterally from centerline and spaced to control cracking from stresses caused by shrinkage, moisture, and thermal changes. Joints may either be oriented at right angles to the centerline or skewed to the centerline.

Pavements that carry a significant amount of truck traffic will have dowel bars placed in the joint in order to transfer the load as truck tires cross the joint from one slab to the next. This prevents vertical movement of the slabs and pumping of the subgrade material.

Most primary pavements will have dowel bars at the joints. Often secondary roads and city streets do not.

As the pavement expands and contracts with change in temperature, the joints open and close. The dowels are smooth bars to allow for movement. They are coated with an asphalt or wax material to prevent bonding with the concrete.

**Figure 4-2 Transverse Contraction Joint**

## b. Day's Work and Header Joints

PV-101

Joints installed at the end of the daily paving operation are called Days Work Joints.

Transverse construction joints are also placed when there is a significant delay with concrete delivery to the site or other gaps in continuous paving operations and are called headers. These are installed at a location between planned contraction joints and utilize deformed bars.

**Figure 4-3 Days work or header joint**

## c. Longitudinal Contraction Joints

**PV-101**

These are tied joints that are constructed between lanes or other pavement adjacent to a lane. They are intended to prevent adjacent lanes from separating.

The sawing of these joints may be delayed until after the sawing is completed for the contraction joints. An early entry saw may be allowed for sawing these joints provided the correct depth and width of joint can be achieved. Deformed tie bars are used in these joints because their purpose is to prevent movement.

**Figure 4-4 Longitudinal Contraction Joint**

## d. Expansion Joints

**PV-101**

While it may not be readily apparent when standing on the side of a roadway, pavements move due to expansion and contraction caused by temperature and moisture differences. Some bridges also move, but don't necessarily move in the same manner as the adjacent pavement. Because bridges are scattered between sections of pavement, and both move independently of each other, something needs to be done to prevent the differences in movement from damaging the pavement and the bridge. For this reason, expansion joints are constructed on either end of the bridge. These are wide, often 3 or more inches, and typically close over a number of years. These isolation joints as they are often called help absorb the differential movement of the pavement and bridge to prevent damage.

Expansion joints may also be specified at railroad crossings. In the past, they have been used at regular intervals in pavements to provide relief and prevent blowups. This practice is usually discouraged because of the faulting of the contraction joints that often develops as the aggregate interlock in non-doweled pavements is lost.

Normally, these joints will have dowels to provide load transfer. They are filled with a filler material to keep out rocks and dirt that might resist their closing up, which they are designed to do.

**Figure 4-5 Expansion joint**

## 2. Saw cuts

The Iowa Department of Transportation requires joints to be sawed with one pass. The alternative procedure is to make an initial narrow, deep cut and then come back and make a widening reservoir cut later. The two cut procedure has not been a part of the Iowa specifications for a number of years, but it is still in use in many other states.

Timing of the saw cut is critical. To begin sawing when the concrete is too green will result in raveling of the joint. If the sawing operation is delayed too long, random cracks

will form. There is a window of time between the two extremes when the sawing operation must take place. It is the contractor's responsibility to determine the proper time to saw the pavement. The specifications require that cracks be prevented, but the inspector can only advise the contractor to watch the set of the concrete in order to accomplish the sawing within the necessary time.

The depth of the saw cut at the joint is determined by the category of saw used and thereby the timing of the saw cut. Road Standard PV-101 gives the specific requirements for each of these two joint types, as determined by the type of saw used.

There are two categories of saws that can be used for sawing.

### a. Conventional Saws

The conventional saw is a large powerful saw that begins the sawing operation once the concrete has obtained enough strength to support the weight of the saw. It must complete the sawing operation before the concrete begins to contract and build up tension within the concrete to the point of cracking.

The conventional saws are of two types, wet saws or dry saws. Wet sawing uses diamond blades and requires a stream of water to cool the blade. Dry sawing uses abrasive or diamond blades and does not use water during the sawing operation.

**Figure 4-6 Dry saw**

**Figure 4-7 Wet saw**

### b. Early Entry Saws

The other category of saws are early entry saws. The age of the concrete when early entry sawing begins is much sooner than with the conventional saws. The window for sawing the concrete is also smaller with this type of saw. If the concrete starts to contract and develop stresses, it is too late to saw the slab with a early entry saw. The early entry saw is used to cut a shallow cut (about 1 1/4 inch deep) instead of the

traditional one-third the thickness cut.  This shallow cut provides adequate stress relief for the concrete if it is cut when the concrete is very green.

**Figure 4-8  Early entry saw**

# CHAPTER 5
# EQUIPMENT

# Chapter 5 Equipment

## *A. Trimmer and Roller*

Section 2001 and 2109

A variety of equipment is used to prepare subgrade and place base prior to the placement of concrete.

In some cases, the subgrade may need to be ripped and re-compacted in order to create a uniform platform on which to place the base material. When this is done, normally a motor patrol is used to accomplish this work.

**Figure 5-1 Ripping the grade prior to subgrade trimming**

The first step after the stringline has been placed and checked, is to trim the subgrade to the correct profile and cross section. A trimmer is typically used to trim the subgrade, but motor patrols have also been used. Trimmers are equipped with controls that run off from the stringline to adjust both the elevation and alignment of the machine.

**Figure 5-2 Trimming subgrade**

If the subgrade or subbase needs water for proper compaction, a distributor mounted on a truck or trailer equipped with pneumatic tires will be used for applying water to the roadway. The distributor shall be equipped with an adequate pressure pump and flush or spray bars to distribute water evenly over the intended area.

Once the subbase is placed on the grade, a motor patrol, small self-loading scraper, or small bulldozer is used to level the aggregate subbase material and bring it to the rough grade.

**Figure 5-3 Small dozer used to level subbase material**

The trimmer will again be used to trim the top of the subbase to the elevation of the bottom of the pavement. A roller is then used to consolidate the subbase material.

**Figure 5-4  Trimming subbase material**

**Figure 5-5  Roller used to compact subgrade and subbase**

## *B. Transporting Vehicles*

Section 2001, Article 2301.02, B

There are primarily three types of vehicles that are used to transport concrete to the project site: dump trucks, agitator trucks, and transit mixers, better known as ready mix trucks.

## 1. Dump Trucks

Dump trucks are the most commonly used vehicle to transport concrete from the batch plant to the paving site.

**Advantages:**

- Versatile. They can be used for hauling other material when not used for transporting concrete, such as rock for base and shouldering.
- Quick loading and unloading.

**Disadvantages:**

- Limited haul time, 30 minutes by Iowa DOT Specifications, between batching and placement. This limitation is imposed because no mixing or agitation is performed within the transit vehicle.
- Limited flexibility during discharge. Discharging a portion of a load at a time or placing it anywhere other than at the end of the dump box is difficult. Construction headers or irregular shapes normally utilize one of the other two delivery vehicle types.
- Overhead clearance necessary to discharge.

**Figure 5-6 Dump truck**

Although not commonly used in Iowa, concrete can be delivered in semi trailer trucks. These will carry two batches of concrete and thereby reduce the number of trucks needed. Some modification of dumping procedures may be needed due to the large amount of concrete in a single load.

These may include either the dump box type or flow boy trailer. The dump box type has the problem of overfilling the hopper when discharging at the belt placer. Flow boy trailers work very well since uniform, contiuous flow of concrete is discharged into the hopper.

**Figure 5-7 Semi trailer delivery truck with dump box**

**Figure 5-8 Semi trailer delivery truck with flo boy box**

## 2. Agitator Trucks

The agitator truck is commonly used in paving operations. These are called agitator truck because they have paddles inside the truck box. These paddles continually turn the concrete while the truck is in transit.

The turning of the concrete is the reason the haul time is extended. If the paddles are not rotating, the truck is no different than a dump truck and haul time would be only 30 minutes.

**Advantages:**

- Extended haul time, 90 minutes by Iowa DOT Specifications.
- Ability to direct discharge for hand pours.

**Disadvantages:**

- Reduction in ease and speed of both loading and unloading.
- Limited in usage, to concrete delivery.
- Overhead clearance necessary to discharge.

**Figure 5-9 Agitator truck**

**Figure 5-10 Paddles inside agitator box**

Often a small number of agitators are used in a paving operation along with a majority of dump trucks. This gives the contractor the ability to take advantage of the extended haul time during hand operation at the beginning and end of the day and during breakdowns.

## 3. Ready Mix Trucks

Ready mix trucks can be used as delivery vehicles when they are charged from a central batch plant or they can be used to mix the concrete. These vehicles are normally used in lower volume paving, such as urban paving. When they are used for higher volume production, they are usually used as delivery vehicles with the mixing done at the central batch plant.

**Advantages:**

- Extended haul time, 90 minutes by Iowa DOT Specifications.
- Ability to add water or air entrainment at the project site.
- No overhead clearance restrictions.

**Disadvantages:**

- Reduction in ease and speed of both charging and discharging.
- Limited in usage, to concrete delivery

**Figure 5-11 Ready mix truck**

## *C. Placing and Consolidating*

Article 2301.03, F

There are two pieces of equipment that move the concrete from the point of discharge of the truck, place it on the grade and construct it into a finished pavement.

The belt placer is the first piece. Not all paving operations will utilize this piece of equipment, but when used, it performs a number of functions.

If the concrete can be hauled on the grade ahead of the paving operation and dumped directly in front of the paver, a belt placer is normally not used.
The paver is the other piece of equipment. It is the heart of the paving operation.

### 1. Belt Placer

A belt placer conveys the concrete from the truck to the front of the paver. It is used when it is not permissible to back trucks down the finished grade, and dump directly on the grade in front of the paver. The belt placer allows the truck to unload from the side of the roadbed. The belts then deposit the concrete in the middle of the paving area just in

front of the paver.  Like the trimmer, it utilizes the stringline for horizontal and vertical control.

A belt placer is normally not used when ready mix trucks deliver the concrete.  The shoots attached to the drums allow the concrete to be placed out on the grade, even with side delivery.  Belt placers are not commonly used for county and city paving.  These pavements often are not placed on granular base and do not contain dowels.  Therefore trucks can back on the grade and unload ahead of the paver.

The belt placer performs the additional function of spreading the concrete uniformly across the width of the pavement.  This provides a more uniform flow of concrete into the paver, which can result in a smoother pavement.

**Figure 5-12  Belt placer**

**Figure 5-13  Concrete spread on grade by belt placer**

**Figure 5-14 Dumping concrete on grade without belt placer**

## 2. Iowa Special

The Iowa Special is a piece of equipment that was developed in Iowa and often used for county paving. It is a special conveyor attached to a trimmer and used to convey concrete from in front of the trimmer to behind the trimmer. This allows trucks to back down the grade to the trimmer but still have the trimmer bring the grade to a true shape and elevation right ahead of the paver. This equipment is used when there is limited shoulder width for a haul road.

**Figure 5-15 Iowa Special**

**Figure 5-16 Iowa Special - Front**

**Figure 5-17 Iowa Special – Back**

## 3. Paver

The paver, or more formally known as the finishing machine, is the heart of the paving operation. It forms the concrete into the pavement, with proper width and at the proper elevation and thickness. It consolidates the concrete through vibration. Centerline tie bars and sometimes dowel bars are inserted into the fresh concrete as a part of the paver's function.

The paver has three main parts. The augers move the concrete pile one way or the other in order to maintain a fairly uniform head of concrete in front of the paver. This helps insure that one area does not run out of concrete and prevents a big pile in one area, which may make the paver ride up over it and thereby create a bump.

**Figure 5-18 Front of paver**

Next comes the vibrators. They consolidate the concrete. Proper setting of the frequency of each vibrator is important. Over vibration can damage the air entraining system and segregate the aggregate within the concrete. Under vibration can result in voids within the concrete and reduce both strength and durability.

**Figure 5-19 Augers and vibrators**

The last major component of the paver is the pan. It strikes off the concrete to the proper elevation and smoothes the surface. There are a number of adjustment devices attached to the pan in order to be able to make changes to the crown of the pavement, particularly as superelevations are encountered. Some contractors attach finishing equipment, such as a V float to the paver as the first step in the finishing process and specifically to help create a smooth ride.

**Figure 5-20 Vibrators and pan**

## *D. Finishing*

Article 2301.03, H

Finishing tools are used on the surface of the pavement immediately after it comes out from under the pan of the paver. Finishing closes the surface and removes bumps and irregularities.

The common types of finishing devices that are attached to the paver are the V float and the oscillating screed. Not all contractors use these but some feel they aid in obtaining a smooth ride.

**Figure 5-21 V float**

The oscillating screed brings some mortar to the surface. If it is not excessive, it is not a problem and simply aids in closing the surface. If excessive slurry is evident, either too much water is being applied to the burlap or water needs to be taken out of the mix.

The V float is suspended behind the paver and floats the entire surface as it passes. The oscillating screed works back and forth across the slab while it oscillates on a short forward to backward stroke.

**Figure 5-22  Oscillating screed float**

Hand finishing tools include floats, and straight edges.  Iowa specifications require the pavement surface be checked with a ten-foot straight edge.  The final finish is usually accomplished with a bull float.

**Figure 5-23  Hand finishing tools**

**Figure 5-24 Straightedge and hand float**

## *E. Texturing*

Article 2301.03, H

Texturing consist of two types: micro texture and macro texture. Both are accomplished in the paving operation but normally done with two separate pieces of equipment.

### 1. Micro texture

Micro texture is the roughened surface created by the dragging of astro turf along the fresh concrete surface. Often a bridge simply is attached and is pulled along, using attached cables, behind the paver. Pushing this bridge along by hand is discouraged. The results in the bridge "crabbing" along and leaves a wavy texture pattern.

Such a pattern, although not addressed in the specifications, is very noticeable to the driver and conveys a message of poor workmanship.

**Figure 5-25 Turf drag for microtexture**

## 2. Macro texture

Macro texture is the grooving pattern struck into the fresh concrete through a process normally referred to as tining. A machine, which has a rake containing many wire teeth and controlled by the stringline is used to construct grooves and is usually called the tining machine. Iowa allows either longitudinal or transverse tining, at the contractor's option.

**Figure 5-26 Transverse tining with blanking band**

The texturing may be done either transversely or longitudinally. The contractor has the option to do either but consistency along a section of roadway is desired. This should be discussed with the contractor prior to the start of paving operations.

**Figure 5-27 Longitudinal tining**

The Contractor is encouraged to construct the grooves as shallow as practical within the Specification limits. Shallow texture reduces pavement noise but still provides adequate friction.

**Figure 5-28 Longitudinally tined surface**

## *F. Curing*

Article 2301.03, K

Curing is a critical final step in the paving operation. This is completed with a machine commonly known as a cure cart. It has a holding tank to hold the curing compound and a spray bar with nozzles to apply the cure to the surface of the pavement, including the edges, in a uniform application.

**Figure 5-29 Cure/texture cart**

Sometimes the curing operation and the tining operation are combined on one machine. This has advantage for the contractor by minimizing the amount of equipment needed but has the drawback of interfering with one operation if a malfunction occurs with the other operation.

**Figure 5-30 Spray bar on cure cart**

## *G. Sawing*

Article 2301.03, N

Saws are used to cut the joints in concrete pavements. They are commonly grouped into two categories: early entry saws and conventional saws. Span saws are also used, but are rarely used in Iowa.

### 1. Early entry saws

Early entry saws may be used, at the contractor's option, to cut the transverse joints. They make a shallow cut, a little more than an inch deep. Sawing must begin very soon after the concrete is placed, often within about three to four hours. The saws used by many contractors in Iowa use an up-cut design. This produces a clean joint with very little dust.

**Figure 5-31 Early entry saw**

**Figure 5-32 Conventional dry saw**

### 2. Conventional Saws

Conventional saws are much heavier and more powerful than early entry saws. The contractor must wait to begin sawing until the concrete has gained more strength than the point at which sawing can begin with early entry saws. The saw depth is the major difference in the approach to sawing. Conventional saws make a cut that is normally one-third the thickness of the slab. Often the sawing is done at night.

Conventional saws can be of two types: dry saws and wet saws. Wet saws use water to cool the saw blade during the sawing operation. These saws use diamond blades. Dry sawing does not require water and utilizes either diamond or carborundum blades. A disadvantage of dry sawing is the dust that is created, which can especially be a problem in urban areas or when wind carries the dust across open lanes of traffic.

### 3. Span Saws

Span saws are heavy duty saws used for high production on large projects. They are capable of spanning the full with of a pavement and sawing joints much more quickly than conventional saws. They are very similar to conventional saws in that the contractor must wait to begin sawing until the concrete has gained sufficient strength to allow the weight of the equipment without damaging the slab.

**Figure 5-33 Wet conventional saw**

**Figure 5-34 Span saw**

## *H. Sealing*

Article 2301.03, P

The joint sealing operation will follow the joint sawing and includes a number of steps. The type of joint being sealed and the type of saw that was used will determine what operation will be required.

The joint must be cleaned. A high-pressure water blast must be used if the joints were sawn with a wet saw. An air blast must be used to clean the joint if a dry saw was used. A conventional air compressor is commonly used for this work.

**Figure 5-35 Air blast prior to sealing**

**Figure 5-36 Water blast prior to sealing**

Depending on the joint design, a backer rod may be required. A suitable tool must be used which will insert the rod to the proper depth.

Hot pour sealers are installed using equipment that has a kettle that is thermostatically controlled. It is very important to keep the temperature within the temperature limits set forth by the manufacturer. If the temperature is exceeded, bubbles can form on the surface of the in place sealant. These bubbles eventually can pop and create a hole in the joint seal, which allows water to enter the joint.

**Figure 5-37 Backer rod installation**

**Figure 5-38 Sealing with hot pour sealant**

# CHAPTER 6
# PRIOR TO PAVING

# Chapter 6 Prior to Paving

Before the contractor can begin paving, a number of activities must occur. This chapter describes those activities that are a part of the paving process but are performed before commencement of the paving operation itself.

## *A. Control*

Section 2526

In order to construct a pavement to a set profile, reference points must be established. A construction survey crew will begin the process by setting paving hubs at certain intervals and establishing elevation references on those stakes.

**Figure 6-1 Setting paving hubs**

**Figure 6-2 Paving hub with survey information on flat or "pie" stake**

The next step is for the contractor to erect a stringline supported by stakes. This is set at a certain distance above the grade line at an offset, and normally above the construction stake. It will be used as guidance for all the equipment that will be trimming grade, trimming base, placing and shaping the concrete, and constructing texture. These machines are set up to use the string line as control for alignment and elevation. There will normally be a string line for each side of the pavement. The contractor will set this string line at a vertical offset to the edge of slab using the grades marked for these hubs.

Before the contractor begins paving, it is necessary for the PCC grade inspector to do a number of checks utilizing the paving hubs and these lines. Normally these stringlines will be level with each other on a tangent section of roadway. However, sometimes the stringline on the haul road side is placed lower to facilitate the use of a belt placer. In a transition to a curve, one stringline will be raised as the roadway transitions into the curve and the other will remain the same or is lowered.

**Figure 6-3 Setting the stringline**

## 1. Survey Stakes

It is necessary for the inspector, surveyors, and grading contractor to get together before the paving hubs are set to discuss how the grades will be derived. There are basically two ways to grade the paving hubs, off a level line or off a projected line. A level line grade would be as if you were to place a level on the edge of slab and measure over the offset distance to the hub, the distance between the level and the hub will be the grade for that hub.

When the grade is a cut, the level line would actually be lower than the top of the hub. This would happen when the top of the paving hub is set higher than the edge of slab. The surveyors will subtract the edge of slab elevation from the hub elevation to calculate the cut grade.

When the grade is a fill, the level line would be higher than the top of the hub. This would happen when the top of the paving hub is set lower than the edge of slab. The surveyors will subtract the hub elevation from the edge of slab elevation to calculate the fill grade.

A projected line grade is the grade at the edge of slab projected out to the paving hub. It is the distance of the offset times the % of cross slope. It can be thought of as the slope along the top of the pavement projected on out to the hub. The surveyors will multiply the offset to the paving hub by the % cross slope and add it to the edge of slab grade. They will then take this projected grade and the hub elevation to calculate the grade for that paving hub as they do with a level line grade. Although both methods are acceptable and widely used, the use of both methods on the same project is discouraged. This could lead to confusion and costly errors.

**Figure 6-4 Front of the flat**

**Figure 6-5 Back of the flat**

A common practice to help mark the transition points for superelevations and horizontal curves is to paint a transition hub stake with orange or some other color paint in order to alert the paving crew of the transition.

**Figure 6-6 Stake showing trasition to superelevation**

## 2. Stringline

The stringline may be wire, cable, woven nylon, polyethylene rope, or other similar material. The stringline stake should be long enough to be rigid when driven into the subgrade. There must be an adequate stake length exposed above grade to allow adjustment of the stringline to the desired height above the subgrade profile.

The stringline stake is placed in a vertical position outside the hub line. When the line is inserted into the holder arm slot it can be adjusted to a point directly over the hub tack point.

**Figure 6-7 Setting the stringline**

**Figure 6-8 Stringline above the survey stakes**

The stringline supports are required to be located at 50-foot (15-meter) intervals unless horizontal or vertical curves are encountered. In those cases the stringline supports are required to be placed at 25-foot (8-meter) intervals.

Many contractors prefer to run a stringline on each side of the paver. They feel that a smoother ride can be obtained with this dual stringline system.
The staking system normally includes hand winches placed at appropriate intervals (usually not more than 1000 feet (300 meters)) to tighten the line to the extent necessary to avoid any perceptible sagging between stakes. Use caution when tensioning the stringline. A sudden break in the stringline could cause severe injuries.

Some agencies increase the visibility of stringline by placing ribbons on them.
The machine elevation sensing wand rides beneath the string, and the alignment-sensing wand rides against the inside of the string. Neither of these wands should deflect the line a measurable amount.

**Figure 6-9 Guidance wands for alignment and elevation**

A quick and easy check to see if there are any errors in setting this string line is to get eye level with the string and look down the line. If there is a noticeable dip or a noticeable bump in the line it is probably a good indication of either an error of the grade for the paving hub or an error when the contractor set the string line. Either way this should be checked out and corrected before the contractor proceeds to work in this area.

**Figure 6-10 Eyeballing the stringline**

Correcting surveying mistakes by eyeballing is a poor substitute for accurate surveying. Meticulous setting of the stringline cannot be overemphasized. This is the time to resolve all questions, prior to any pavement being placed.

## B. Proof Rolling

Article 2301.03, B, 3

Often with county and municipal paving, the placement of the concrete pavement is directly on an earth grade. In most cases on primary highway work, a base material is placed on the earth grade. Normally the base will be extended through the track line area. Therefore the condition of the subgrade is very important, both prior to the placement of the base material and prior to paving.

Inspection personnel need to be alert to soft spots, excess moisture areas, drainage problems, and so on. Early identification of these problem areas means they can be corrected by undercutting and/or stabilizing, thus providing the needed degree of uniformity. Specification Section 2301.10, Paragraph C, "Proof Rolling Requirements" requires that the subgrade be proof rolled no more than one week prior to trimming of the final grade. This proof rolling is very critical to make sure that the subgrade is strong enough to help support the pavement. Soft spots or unstable areas must be reworked to obtain adequate stability. This is often done with a loaded truck driving on the grade with soft spots being identified by rutting in the wheel tracks. The inspector must watch for soft spots that may develop as the base placement operation proceeds or the paving operation progresses if driving on the grade is permissible.

## C. Check Subgrade

The inspector will periodically check the subgrade using the two string lines. By pulling a string between the two lines, on a tangent section of roadway or when the roadway is in full super elevation, the inspector can measure from the string to the subgrade. A detailed explanation of this process is found in Section H below.

**Figure 6-11 Trimmer preparing subgrade**

There are different tolerances for how close the grade needs to be when the contractor is finished correcting grade. The inspector will need to know where to look for this information in the spec book or appropriate revisions.

**Figure 6-12 Checking the subgrade**

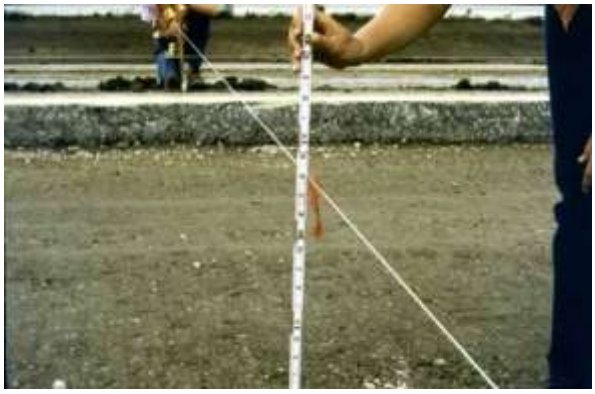


**Figure 6-13 Checking grade at centerline**

While in the transition for a curve, it is helpful to the paving contractor to have the different rates of slope on the flat with the paving grade. It is also helpful for the contractor to have the different points of transition located for them. This way they know when and how much to adjust the paving machine. If the surveyors do not provide this information to the contractor the inspectors will need to.

This subgrade check should be made at random locations or regular intervals. The frequency will depend on how accurately and consistently the contractor has trimmed the grade. Be careful not to become the contractor's checker. The grade should be completed to proper elevations before the inspection checks are made.

## *D. Place Granular Subbase*

Section 2111 & 4121
I.M. 204

Once the subgrade has been trimmed and checked, the contractor can begin to place the granular subbase. This granular material is normally crushed stone or crushed concrete. See Section 4121 for requirements of this material. It is delivered to the project in dump trucks or belly dumps. Or, the material can be old concrete pavement processed in place to granular subbase specifications. Chapter 6 discusses this procedure.

**Figure 6-14 Granular subbase placed on the subgrade**

The subgrade can not be used for a haul road. Trucks are only allowed to drive on the grade in the areas of dumping. Similarly, haul traffic is not allowed to travel on the Granular Subbase material either. This is to prevent degradation of this drainable material to a point where it may become non-drainable. For constructability reasons, haul traffic must drive on the subgrade and granular subbase material to place the material. A reasonable expectation of the contractor is that they enter the subgrade/subbase material, dump, and exit within a 500 to 1000 foot area.

**Figure 6-15Dumping and trimming granular subbase**

**Figure 6-16 Stringless trimming of granular subbase**

The material is spread using a dozer or motor patrol. The next step is to compact the material with a non-vibratory roller by making three passes only, as per specification. The final step is to bring the surface to the fine grade using a trimmer. Any trimmed material is salvaged and reclaimed.

**Figure 6-17 Spreading subbase material**

As with the subgrade, the surface elevations must be checked before the next operation can take place. Normally a string is stretched across the grade between the string lines at one of the support stakes. The distance is checked between the check string and the top of the granular material. Section H below describes this procedure.

**Figure 6-18 Final trimming of subbase**

**Figure 6-19 Subbase surface elevation check**

I.M. 204 specifies the minimum frequency at which these elevation checks must be performed.

Some agencies use other types of bases. Iowa Department of Transportation currently uses granular subbase under most PC pavements and special backfill or modified subbase under some pavements, primarily in urban areas. Cement or asphalt treated bases are used by some agencies, but are not discussed in this text.

## *E. Pad Line, Track Line, and Form Line*

All of these terms are often used to describe the area outside the edge of the proposed pavement that provides the foundation for all the paving equipment operations.

Most contractors believe that this line is one of the major keys to smooth pavement and should encompass the following characteristics:

- The base itself should be extended to a point at least three feet (one meter) beyond the outside edge of the pavement.
- The base should be constructed or trimmed parallel to the projected cross slope of the base. The creation of parallel lines is essential in minimizing the yield loss. In addition, parallel planes ensure both the agency and the contractor that the proper thickness of pavement will be placed over the entire roadbed.
- The base should be durable enough to provide a relatively smooth passage for the entire paving train. The placement of edge drains or subdrains beneath the track lines (longitudinally) prior to paving should be avoided. The weight of the paving equipment can crush the drainage pipes. Most agencies allow the contractor to place these drains after placement of the pavement.
- The line should be kept clean of dirt, debris, and surplus concrete during the pavement operations.

**Figure 6-20 Base material extended beyond pavement edge to form pad line**

**Figure 6-21 Paver track on pad line**

## *F. Placement of Dowel Baskets*

Article 4151.02 & 2301.03, E
Road Standard PV-101

Once the base has been trimmed to grade and the inspector is satisfied that the base surface has been brought to the proper profile, the contractor can begin to place the dowel baskets.

The contractor will then place the baskets on the grade, align them properly, and stake them down according to the PV-101  road standard.

Positioning will normally begin at a header but often must be adjusted in order to match side roads, crossovers or taper locations.  Both contractor personnel and agency inspectors must think ahead as to where joints will be sawn and make sure they match properly with existing joints in existing abutting pavement

Basket stakes should be placed so the vertical portion of the stake is behind the basket wire, relative to the direction of paving.  This supplies support as concrete pushes against the assembly.

**Figure 6-22  Staking down the basket**

**Figure 6-23  Pins placed behind the basket (paving direction is from top to bottom of of photo)**

At the contractor's option, up to three tie wires may remain uncut on each CD basket assembly. If they are cut, the inspector should approve their placement before they are cut in order to avoid risking loss of the basket if they must be repositioned.

**Figure 6-24  Cutting the tie wires is a contractor option**

The position of the bars is critical since the joints open and close throughout the year. If the bars are not truly aligned, both horizontally and vertically, they may bind up when this movement takes place and this can crack and break the pavement.

A final check would include the following:

- Sight down the grade. All the dowels should look straight as you look down the road at rows of assemblies. If they are not straight, it is easy to pick out the ones that are misaligned.

**Figure 6-25 Sight down the grade to check dowel alignment**

- Sight across the assemblies. All the dowels should be level and at the same elevation. If the grade was trimmed with a small trimmer which required two passes, the base may not match at the center. This can lead to the two assemblies not matching, with the end dowel of one being higher than the adjacent end bar of the other center. Also look for bars that are not level or have been bent down. These need to be straightened or replaced.

- Sighting across the basket from one pin or mark toward the one on the other side of the road. This is the line the saw will follow and should run across the middle of the basket for the entire length. If one of the assemblies is slightly off alignment, the saw cut can wander off the middle and result in an insufficient length of dowel on one side of the joint. This can lead to inadequate load transfer and early cracking of the new pavement.

**Figure 6-26 Dowels not level**

**Figure 6-27 Dowels not aligned across joint**

- In some fashion, marks will be made to show the exact locations of each assembly outside the edges of the pavement. Often pins are set on either side of the roadway to mark the locations. Some contractors simply paint marks in the rock on either side. The inspector should spot check the spacing to make sure they are properly spaced and aligned.

**Figure 6-28 Paint mark to locate joint for sawing**

- Dowel bars are required to be dipped in a bond breaker material prior to being delivered to the site. The bond breaker material may be either a bituminous material or a paraffin material. The paraffin material is normally clear so the bars look green. When bituminous material is used, the whole assembly looks black. The inspector should check the bond breaker to make sure that it is not weathered or worn. If the bond breaker is showing signs of weathering or wear, the basket should be recoated. There are several options for recoating bars including returning them to the manufacturer to be redipped or spraying with form oil or other approved material.

**Figure 6-29 Paraffin coated bars at top and bituminous coated bars at bottom of photo**

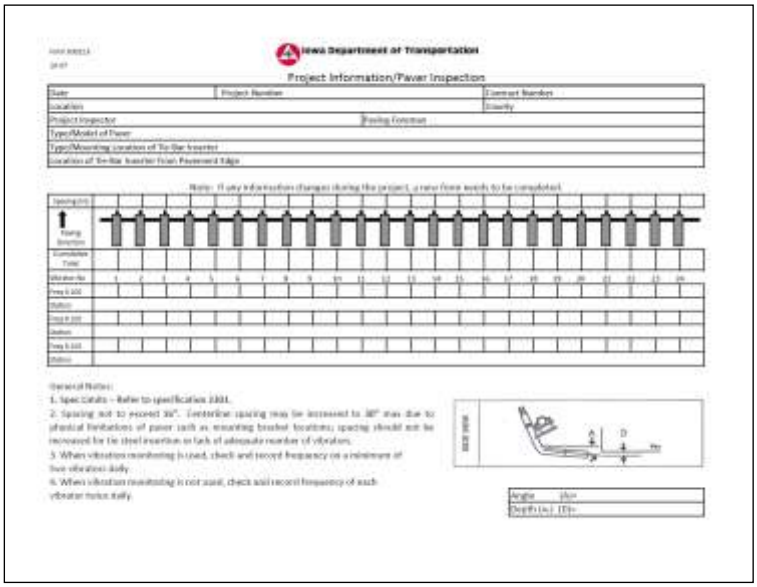
## *G. Paver Checks*

Form 830213

Before paving operations begin, it will be necessary for the PCC Grade Inspector to check the screed on the paving machine. With the screed set for a normal 2% crown, the Inspector will be able to pull a level line across the width of the screed. Utilizing the plan cross slope, the Inspector will be able to calculate an offset distance between the level line and the bottom of the screed. For instance, if you measure 4 feet (2 m) from the outside edge of the slab and the rate of cross slope is 2%, the offset distance from the level line and the bottom of the screed will be 0.08 feet (40 mm). If there is any deviation, the screed will need to be corrected.

The same method can be used for ramp paving. Pull a level line from the low end of the screed and measure the offset distance from the level line and the bottom of the screed. There will be no crown in the ramp so the same rate of cross slope will be used for the entire length of the screed. It is a good idea for the Inspector to get acquainted with how the Contractor changes the cross slope of the screed. This is commonly referred to as "Dialing in the Cross Slope." If the Inspector is aware of how this is done, they will be able to notice a discrepancy if one should occur. The screed should also be clean from any debris before it is used.

Project Information /Paver Inspection form 830213 is to be filled out prior to paving with a slip-form paving machine. A sample form is included in the Appendix. Usually this is done one or two days prior to paving for different machine widths or configurations to document machine and vibrator set-ups. Then during paving, this same form can be used to document daily vibrator checks.


Iowa Department of Transportation

Project Information/Paver Inspection

| | | |
|---|---|---|
| Date | Project Number | Contract Number |
| Location | | County |
| Project Inspector | Paving Contractor | |
| Type/Model of Paver | | |
| Type/Mounting Location of Tie Bar Inserter | | |
| Location of Tie Bar Inserter from Pavement Edge | | |

Note: If any information changes during the project, a new form needs to be completed.

| Spacing (in) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paving Direction | | | | | | | | | | | | | | | | | | | | | | | | |
| Cumulative Total | | | | | | | | | | | | | | | | | | | | | | | | |
| Vibrator No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Freq & Amp | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |
| Freq & Amp | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |
| Freq & Amp | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |

General Notes:

1. Spec Details – Refer to specification 2301.
2. Spacing not to exceed 30". Centerline spacing may be increased to 38" max due to physical limitations of paver (such as mounting bracket locations); spacing should not be increased for tie steel insertion in lieu of adequate number of vibrators.
3. When vibration monitoring is used, check and record frequency on a minimum of two vibrators daily.
4. When vibration monitoring is not used, check and record frequency of each vibrator twice daily.

SIDE VIEW

| | |
|---|---|
| Angle | (A)= |
| Depth (in.) | (D)= |

**Figure 6-30 Paver inspection form 830213**

This form is started when the contractor notifies the inspector that the paver is assembled and set at the correct width. The first thing to check is the actual width of the paver. Generally the paver will be set slightly narrower than the proposed width to allow for expansion of the plastic concrete as it comes out of the paver.

Next, beginning on the left side (looking forward from behind paver) measure and record the distance and spacing of each vibrator. This information, along with the approximate angle of the vibrators and clearance between vibrators and the bottom of the paver pan, is to be included on this form.

**Figure 6-31 Checking the vibrator spacing**

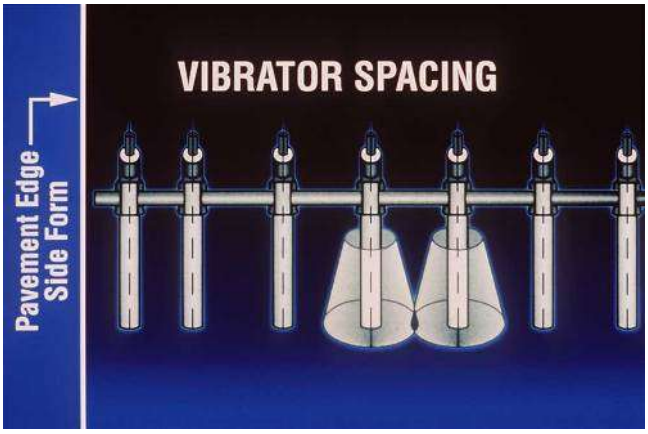



**Figure 6-32 Sphere of influence of a vibrator**

## *H. Determination of Subgrade and Subbase Elevations*

Section 2111

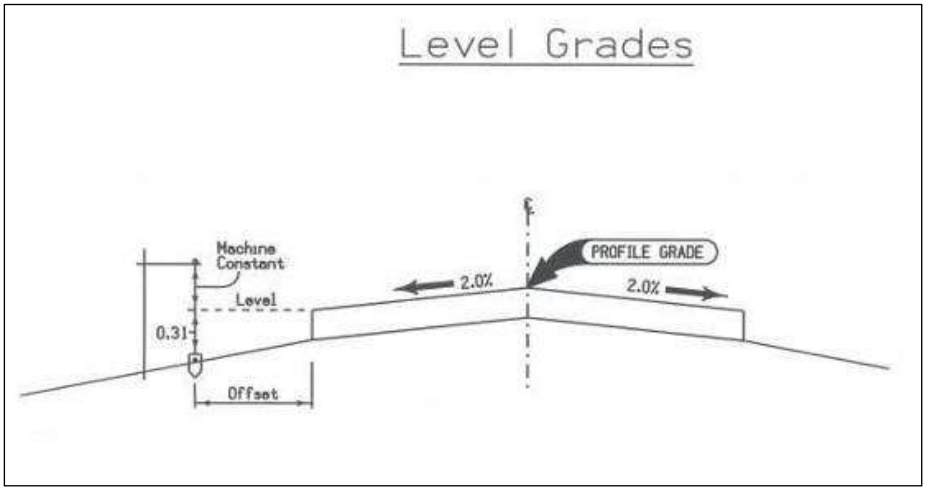
### 1. Subgrade

Generally the inspector will be responsible for checking the base once it has been cut to the proper elevation by the contractor. Standard specification 2111.03, B states that the tolerance is 0.05 foot (15 mm) high or low. This can be simply checked with a string, 6-foot ruler, and a set of plans.

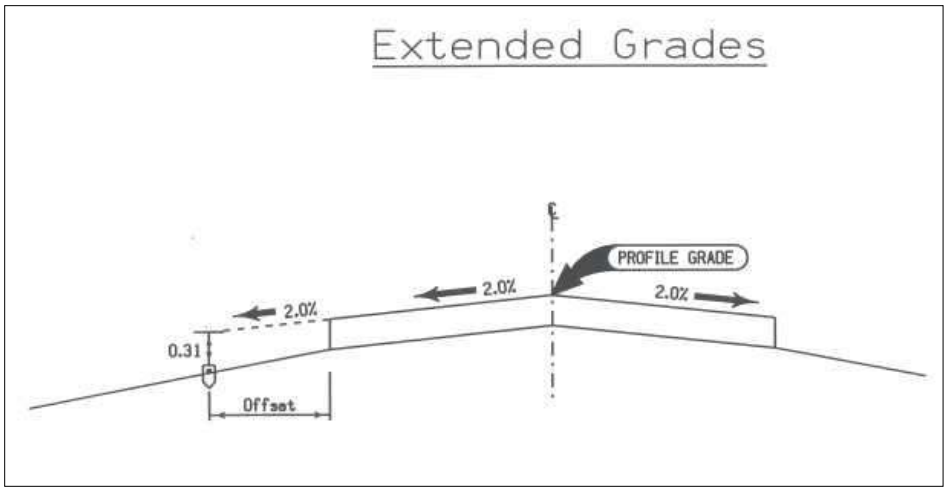
Some definitions are given below for terms that will need to be understood in order to check the accuracy of the subgrade and base. Based on the machinery clearances, working conditions, and haul road locations, the contractor determines the offset. The machine constant is used to give the contractor's equipment clearance above the stringline pins and survey control.

**DEFINITIONS**

- **OFFSET:** The distance from the survey control stake to the edge of the pavement
- **PROFILE GRADES**: The elevation at the top of the proposed pavement. The plans must be checked to insure the location of this grade. In some cases it is defined at the edge of the pavement but traditionally it is the centerline of the roadway
- **LEVEL GRADES:** Survey elevation control referenced level across the distance of the offset




- **EXTENDED GRADES**: Survey elevation control referenced by extending the pavement cross slope across the distance of the offset




- **MACHINE CONSTANT:** The distance the contractor sets the stringline above the survey stakes in addition to the survey information.

First check the height of the wand above the hub. This should be the elevation of the hub plus the machine constant. Hook one end of a string to the control string line pin. Running the string under, and intact with control string line, over to the pin directly across the roadway. Your string will be perpendicular to the centerline of the roadway. Care should be used to insure that your string is tight enough to eliminate sag, but not too tight as to cause distortion in the control stringline and/or pins. Measure from the hub, towards the centerline, the width of offset on the survey stake and mark this location for each side. These points are the outside edges of the proposed pavement. Next measure the vertical distance from the stringline to the top of base and record this distance.

To calculate what this dimension should be, you would need the typical cross-section and survey information for the station that is being checked. Also needed is the constant distance that is used by the contractor for clearance to prevent the equipment from hitting the control stringline and pins. Remembering that the survey stake is referenced to the top of slab, start with the constant that the contractor is using. Add to this the thickness of the pavement. Then add the subbase thickness. This is the desired distance from string to top of subbase.

Machine Constant + Pavement Thickness + Subbase Thickness = Desired Distance

Compare the actual distance to the desired distance. Document the difference and notify the contractor of any corrections needed. Re-check after corrections in the same manner.

On some projects, when the grading is done separately from the paving, the grade is accepted on the basis of the blue-top stakes. This process will vary from office to office, and factors like wintering of the grade should be taken into consideration.

## 2. Subbase

After the subgrade is accepted, the contractor will begin to haul subbase on to the grade and begin compacting and cutting to grade. Standard Specification 2111.03, D states that the tolerance is 0 high and 0.05 ft. (15 mm) low. This elevation can be checked in a similar fashion, with the exception of a few differences in calculating the desired elevation. Attach your stringline as before and mark the edges of the slab using offsets on survey stakes as before.

This check also requires that the center of the proposed roadway be located, since a check will be required there as well. Measure from the string to the top of the subbase at both edges of the proposed pavement, as well as the centerline, and record these measurements.

To calculate what this dimension should be, again you will need typicals and survey information from the hub. Also you will need the contractor's constant which may or may not be the same as for the subgrade check. Once again, remembering that the survey information is referenced to the top of the slab, start with the constant that the contractor is using.

Next add the thickness of the pavement. This would be the desired measurement for the outside checkpoints. For the centerline point you will need to remember that the subbase will generally mirror the top of the slab so it is necessary to account for the cross slope and/or the crown. To determine this, use the cross slope shown on the hub and multiply by the distance to the centerline. This will be a negative or positive adjustment, depending on whether there is a crown or superelevation.

Machine Constant + Pavement Thickness +/- Proposed cross slope * distance between edge and centerline

Compare actual distance to the desired distance. Document the difference and notify the contractor of any corrections that are necessary. Re-check after the corrections are made in the same manner.

Subgrade/Final Grade Check

Line No.: _____

Item Code: _____ Page No.: _____

Description: _____ Category No.: _____

Project No.: _____ Contract ID: _____

| Date | Location Sta | (Lane) (Side) | Distance (Ft.) | | | | | | | By |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

**Figure 6-33 Subgrade/Final Grade Check Form E109**

Subgrade and subbase elevation checks should be recorded on Form E109.

# CHAPTER 7
# PAVING OPERATIONS

# Chapter 7 Paving Operations

## *A. Wetting the Grade*

Wetting the grade is a very important step, but can easily be overlooked. It is especially important in hot, dry, or windy weather. A dry subgrade draws water from the concrete which can lead to inadequate strength gain and increased risk of cracking.

**Figure 7-1 Wetting the grade**

If there was sufficient rain the day before, wetting the grade may not be necessary. Overwetting the grade is not desirable either. The surface should be noticeably wet but need not be wetted to the point of water standing

## *B. String Line Control*

As discussed in chapter 7, string lines are used as a means to control the elevation and alignment of many pieces of equipment. The trimming that is done prior to paving uses these as guidance. The spreader and paver also use them. Normally string lines are used on each side of the grade to control elevation and one of the strings is used as guidance for the machine. The tining/cure machine also runs off the string lines.

**Figure 7-2 Spreader and paver with guidance from stringline**

**Figure 7-3 Adjust sensor arm to raise or lower paver**

As people walk around the paving operation, they must be very careful of the string lines. If a string is bumped, it can be knocked out of alignment and cause the paver to create a dip or hump in the slab. People also need to be careful not to knock the wand off from the string. The wand is the controlling mechanism for the machine and if the wand is loose, it will cause the machine to either rise or fall. That will create additional work for the contractor because the new pavement will have to be fixed, either by backing the paver up and going over the section again or by sawing it out later and replacing it.

Care needs to be taken when walking around the string lines for the safety of the inspectors and contractor's personnel. If one would trip over it, it would be easy to fall onto the haul road and serious injury or worse could result.

## *C. Deposit and Spread Concrete*

On thicker pavements and almost all Iowa Department of Transportation projects, dowels are required. The dowel basket placement on the grade and restrictions against driving on the base material lead to the concrete being delivered from the haul road and then placed out in front of the paver. The belt placer is used to accomplish this operation. It places the concrete near the center of the roadway and then, with augers, spreads it across the width of the pavement at a fairly uniform thickness. This helps create a uniform amount of concrete going into the paver which helps create a smoother pavement.

**Figure 7-4 Spreader to distribute concrete across the grade**

## *D. Place and Consolidate*

Article 2301.03, F

The paver is the heart of the paving operation. As discussed in Chapter 5, it forms the slab to the desired dimensions, and it consolidates the concrete. If correctly done little effort will be required by the finishers.

**Figure 7-5 Concrete entering the paver**

## *E. Finish*

Article 2301.03, H

When everything (mix, equipment, timing, delivery, etc.) is substantially correct, no finishing other than the texturing would be required. However, many things can happen to this outdoor assembly line process requiring correction in the final phase.

Finishing should not be undertaken while any bleed water is present. Under some weather conditions or with some mix peculiarities, bleed water can be significant.

## 1. Mechanical Floats

Several pieces of equipment may be utilized to correct minor variations and help seal any small imperfections in the finished slab surface. Combinations of these tools may be utilized on the same slab.

The longitudinal float or oscillating screed float, which may either be attached to the paver or self-propelled, is a float that may be up to 12 inches (300 mm) wide and 12 to 15 feet (4 to 5 meters) long. This float is normally placed parallel or close to parallel with the centerline of the slab. The float is carried from one side of the slab to the other while being oscillated front to rear. This is commonly termed the final finisher.

**Figure 7-6 Oscillating screed float**

The Lewis float or V float consists of a truss with floats attached to the bottom normally attached to the paver near the centerline and fanning out toward the edges of the pavement. This truss has a narrow float attached to the edges. This float rests on the slab and can be pulled by the paver.

**Figure 7-7 V float**

A burlap drag may be attached to the paver to help close the surface. Water is applied to the burlap and should be applied in limited amounts. A good indicator of too much water added to the burlap is the appearance of small bubbles on the trailing edge of the burlap.

**Figure 7-8 Burlap drag used to help close the pavement surface**

## 2. Straight Edge and Hand Float

Checking the surface behind the paver with a 10-foot straight edge is required. Should any surface imperfections be found, they should be corrected with a hand-operated float. Periodically check the trueness of the straightedge with a stringline.

**Figure 7-9  Straight edge and hand float**

## 3. Edge Slump

Out-of-tolerance edge slump, for whatever cause, will have to be corrected by the finishers by placing a bulkhead against the slab, adding some concrete, and floating the surface.

Today's pavers are equipped to overbuild the edge area and to allow a certain amount of sag to occur as the slab leaves the traveling form.  When the mix is within prescribed limits for air and slump, the edge is normally acceptable.

**Figure 7-10  Straight and true edge with no edge slump**

## 4. Water on the Surface

Excess water, if worked into the surface, can cause plastic shrinkage, excessive water cementitious ratio at the surface, and eventual scaling of the surface.

Water shall not be used in any significant amount to close the surface. If the surface is not closing well, the entire operation must be reviewed, including paver adjustments, increasing the mixing water, and changing the aggregate gradation.

**Figure 7-11 Ridge of slurry coming from the screed**

Equipment breakdowns cause delays that can put a burden on the finishers, but even then, water usage must be strictly limited. The burlap drag may be kept moist, but not sloppy. If trails of bubbles are observable behind the drag, it has excessive free water. Also, if slurry is forming along the edge of float or slurry is collected by the float and runs down the edge of the slab, excessive water is being added to the surface, and this practice should be stopped.

**Figure 7-12 Surface scaling resulting from excessive moisture on pavement surface**

## 5. Rumble Strips

Most new primary road pavements are built wider than the traveling lanes. They include a two-foot (0.6m) piece of pavement on the outside edge that is considered part of the shoulder. This is called a widening unit and must have a rumble strip constructed along it. When continuous milled shoulder rumble strips are not included on the project, structural rumble strips are placed by hand in the two foot widening. The purpose of the structural rumble strips is to keep traffic from driving on the widened portion of the pavement. This helps to reduce stresses on the pavement edge. Occasionally contractors forget to stop placing rumble strips in areas where they are not required such as along turn lanes, side road connections or ramp tapers. Check the plan before the project begins and discuss this requirement at the preconstruction conference as well when the project begins.

**Figure 7-13 Structural rumble strips placed in widening**

**Figure 7-14 Milled shoulder rumble strips placed in widening**

## 6. Marking Joints

To aid in sawing, the joint locations are identified. Some contractors use a rope or chain to score the joint location into the pavement surface after finishing and texturing. This is less common than in the past since contractors have discovered that scoring the pavement surface has an impact on pavement smoothness. Now, a more common practice is to place a paint mark and/or basket stake off each end of the basket prior to paving. The joint is then marked later using a chalk line so the saw crew will have a line to follow when sawing the transverse joints.

**Figure 7-15 Paint line to mark joint location for basket placement and sawing**

**Figure 7-16 String used to score the surface as a mark for the joint sawing**

## *F. Texture*

Article 2301.03, H

After finishing operations are complete, a two-step texturing process is accomplished. The first step is applying the microtexture to the surface. This is done to roughen the surface and provide more grip with the tires to assist in stopping on dry pavement. The second is the construction of the macrotexture through the placement of small grooves in the surface of the plastic concrete. This breaks the smooth surface and allows water to escape out from under tires during a rain and thereby reduce the tendency for hydroplaning.

### 1. Microtexture

Microtexture is achieved by use of a turf drag, coarse carpet, or burlap. This drag can be attached to the front of the tining machine but is normally attached to a small bridge. If the bridge is used, the paver should pull it. It will be some distance back, which will allow room for the finishers. Having the bridge pulled by the paver will result in a uniform forward motion and create a straight, uniform microtexture pattern. Only during unavoidable circumstances should the bridge be pushed forward by workers. Often hand pushing results in a back and forth pattern on the pavement surface, which is very visible to motorists for the life of the pavement.

Figure 7-17 Turf drag for microtexture

Figure 7-18 Burlap drag for microtexture

## 2. Macrotexture

Most states require tining to increase the friction of the surface of the pavement. Placing macrotexture in the pavement surface is typically accomplished by transverse or longitudinal tining. Today, longitudinal tining is most commonly used because it is a less labor intensive operation than transverse tining and still results in acceptable friction levels. The inspector should review Article 2301.03, H to determine current acceptable tining requirements and discuss this with the contractor.

Figure 7-19 Longitudinal tining

The tining machine must be parallel to the pavement surface. If not, an uneven pressure will be exerted on the pavement surface, resulting in a non-uniform texture. The depth of the tining should be as shallow as practical, within the specification. Shallow texture results in less noise being generated by the tire-pavements interaction while still providing adequate friction.

In some cases the transverse texturing machine is designed to rise from the pavement surface several inches (millimeters) away from the edge of slab. This preserves edge integrity and alignment.

When transverse tining is used, the area along either side of the proposed joint location is not textured. This provides an excellent surface for sawing and sealing operations. For longitudinal tining, a blanking band is not required. When placing transverse tining, overlapping of the texturing should be avoided because the resulting thin fins will be extremely fragile.

**Figure 7-20 Placing the blanking band ahead of tining**

**Figure 7-21 Transverse tining**

## *G. Curing*

Article 2301.03, K

An important step in concrete paving is the curing process. The surface and edges of the slab are sprayed with curing compounds to retard the loss of moisture from the concrete. The standard curing material for pavements is white pigmented curing compound. Curing compounds that are visible when applied provide a visible opportunity to determine uniformity of placement.

The curing compounds should be thoroughly mixed and continually agitated. Larger paving projects usually utilize bulk delivery and storage. The bulk storage is normally air agitated, and the spray machine tank is stirred with electrically driven paddles. Today curing compound is commonly delivered to the project site in reusable totes. Smaller deliveries are usually in barrels.

The rate of cure application in gallons per square yard (liters per square meters) should be checked routinely. Be sure to apply the cure to vertical slab edges and include them in rate calculations.

**Figure 7-22 Curing operation**

**Figure 7-23 Curing compound delivered in reusable totes**

## *H. Headers*

Article 2301.03, J
Road Standard PV-101

A header is constructed when the contractor ends a section of pavement. They are placed at the end of a day's run and whenever the paving operation is stopped for more than 30 minutes. A header is normally a hand poured area that is placed beyond where the paver pulled away from the slab. It consists of a header board and tie bars. Each tie bar is placed partially in the fresh concrete and partially sticking out beyond the header board. These protruding ends will then be incorporated into the next section of pavement.

**Figure 7-24 Hand placement and finishing of header**

Headers cannot be placed within five feet of a contraction joint. The header board normally has pre-drilled holes at the location where the tie bars are to be placed. Care must be taken to insure that the bars are parallel with centerline and level.

The header board is placed at the location of the header. The area behind the header board is filled with concrete. The concrete is vibrated and finished. The surface is textured and cured. The date should be placed at all header locations to properly identify the date of placement.

**Figure 7-25 Header with date stamped in each placement**

An alternative method to construct a header is for the contractor to pave beyond the location of the header and leave the end of the pavement irregular. The next day a full depth saw cut is made at the location of the header and the irregular portion removed. Holes will be drilled into the smooth face of the pavement end, and the tie bars will be anchored into the slab. This method is used to reduce the likelihood of a bump at the header.

**Figure 7-26 Run out header**

**Figure 7-27 Previous day's header**

The inspector must watch for delays or breakdowns that stop the paving operation. This can happen either to a piece of equipment on the paving train or at the plant, which stops the delivery of concrete. Once the paver is stopped for 30 minutes, a header must be placed. In

an effort to buy time while repairs are being made, the contractor may elect to slow the paver to a crawl. This is acceptable as long as the time for placement of the concrete does not expire. Communication between the field inspector and the plant, in order to determine batch time of the concrete loads, is critical.

If a header is placed, a contractor often will then resume paving, when the equipment problem is solved, by pulling the paver ahead some distance and beginning again. This will leave a gap between the ending header and the beginning header that will be filled in at a later time as a patch.

## *I. Hand Pours*

Hand pours are areas of paving which are not placed with a paver. They are constructed by placing the concrete on the grade, within the confines of forms and/or existing pavement. The concrete is struck off and vibrated with hand methods. This type of construction is used in irregular areas such as radii, ramp tapers, and gaps.

The forms must be checked for proper alignment and straightness. The depth of the concrete can be checked prior to placement by stretching a stringline across the top of the forms and measure down to the base material.

While there are no slump requirements for slip form paving, there are limitations on slump for hand pours. Also, the vibrator requirements are different for hand pours.

**Figure 7-28 Hand pour in an irregular area**

**Figure 7-29 Hand pour at bridge approach**

## *J. Cold Weather Protection*

Article 2301.03, K

Article 2301.03, K dictates the type of protection needed for concrete paving. It is necessary for the grade inspector to obtain the projected low temperatures to assure the paving is being protected adequately. An easy way to obtain this information is from a local radio station. At times the contractor will use a weather service to obtain this information also. Normally these temperatures will be the overnight temperatures.

**Figure 7-30 Burlap covering for cold weather protection**

Article 2301.03, S dictates the concrete and air temperatures required for the contractor to be allowed to pave. The grade inspector will need to actually carry a thermometer and take the air and concrete temperatures to be sure the contractor is in compliance with the specification. The problem with using the current air temperatures from a radio station is the station may be a fair distance away from the project and there could be a difference in temperatures between the two locations. Another problem is the station is probably in town where the temperatures are normally warmer than what they are on a rural paving project.

It is necessary for the inspector to record these temperatures and the time they were taken. If any action is taken such as not allowing the contractor to start or having them shut down, this should also be documented in the inspector's diary.

# CHAPTER 8
# TRAF. CONT. & SAF.

# Chapter 8 Traffic Control & Safety

## A. Traffic Control

Traffic control is an integral part of safety on a construction project. While inspection and maintenance of traffic control devices is the contractor's responsibility, an inspector should always bring deficiencies to the contractor's attention so repairs or changes can be made to provide a safe work zone for everyone. The inspector should also encourage the contractor to make these repairs or changes as quickly as possible to minimize the risk of incident.

**Figure 8-1 Inform the contractor of any traffic control deficiencies**

## B. Safety

Section 1107

Safety is everyone's job. The inspector needs to be alert to any activities that may pose a safety concern. The contractor is responsible for safety on the project site but the inspector should always be on the alert and immediately bring to the attention of the contractor anything that needs to be changed or improved.

The Contractor's machines and equipment should all be in good mechanical condition. This should also include any safety guards required for the equipment. The inspector will not actually use the Contractor's machines or equipment, however they will be working right along side of it. The safety of the inspector and the contractor's personnel depends on their safe operating condition.

Any time anyone must walk near the spreader belt, they need to be cautious. Trucks are backing up to the belt and can't see someone that may be standing between the truck box and the spreader. Also one should never walk under the belt when it is in the upright position. The hydraulics can fail and the belt can simply fall without notice.

**Figure 8-2 Be cautious when near trucks backing up to the spreader belt**

**Figure 8-3 Never walk under the spreader belt when it is in the upright position**

The condition of the haul roads used by the contractor should also be inspected. The contractor has the responsibility to maintain dust control on these roads. Normally a water truck is used to periodically spray water on the road. If dust begins to make visibility difficult, the inspector should have the contractor water the haul road more frequently.

**Figure 8-4 The contractor must water the haul road to control dust**

If the construction is immediately next to traffic, a greater degree of awareness of one's surroundings is required. Anyone that must be next to an open lane must always be aware of where they are relative to the passing traffic. The picture at the right illustrates what can happen if the float handle is struck by the passing truck. If the handle is on the upstream side of his head, he could be seriously injured if a passing vehicle struck it.

**Figure 8-5  Be alert when working near traffic**

The string line is also a hazard.  If someone trips over it and falls, they could fall under a passing vehicle.

**Figure 8-6  The stringline can be a tripping hazard**

The inspector and the Contractor must designate areas for parking vehicles.  Parked vehicles can be an obstruction to both the construction vehicles and the motoring public.  Normally vehicles should not be parked on the shoulder of open roadways.  If they can be pulled down into the ditch and out of the way, this may work as a temporary location.

**Figure 8-7  Park vehicles in safe areas away from traffic**

During shouldering operations often dirt must be excavated and hauled to the project location.  Although it is not the inspector's job to direct the contractor's actives, if an unsafe condition becomes evident, the inspector should not let it go on with out reporting it.  The picture illustrates an unsafe condition where a collapse of the embankment could be disastrous for both the backhoe operator and the truck driver.

**Figure 8-8  Unsafe conditions need to be reported**

If any violations of the specifications or any safety problems are noticed, the inspector should notify the contractor immediately.  The inspector should also notify the inspector in charge of

the project as soon as possible. Any violations or problems and conversations with the contractor about them should be noted in the inspector's diary.

The contractor's plant site also poses many safety concerns. Often during high production, a contractor may batch up to four hundred truck loads of concrete every day. This means that not only will the trucks hauling the four hundred loads of concrete to the paver be cycling through the plant site, but the trucks delivering the unmixed materials to the plant site will be cycling through also.

Because the plant site is such a busy place it is easy for an inspector or their vehicle to be forgotten or overlooked. It is very important that when visiting a plant site, an inspector make sure that they are seen by all. To stand out as much as possible, a safety vest should be worn at all times. Vehicles should be parked in a conspicuous location away from the haul routes of the delivery vehicles. Production vehicles should always have the right of way unless the driver clearly motions for the inspector to proceed.

**Figure 8-9 The plant site poses many safety concerns**

Because there is equipment and materials overhead at the plant site, a hard hat must be worn at all times when on foot. As a policy, most contractors require this of their employees as well as all visitors.

# CHAPTER 9
# ROLE OF THE INSPECTOR

# Chapter 9 Role of the Inspector During Paving

Prior to the day of paving, the inspector should assemble the testing equipment and tools that will be needed for testing and inspection. These items include an air meter, a siphon bottle, a bucket, a rubber mallet, a shovel, a slump cone, a long rod, a margin trowel, and a set of station numbers.

The air meter should be calibrated and in working order. As with any equipment, care needs to be taken in handling and transporting the meter. It is best to leave the meter at your job trailer until it is needed. To insure air content readings are accurate, calibrate your air meter regularly.

**Figure 9-1 Assemble and check testing equipment**

Prior to the day paving begins an inspector should have checked the grade, the dowel basket placement, and the equipment. A visual check should be made of the roadway area to be paved that day. This should include looking for debris on the grade, dowel bars that have been bent out of position, wetness of the grade, and eyeballing the stringline for any inconsistencies. This can simply be accomplished by periodically walking out ahead of the paving train throughout the day. When problems are identified, the contractor should be notified immediately to allow time for correction.

**Figure 9-2 Check grade conditions before start of paving**

It is good to check the most recent weather forecast and be prepared for any changes in the weather conditions. If there is any chance of rain, discuss it with the contractor. Plastic or burlap should be readily available to use for protection of the concrete from rain damage.

## *A. Traffic Control*

Section 2528

The contractor is required to review the traffic control for the project and document its condition. If there are corrections or repairs that need to be made, they should be noted in the contractor's traffic control daily diary. The contractor should also document when the corrective action was taken. This information may be needed at a later time. This information is critical in case an accident would occur.

Even though the contractor is responsible for maintenance and repair of traffic control, the inspector should bring deficiencies to the contractor's attention when discovered. If corrective action is not made within a reasonable timeframe, a non-compliance notice should be issued.

**Figure 9-3 Traffic control devices are often hit, moved, or destroyed**

**Figure 9-4 Notify the contractor of devices in disrepair**

After paving has begun, the contractor and inspector should observe the traffic patterns of the delivery vehicles and especially how safely they interact with public traffic. If it appears that the operation needs to be revised in order to make it safer, the inspector should discuss possible changes with their supervisor and the contractor.

Everyone associated with the traffic control for the project must be notified of any changes. The contractor must note in their traffic control daily diary any changes if a revision was implemented.

## *B. Wetting the Grade*

Wetting the grade is a very important step, but can often be overlooked. It is especially important in hot, dry, or windy weather. A dry subgrade draws water from the concrete which can lead to inadequate strength gain and increased risk of cracking.

**Figure 9-5 The grade must be wet ahead of the paver**

If there was sufficient rain the day before, wetting the grade may not be necessary. Overwetting the grade is not desirable either.

## *C. Concrete Delivery*

Articles 2301.02, C, & 2001.21

There are a number of inspection duties that the inspector must be continuously watching with regard to the concrete being delivered to the grade.

### 1. Delivery Time

There are three methods of transporting the concrete to the grade: with regular dump trucks, agitators, and transit mixers, better known as ready mix trucks. Article 2301.02, C provides the discharge times for all three methods. In brief summary, concrete delivered to the grade without continuous agitation must be placed within 30 minutes but concrete delivered to the grade with continuous agitation must be placed within a period of 90 minutes. Concrete delivered in a ready mix truck also must be placed within 90 minutes.

**Figure 9-6 Dump truck - 30 minute time limit**

**Figure 9-7 Agitator truck - 90 minute time limit**

When a stationary mixer is used, the grade inspector will have to go to the plant site and document the batched time. This will be the time when all of the materials are placed in the mixer as per Article 2001.21. The inspector will then follow the truck to the paving site and document the time of discharge. The time interval must not exceed the specified time for discharge for the type of truck the mix is being hauled in.

With a ready mix truck the time batched will be on the ready mix ticket. The plant inspector will fill out this ticket. The time discharged is when the ready mix truck is finished discharging the load. This time will be recorded on the ready mix ticket by the grade inspector. This time cannot exceed 90 minutes.

**Figure 9-8 Ready mix truck - 90 minute time limit**

## 2. Added Water

When necessary, the contractor can add water to the concrete at the grade if a ready mix truck is being used. Per Article 2301.02, C, the concrete must be mixed at least an additional 30 revolutions if water is added at the grade. It is necessary for the inspector to count and assure that these additional revolutions are performed to insure proper mixing.

**Figure 9-9 Water can be added to a ready mix truck at the grade**

When water is added to a ready mix truck the grade inspector must be sure total water does not exceed maximum water allowed. This maximum water allowed will be entered on the ready mix ticket by the plant inspector. It is necessary for the grade inspector to communicate with the plant inspector on a daily basis to let them know how much water has been added at the grade. The plant inspector will then use this information to calculate the water/cement ratio.

### 3. Mixing

Concrete delivered by the first two methods is mixed in a stationary batch plant and then dumped into the trucks. The concrete delivered by a ready mix truck will be mixed in either a stationary batch plant and then discharged into the truck or mixed in the drum of the ready mix truck itself.

At any time the grade inspector notices or suspects that something is not right with the mixing operation or the concrete itself, the inspector should contact their supervisor and the contractor immediately and document it in the daily diary.

### 4. Clean Boxes

Throughout the day the inspector needs to watch the inside of the delivery truck boxes. Concrete can, and often does, stick to the inside of the box, particularly in the corners. The contractor and the inspector need to make sure that all the concrete falls out of the truck when each load is emptied at the grade. If concrete sticks to the box, the box should be cleaned out before the next batch is dumped into the truck. This is important because this concrete will ride along the truck all day and, at some point, may come loose and end up in the pavement.

**Figure 9-10 Concrete stuck in box must be removed before next batch is loaded**

## D. Placement

It is important to watch the concrete as it piles up under the belt placer. The pile should be somewhat bell-curve in shape. Segregation of the concrete can occur as it comes off the belt. If this occurs the pile will be more vertical on the side away from the belt and more flat toward the belt. The larger aggregate is being thrown further and the paste is running off the end to the belt. This can effect how well the edge of the slab stands up. Normally the edge next to the delivery will slump more than the side away from where the trucks dump.

**Figure 9-11 Uniform concrete pile - not segregated**

## E. Concrete Testing

I.M. 327, 204
Construction Manual 9.61

I.M. 204 dictates the minimum frequency requirements of testing. I.M. 327 explains how and where to obtain samples. Paragraph 9.61 of Chapter 9, PCC Pavement, in the Construction Manual also addresses concrete sampling.

### 1. Air Content

Article 2301.02, B
I.M. 318, 327, 527, 204, 530

The air content is an important property of the concrete because it has a great impact on how long the concrete will last. Therefore tests are made of the concrete during the placement operation to insure that the proper air content is maintained. I.M. 530 along with I.M. 204 or the Supplemental Specification for QM-C projects, specify the minimum testing frequency that must be followed.

Specification 2301.02, B discusses the required percent of entrained air needed for concrete paving mixes. The concrete paving mixes have been developed so finished, consolidated concrete contains 6% air content. To allow for air loss throughout the paving operation, specifications require the air content for fresh, unvibrated, plastic concrete to be between 6 and 10% before consolidation, with a target of 8%.

**Figure 9-12 Air meter**

**Figure 9-13 Air test on grade**

Newer, heavier slipform paving equipment can sometimes cause an entrained air loss greater than 1.5% due to their higher ability to impart vibration forces into the plastic concrete. For this reason the specifications allow for checking of air content behind the paver to ensure that adequate air content remains in the concrete after consolidation. If adequate air content does not remain, the target air may be adjusted. Air content behind the paver should be checked daily until inspection staff is comfortable that air loss is consistent.

**Figure 9-14 Sampling concrete behind the paver**

The amount of air entraining agent that is dispensed into the mix at the paving plant is the contractor's responsibility. The inspector should not recommend dosage rates but should inform the contractor of non-complying or near non-complying air content.

## 2. Slump

Article 2301.02 B.
IM 204, IM 317

Slump is a test that was used in the past to give an indication of the change in water content of the concrete. Today it may not always do that because admixtures can affect the slump without changes in the water content. Often the slump test is used to approximate the workability or flowability of the concrete. This too is inexact because the workability may not always be reflected by slump characteristics.

The slump test is best used to measure consistency of a given concrete mixture. Current slump limits are given in Article 2301.02, B and the testing frequency is given in IM 204. For slip form paving, the slump test is not required.

Rev 9/06 Form: E115

**Air and Slump Tests**

Line No.: _____ Page No.: _____
Contractor: _____ Category No.: _____
Project No.: _____ Contract ID: _____

| Date | Location | Mix Type | Air (%) | Witnessed Quality Control Test (X) | Slump (in) | Application | Remarks | By |
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| | | | | | | | | |

**Figure 9-15 Record air and slump test results on Form E115**

## 3. Mix Temperatures

Article 2301.03, S

Because of the important influence temperature has on the properties of freshly mixed concrete, some specifications place limits on temperatures. In Iowa, the minimum mix temperature for concrete paving is 40 degrees F (4 degrees C).

The contractor or inspector can measure the concrete temperature at any time, although no frequency is specified. The change in temperature can relate to changes in air content, water demand, and workability.

**Figure 9-16 Thermometer inserted into the concrete in the air pot**

## *F. Pavement Testing*

### 1. Edge Slump

Article 2301.03, H
Construction Manual 9.53

There are times when the moisture level of the aggregate brought into the plant site varies greatly. The individual loads may have lower or a higher moisture level then what was being used previously. Also there may be a wet pocket of material in the stockpile. The Plant Inspector may not notice this until they do a moisture test. A wet pocket in the stockpile may only affect a load or two and no corrective action will be necessary.

If the aggregate that is brought into the plant site is consistently higher in its moisture content, then the water added at the plant site may need to be adjusted. It is this increase in water in the concrete that can lead to edge slump.

Article 2301.03, A states that a slip form paving machine should be used that leaves the edges of the slab vertical. If the edge of the pavement begins to slump, it may need to be supported by a temporary form. This form should also meet the specifications for forms as stated in Article 2301.03, A. Section 9.53 of the Construction Manual covers the use of forms for repairing excessive edge slump.

**Figure 9-17 Using a level to check edge slump**

Monitoring the edge slump is important. If it is out of tolerance, the finisher should place a form that is of the same height as the slab against the slab, add concrete, refinish the surface, and bring the edge back into tolerance.

**Figure 9-18 A birdbath can be created if the edge is high**

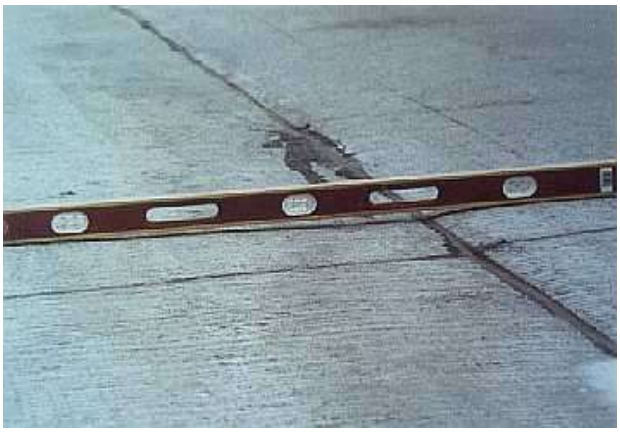

**Figure 9-19 Avoiding edge slump is critical when additional lanes are added**

## 2. Pavement Width

The width of the pavement will be indicated in the plans. Width should be monitored regularly.

With the help of another Inspector, or one of the Contractor's personnel, the Inspector should measure the width of the pavement. Using a measuring tape, simply span the width of the pavement and measure it.

Another method the Inspector can use is to measure the distance from the paving hub to the edge of the slab. This distance should be the offset distance written on the flat for the paving hub.

The Inspector will need to measure from the two hubs at the same station location to use this method. Slight deviations may occur if the paving hub has been disturbed. If the Inspector notices a hub that looks like it may have been disturbed, use a different location or method. Again, notify the Contractor and Project Manager of any deviations and document in a diary entry.

## 3. Cross Slope

Construction Manual 9.44

The slope of the surface of the pavement, given as a percent, will be indicated in the plans. Even though the inspector has already checked the cross slope of the screed prior to paving, additional checks should be taken throughout the paving operation. There will be times when there will need to be a change in the cross slope of the screed, such as during paving of the transitions of a curve.

Also, someone walking by on the deck of the paver may accidentally bump the dial. The Inspector can verify the cross slope by leveling a four-foot carpenter's level and measuring the distance from the bottom of the end of level to the top of the slab. The distance should be four feet multiplied by the desired cross slope. This method is also described in Chapter 9, section 9.44 of the Construction Manual.

**Figure 9-20 Checking cross slope with a stringline**

**Figure 9-21 Checking cross slope with a level**

The inspector should check the cross slope in more than one area when doing this check. The inspector may not get the desired cross slope in one area simply because the carpenter's level may not have been right on when they took the measurement.
This can easily happen if the level sinks into the slab a little while measuring or the Inspector inadvertently moves the level while taking the measurement.

The Inspector should check the cross slope before the finishing operations. This again may lead to a slight discrepancy in the cross slope. If the Inspector is using a four-foot level on a metric project, they will need to mark a meter on the level or convert from English to metric. The Inspector should not be overly concerned with slight discrepancies; however, if they find a deviation that they question or one they are not comfortable with, they should notify the Contractor and Project Manager as soon as possible. The Contractor will also periodically check the cross slope of the pavement after it sets up. This should not be a substitute for the checks made while paving.

## 4. Depth Check

Article 2301.03, A

Probing to check the depth of the concrete should be done regularly by the Contractor's personnel. The inspector should monitor this process.

The design thickness of the pavement will be stated on the contract documents for the paving project. The plan and profile sheets will also show the design thickness of the slab, however, care must be taken when looking at these pages. Note there may be different thickness for mainline, ramps, and side roads. These different thicknesses will be individual bid items.

While paving, it is a good idea for the PCC Grade Inspector to periodically observe the contractor probing the pavement to assure the slab is being placed at the proper depth. When the Contractor uses forms for paving, simply measure the depth of the form and down from the string line stretched across the top of the forms. Article 2301.03, A explains the use of forms for paving. Article 2301.03, C explains the setting of forms. Discrepancies should be brought to the attention of the Contractor and Project Manager and documented in the Inspector's daily diary.

**Figure 9-22 Insert depth checker into slab**

**Figure 9-23 Measure slab thickness**

## 5. Yield

I.M. 204

During the paving operation, the inspector should run yield checks throughout the day. The inspector should use the length, width, and the depth of the paving to find the calculated cubic meters or cubic yards per station. The actual cubic meters or cubic yards will be obtained from the concrete tickets.

The inspector will then take the actual cumulative cubic meters or cubic yards and compare it to the calculated cumulative cubic meters or cubic yards delivered in order to find the running yield. If this number is multiplied by 100, this number is the percent yield. By comparing to the previous yield checks, the inspector can determine whether the yields is increasing or decreasing.

Normally the yield will be over 100%. A yield of 103% to 106% is normal. The inspector figuring the yield should inform the contractor and project inspector of the trend and deviations. The project inspector should check into the cause of any unusual values and determine if any corrective action is necessary.

PCC Pavement Field Page

Line No.: _____

Item Code: _____ Page No.: _____

Description: _____ Category No.: _____

Project No.: _____ Contract ID: _____

| Date | Station | | Lane | Mix No. | Time | | Length (ft) | Width (ft) | Estimated CY Today | Used ( CY ) | | Est. Used ( % ) | Slip or Fixed (S / F) | Cold Weathr (Y / N) | By |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | | Start | Stop | | | | Today | To Date | | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
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| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
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| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |

**Figure 9-24 Document paving information on Form E137**

## *G. Vibration*

Article 2301.03, A
Construction Manual 9.64
I.M. 384

Article 2301.03, A details the use of vibrators in the paving operation. Vibration is important to the proper consolidation of the plastic PCC mix.

Over vibration can cause segregation of the aggregates. The large aggregate will sink in the concrete and mortar will rise to fill that space. This action forms an area of high mortar resulting in high shrinkage and no aggregate to prevent cracking. This phenomenon can become visible through the formation of vibrator trails. The inspector must watch for these behind the paver.

Over vibration will often lower the air content in the plastic mix in the areas near the vibrators. Deterioration of the concrete due to freeze/thaw damage will be the outcome.

The frequency of each vibrator should be checked twice a day (for QM-C projects, this is a part of the contractor's quality control testing procedure) and documented on Form 830213 "Project Information/Paver Inspection" as stated in Chapter 9, section 9.64 of the Construction Manual. If a vibrator is outside the specified range, the Inspector should inform the Contractor to adjust its setting. Article 2301.03, A states that the slip form paving machine shall vibrate the concrete to the full width and depth being placed in a single pass.

### 1. Frequency

Article 2301.03, A requires internal vibrators to operate between 4,000 and 8,000 vibrations per minute. It requires surface vibrators to be maintained between 3,500 and 6,000 vibrations per minute. Hand held vibration is to be between 3,500 and 6,000 vibrations per minute. To ensure proper consolidation of the plastic concrete, the vibration system used in the finishing machine should provide continuous and full coverage. I.M. 384 specifies the Method of Measuring Pavement Vibrator Frequency.

### 2. Paving Machine Vibration

Article 2301.03, A specifies the center-to-center spacing of internal vibrators to be a maximum of 16 inches. Vibrators spaced further apart than this may be forced to run at a higher frequency than allowed in the specifications in order to provide the proper consolidation effort. Construction Manual 9.64 discusses situations where this spacing may be modified by the Engineer.

**Figure 9-25 Vibrator checker touching the vibrator**

**Figure 9-26 Vibrator checker touching vibrator in fresh concrete**

**Figure 9-27 Vibrating reed tachometer measuring vibrator frequency**

Depth and position of the vibrators is also discussed in Construction Manual 9.64. Article 2301.03, A specifies when the vibrator monitors with electronic frequency readout and recording devices are required.

**Figure 9-28 Vibrator monitor display box**

**Figure 9-29 Vibrator frequency display**

When vibration monitoring is not required, vibrator readings should be taken and recorded at the start of concrete placement. Readings should also be taken for each vibrator at least twice daily to check for mechanical failures or problems in the vibration system of the paver. Vibrator readings should be recorded on Form 830213 "Project Information/Paver Inspection."

If vibrator frequencies are greater than allowed by specification, the Contractor should be informed to adjust the paving operations so that future measurements are within required specifications. Excessive vibration frequencies have been known to produce lower entrained air and premature concrete pavement deterioration with shorter pavement life.

It is also helpful to watch for the presence of vibrator trails in the plastic concrete surface behind the texturing operation (but before the curing compound application). These trails show in the surface of the plastic concrete by a deeper groove in the textured surface. This deeper texture follows the path of the vibrator. Many existing Portland Cement Concrete pavements contain these vibrator trails.

**Figure 9-30 Vibrator trail caused by excessive vibration**

**Figure 9-31 Vibrator trails**

**Figure 9-32 Left core in vibrator trail shows segregation due to overvibration**

### 3. Hand Held Vibration

Vibrators are used to consolidate concrete in walls, columns, slabs, and hand pours; basically anything poured inside a form. When concrete is vibrated, it settles in the forms and the trapped air pockets rise to the surface. Proper use of hand held vibrators is also very important.

Vibrators should never be used to move concrete as this causes segregation. If you observe anyone using the vibrator to move the plastic concrete, you should tell them this is not allowed. The vibrator should be lowered vertically in the concrete at regular intervals in a poking manor. Care should be taken to make sure the vibrator does not touch the subgrade form walls or reinforced steel. An insertion of 5 to 15 seconds should be sufficient for proper consolidation. The length of time for the vibrator to be used will depend on the slump of the concrete and the power of the vibrator. Allowing the vibrator to remain in the concrete after the paste accumulates will cause segregation.

**Figure 9-33 Vibration of hand held vibrators must also be checked**

## *H. Steel Placement*

Article 2301.03, E
Construction Manual 9.25 and 9.26
Standard Road Plan PV-101

Project plans include joint layout sheets that show location and type of joints to be constructed within the pavement structure. As the Inspector, your role is to inspect the reinforcing devices to insure the proper location and alignment. If this is not maintained, the integrity of the joint is compromised.

## 1. Transverse Joints

Probably the most important of these joints is the "CD" or doweled contraction joint. This joint utilizes the dowel as a load transfer device and is designed to allow the bar to slide in the concrete. If it's not properly aligned, the pavement joint will not be able to open and close as the concrete expands and contracts due to initial shrinkage of the concrete and temperature changes.

**Figure 9-34 Paint mark to guide sawing operation**

**Figure 9-35 Sighting down the grade to check dowel alignment**

Check the plans for joint locations. It is important to check the placement of dowel baskets to correspond to joint locations, particularly in multiple pass construction and variable width placement. This is important, especially at intersections, crossovers, intakes, or anywhere the joint has to match another feature.

**Figure 9-36 Mismatch of the transverse joint and existing joints**

When multiple paving passes are used, discuss joint placement prior to construction of each pass to insure continuity of joints across stage constructed pavements. Matching

joints of crossovers and median paving with joints of each roadway seems to be a frequent challenge.

## 2. Longitudinal Joints

The two main longitudinal joints are the "L" and "K" joints. "K" joints include both a keyway and a tie bar to hold together two adjacent lanes placed at different times. There are several ways to do this. The keyway can be slip formed in the plastic concrete with a bent tie bar being placed in from the side. Or, the keyway is formed by a preformed metal strip with holes in it for the bent bars. This strip is fed into the front of the paver. For fixed form paving, the preformed metal strips are hung on the side forms with a mechanical device. The ends of the tie bar need to be held in place by something more than just a rock or a pile of plastic concrete.

**Figure 9-37 KT joint with keyway and tie bars**

"L" joints consist of deformed bars called tie bars that are placed across centerline or lane lines when both lanes are placed at the same time. A saw cut is made above the center of the bars after the concrete has hardened.

These tie bars can be placed either manually or mechanically.

To manually place the tie bars, a person often rides on the front of the paver or the back of the belt placer to manually place the tie bar. Mechanical placement accomplishes the same thing, except the person is replaced by a hydraulic ram. In either case, a timing device is needed to obtain the correct spacing. This is usually a wheel with the correct circumference that rides on the paver track. This activates a light to alert the person to place the bar or it trips the hydraulic ram.

**Figure 9-38 Manual insertion of tie bars**

**Figure 9-39 Worker loading mechanical tie bar inserter**

### 3. "L" Joint Tie Bar Inspection

It is up to Inspectors to verify the location and alignment of tie bars both in plastic and hardened concrete. The Construction Manual, Section 9.26 explains how to do this in much detail. Don't forget to document these checks. Tie bar inspection checks are most critical on superelevated curves. Tie bars can float downhill under certain configurations or operating conditions of the vibrators. This results in bars no longer centered across the centerline joint. Checking in the plastic concrete and the hardened concrete is very important in all superelevated curves.

## *I. Finish*

Article 2301.03, A, & H
Chapter 9.14, 9.41

Article 2301.03 explains the requirements for the finishing for paving operations. Article 2301.03, A describes the equipment for finishing and Article 2301.03, H describes the actual finish of the slab itself. Both of these articles should be read carefully before the paving operation begins. Sections 9.14 and 9.41 of the Construction Manual also have information on the finishing operations and should be read prior to paving.

**Figure 9-40 Hand float and straight edge**

The concrete workability and the paver setting are both very important factors in determining the condition of the surface of the slab. It should be a tight surface with few bug holes in order to get a good closed finish. If the Contractor has to use their finishing tools extensively on the surface, this could damage the integrity of the slab. If the Inspector notices that the finishers are working extensively to close the surface of the pavement, they should notify the Project Manager as soon as possible.

There are times the Contractor will attempt to apply water to the surface to assist in finishing. Article 2301.03, H prohibits additional water from being applied to the surface by spray wand, brush, or other methods. If the Inspector notices finishers applying additional water to the surface, they should ask the Contractor to stop this action immediately and notify the Project Manager if they do not. Section 9.41 of the Construction Manual also covers this topic.

**Figure 9-41 Worker spraying water on burlap**

**Figure 9-42 Wet burlap drag**

Contractors are allowed to drag wet burlap behind the paver. The wetting of the burlap should be done sparingly. If more than a slight amount of slurry is being created by the floats or straightedges, the contractor should be instructed to water the burlap less frequently.

**Figure 9-43 Excessive slurry running over edge of slab**

## *J. Texture*

Article 2301.03, H
Construction Manual 9.42

Article 2301.03, H specifies texturing to be accomplished through either transverse or longitudinal tining of the surface of PCC paving.

**Figure 9-44 Uniform spacing for longitudinal tining**

Checking the spacing of the tines on the device used to place the grooves can be done prior to paving. Random checking of the depth of the grooves in the plastic concrete will assure the inspector that the Contractor is placing the grooves at the proper depth. The contractor should be urged to tine at a depth near the shallow end of the specified range. Shallow depth creates a quieter pavement. Also, random checks after the concrete is set up will assure the

inspector that the finished product is within specification limits. If separate documentation is not being used the Inspector should document this information in their daily diary

**Figure 9-45 Transverse gouge from leaving tining rake in contact with pavement surface**

**Figure 9-46 Random spacing for transverse tining**

### Untined Areas

- Transverse Texturing
  The article states that along the length of each transverse joint an area shall be protected from surface tining to provide an untined strip, centered over the joint.

- Longitudinal Texturing
  Article 2301.03, H also requires an untined strip be left along the centerline for longitudinal textured pavements. This aids in the sawing of the longitudinal joint by not having the longitudinal tine marks interfere in the sawing operation and prevents spalling of those joints.

- Transverse or Longitudinal Texturing
  In addition to the areas noted above, tining also is not required on radii, crossovers, paved medians, shoulders, and other irregular areas per Article 2301.03, H.

## *K. Curing*

Article 2301.03, K, & Section 4105

After finishing operations have been completed, concrete pavement must be cured. A white pigmented liquid curing compound, meeting requirements of Section 4105 will be applied in a fine spray to form a continuous, uniform film on the surface and vertical edges of the pavement slab as soon as the free water has disappeared. The specifications require that the cure should be placed no later than thirty minutes after finishing. The rate of application will not be less than 0.067 gallon per square yard (0.3 L/m2). Hand sprayers can be used for spraying the sides and irregular areas.

The inspector must check the lot number for each tote and verify and record that it is from an approved lot. Check with the Office of Materials for approved lot numbers.

**Figure 9-47 Verify lot numbers from cure totes**

Care must be taken to insure that liquid curing materials are well agitated before and during application. When totes or barrels are placed along the roadway ahead of the paving operation, the curing compound may have the solids settle to the bottom. The inspector should discuss with the contractor the agitation means and frequency that will be used to prevent settlement.

The uniformity of cure is determined by visual inspection. The surface should look uniform and white. If there are blotchy areas or areas of puddling, changes should be made. On windy days, extra effort may be needed to obtain proper coverage on the up wind side of the slab.

**Figure 9-48 Curing operation**

**Figure 9-49 Non-uniform cure**

The inspector should check the rate of application. The amount of cure used and the area covered will have to be known. Don't forget to include the vertical edges of the slab when computing the area. Liquid curing compounds should dry to the touch within four hours. After 12 hours, the cure should not track off the concrete when walked on.

Documentation should be made on the PC Concrete Item Checklist, Form M111 or E111.

## *L. Station Markers*

The station numbers will be identified on the lath behind the construction stakes. It is the inspector's responsibility to make sure that the station numbers are correctly stamped into the pavement. After the concrete has been finished and textured, use a margin trowel to smooth a small space to stamp your station numbers. Place the numbers facing outward on the concrete one foot away from the edge of the slab. This allows them to be easily read from the shoulder.
Counties often face the numbers toward the center so they can be read from a car on the road instead of the shoulder.

The numbers should be deep enough to be easily read, but not too deep, as they can hold water when it rains.

Don't place the number in the area of a transverse joint. Move it slightly away from the joint location so the saw cut does not destroy the number.

**Figure 9-50 Station markers stamped into slab**

## *M. Concrete Strength*

Article 2301.03, U
I.M. 316, 328, 383

The PCC Grade Inspector must keep track of the concrete strengths of each day's paving.

### 1. Beams

Unless the contractor elects to use the maturity method, the concrete strength will be determined by the beam break tests. Specification 2301.03, U requires a minimum of two beams be cast daily, depending on the amount of concrete placed. These will be tested for the flexural strength of the concrete at a specified age before opening the pavement for traffic. This information is given to the Contractor by the PCC Grade Inspector so each will know when it is permissible to drive on a section of pavement. Article 2301.03, U regulates the times for opening pavements.

**Figure 9-51 Equipment needed to cast beams**

### 2. Maturity

The maturity method is described in I.M. 383. This is a non-destructive concrete test method that the contractor may choose to use to determine concrete strength. When it is used, the pavement may be opened as soon as the concrete reaches opening strength.

One of the Contractor's people will install the Time-Temperature Factor (TTF) probe wires. Note the station locations, as the temperature will need to be checked on a set schedule. The inspector needs to monitor the temperature testing and maturity determination on a periodic basis. If weather condition change very little, the gain in TTF will normally be rather consistent and therefore monitoring may be less frequent.

**Figure 9-52  Maturity probe location with hand held thermometer**

## *N. Date of Placement*

Construction Manual 9.46

The date (MM-DD-YY) will always be stamped into the concrete at the beginning and at the end of every day's placement, near each header.  As with the station numbers a small space should be smoothed with a margin trowel on the finished and textured concrete.  Then place the numbered stamps onto the concrete 1-foot away from the edge of the slab and near the joint, facing outward, so that it can be read from the shoulder.  The purpose is to be able to easily identify each day's work.  You want the numbers deep enough to read easily but not too deep!

**Figure 9-53  Date stamped into the slab at a header**

## *O. Monitor Contractor's Haul Road*

Section 1107
Construction Manual 2.12

A haul road is the designated road on which the Contractor is to haul material either to the grade from the plant or to the plant from the material suppliers. The Contractor may use a public road between the plant or supplier and the grade or a road within the limits of the project. If the Contractor uses a public road, this road must be considered as a haul road and may require agreements with local jurisdictions. The haul road system must be reviewed and approved by the Project Engineer before the operations associated with the paving begin.

**Figure 9-54 Truck fire blocked haul road**

The material coming from the plant site may come on a different road than the material for the longitudinal subdrain or shoulder work. Their roads must be reviewed carefully before they are designated as a haul road. The structure of the road, weight restrictions of structures, traffic signing, safety, and a number of other aspects should all be reviewed.

There will be occasions when the haul road may not be the most direct route for the Contractor to take and they may want to use a different road. It is the responsibility of both the Grade Inspector and the Plant Inspector to ensure the Contractor is using the designated haul roads. If the Contractor deviates from the designated haul roads, the entity, such as the County or the City, which owns these roads, may, and probably will ask for damage considerations. That is why an agreement is reached with the affected entity of the designated haul road in advance of its use.

Section 1107 “Safety, Health, Pollution, and Sanitation” and the Construction Manual Chapter 2.12 explains when and how dust control should be maintained. This can be a little confusing and should also be reviewed with the Project Manager before operations begin.

Haul roads are created on the project site for the delivery of concrete to the paver. These normally are alongside the new slab, just outside the stringline. Because they are only used for a short time, they normally are not stabilized and can become either soft during wet conditions or dusty during dry conditions. These roads are the responsibility of the contractor, but in the case of dust, they can become an issue for the inspector because of safety considerations.

**Figure 9-55 Wetting the haul road for dust control**

During wet periods, the roads can become rutted and, because of the soft conditions, care must be taken not to have the stringline stakes be “pumped” or move up or down and change the elevation of the string which can create bumps in the slab.

**Figure 9-56 Muddy, rutted haul road**

**Figure 9-57 Motor patrol grading haul road**

## *P. Documentation*

The Inspector must document the checks they perform or witness and any violations of the specifications and corrective actions taken. The documentation could include, but may not be limited to, the date, location (NBL, SBL, station, centerline offset), who was notified, the corrective action needed to be taken, and when such action was taken.

Individual check sheets could be made up for each test or check the Inspector performs. This may seem like extra paper work, but if the Inspector were asked what the depth of the pavement was on a certain date at a certain location, they would be able to check the appropriate worksheet and provide this information. This would be easier then reading through the diary entries or a worksheet where all of this information has been compiled. When a separate form is not used, the Inspector should document the violations of the specifications, when the Contractor was notified, and corrective actions taken, in their daily diary.

## *Q. Monitor Contractor's Housekeeping*

The role of the Inspector on the housecleaning of the Contractor is actually quite limited. If the Contractor is not posing a health or safety threat, there is little an Inspector can do. The Inspector can suggest to the Contractor how the traveling public may perceive an unsightly work site, but again, if the health and safety of someone is not threatened, the Inspector has little authority to make them clean it up.

The Inspector can monitor open burning. The Contractor is not allowed to burn anything that is considered trade waste. Trade waste is described as any refuse resulting from the prosecution of any trade. This would include the burlap and plastic used by the Contractor to cover the pavement.

The Inspector should monitor the sites that the Contractor is using to assure that no toxic substances are being allowed to enter the ground. For a PCC Inspector, this could include, but is not limited to, curing compound or oil from machines.

If the Inspector sees something they are uncomfortable with or unsure about, they should inform the Project Manager as soon as possible.

**Figure 9-58 Communicate with the contractor when questionable activities are observed**

## *R. Non-Compliance Notices*

Construction Manual 2.53
Construction Manual Appendix 2-34

When the Inspector encounters work that is outside of the specifications, it is considered to be non-complying. The Inspector should notify the Project Manager as soon as possible. The Project Manager will then issue a Non-Compliance Notice to the Prime Contractor. The notice will inform the Contractor which article has been violated, the specification limits, and the actual value. A price adjustment, if any, will be described in the remarks area, and the corrective action will be stated, if applicable. This form number is 830245. No matter how minute the violation is, a notice should be issued so that there is a written record of the Contractor being notified.

Iowa Department of Transportation
NONCOMPLIANCE NOTICE

Contractor _____ Project No. _____

County _____ Contract No. _____ Date _____ Time _____

To: _____ (Name) _____ (Title) _____ (Signature)

You are hereby notified that tests indicate that the _____

_____

_____

is outside our specification tolerances. The specification violated is Article _____

The test data value is _____

_____

_____

and the specification limits are _____

_____

Additional tests may be performed.

Noncomplying work may be required to be removed and replaced at no cost to the contracting authority.

You are to determine corrective action necessary.

You are to determine if you wish to discontinue operations until the additional tests confirm or refute this failing test.

Remarks: _____

_____

_____

Correction: _____

_____

_____

Signed: _____
Inspector - Iowa DOT

Distribution: White Copy - Contractor; Canary Copy - File Copy

**Figure 9-59 Noncompliance form 830245**

Additional guidance and discussion on price adjustments can be found in Construction Manual 2.53 and Construction Manual Appendix 2-34.

# CHAPTER 10
# POST CHECKS

# Chapter 10 Post Construction Checks

## *A. Saw Cuts*

Article 2301.03, N
Road Standard PV-101
Construction Manual 9.21, Appendix 9-6

In Chapter 3, Design, the types of saws were discussed. Road Standard PV-101 has types of contraction joints detailed, one for each of the types of saws.

All joints will be sawed in a single cutting operation. Each joint shall be sawn true to line and dimension. Joint sawing will begin as soon as the concrete has hardened enough to permit sawing without raveling or moving of aggregate.

The inspector should check the width and depth of the sawcuts. A worksheet to document those checks is included in the Appendix. Documentation should be made in the Inspector's Daily Diary.

The inspector should check the location of sawcuts. The location of CD baskets should be properly marked so the sawcuts can be placed directly over the middle of the basket.

**10-1 Measuring saw cut depth**

**Figure 10-2 Randomly inspect joint locations for conformance to dowel reference markers**

Construction Manual Section 9.21 gives instruction as to the practice of stopping the saw cut before it reaches the edge of the pavement. This prevents the spalls or "blow outs" that can happen with the light weight early saw at the edge of the slab as the saw comes out the pavement. This stopping of the saw cut shy of the edge also is helpful to the sealing operation by preventing the sealant from running down the edge of the slab.

**Figure 10-3 Pull up of sawcut before edge of slab**

**Figure 10-4 Blowout at edge of slab**

## 1. Early entry saws

When the early entry saw is used, the start of the sawing window is much earlier than when the larger conventional saws are used. Often, sawing can begin within about 3 hours of placement of the concrete, depending on weather conditions and concrete mix temperature.

**Figure 10-5 Early entry saws**

The early entry saw offers a number of advantages compared to conventional saws. There is very little dust because the saw cut is made when the concrete is very green and there is a lot of moisture still in the sawing residue. The sawing residue is then left in a small pile next to the joint. Also, this type of saw is smaller than conventional saws so it

is less powerful, but much quieter. This is particularly helpful in urban environments where noise is a concern.

**Figure 10-6 Residue from early entry sawing**

## 2. Conventional saws

With conventional saws, the sawing normally doesn't begin until eight to twelve hours after placement. The sawing is normally done with diamond blades and can be done as a dry process or wet sawing may be used.

**Figure 10-7 Conventional dry saw on longitudinal joint**

Note that the specifications do not allow the early entry saw to be used to cut longitudinal joints unless it can cut the joint to the conventional depth and specified width. This is intended for rural mainline paving but may not be true for overlays with small panel design.

Joints must be sawed before uncontrolled cracking takes place. Sawing operations will be continuous, regardless of weather or daylight conditions. Sawing of a joint will be discontinued if a crack develops ahead of the saw. In this case a joint will be formed with a crack saw along the line of the crack and the joint will be cleaned and sealed. When random transverse cracks occur, Article 2301.03, N requires that the pavement be repaired. Appendix 9-6 in the Construction Manual provides guidance for repair of random cracking.

The inspector needs to work with the contractor to insure that joints in irregular areas are sawn properly. Project plans will show the location of these joints. Be careful not to have saw joints intersect at a "T" corner. Often these will lead to a random crack.

**Figure 10-8 Late sawing crack**

**Figure 10-9 Poor jointing resulted in crack**

## *B. Sealing Joints*

Article 2301.03, P & Section 4136
Road Standard PV-101
Construction Manual 9.22 and 9.23

Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, expansion joints and transverse joints will be sealed. The exception to this would be on overlays where the pavement is sawn into panels smaller than a lane width. See Section 2310 for specific instructions.

The joint opening will be sawed or prepared to the designated dimensions and cleaned. Joint sealer, meeting requirements of Section 4136 will be used to seal sawed joints in PCC pavement, shoulders, medians, crossovers, and side road pavement unless otherwise specified.

Within three hours after the joint has been wet sawed, the residue will be flushed away with a high-pressure water blast. Within three hours after the joint has been dry sawed, the residue will be blown from the joint. Sand cleaning will not be required for joints narrower than 3/8 inch (10 mm). If they are that width or wider, sand cleaning will be required using the proper equipment.

Immediately prior to the installation of the backer rod and sealant, the joint will be cleaned with an air blast. The backer rod will be of the proper size and type and will be installed dry, with a suitable tool. Joints sawn with early entry saws do not require a backer rod.

**Figure 10-10 Air blast of joint prior to sealing**

**Figure 10-11 Installing backer rod**

Joint sealer will be prepared and installed in the joint to the proper level. To insure that the transverse joint is filled uniformly across the entire width of pavement, the contractor should raise the saw immediately before the edge of the pavement, thereby not continuing the saw cut opening through the edge of the pavement and preventing sealer material from running out of the joint. After sealing, excess sealer will be removed from the pavement surface.

**Figure 10-12  Installing hot pour sealant**

Joint sealer can be placed only when the pavement and surrounding air temperature are 40 degrees F (4 degrees C) or higher.  Sealing will be done only when the joint surfaces appear dry by visual inspection.

**Figure 10-13  Joint sealant both overfilled and underfilled**

The inspector should check that all joints are cleaned sufficiently and the backer rod is approved and installed properly.  An approved joint sealer must be used and installed in the joint at the proper elevation.  A worksheet to document these checks is included in the Appendix.  Documentation should be made in the Inspector's Daily Diary.

Project No. _____ Contract ID _____ Page No. ____

JOINT CHECK WORKSHEET

| DATE | STA. | ℄ | TRANS | DEPTH | WIDTH | SAND BLASTED | SEAL | REMARKS | INSP. INITS. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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NOTE

**Figure 10-14 Joint check worksheet**

## *C. Texture*

Article 2301.03, H
Chapter 9.43

Once the pavement has hardened, checks of the depth can be made to determine compliance with Article 2301.03, H. Chapter 9.43 describes the procedure required to check the depth of the texture. A worksheet to document these checks is included in the Appendix.

**Figure 10-15 Check tining depth with a tire tread checker**

The depth of the texture is important.  The grooves are constructed to break the plain surface and thereby prevent hydroplaning.  But, the grooves can create a noise problem.  In order to minimize the noise from the pavement surface, the tine depths shall be as shallow as possible within the specification limits.  This will insure safety but minimize any objectionable noise.

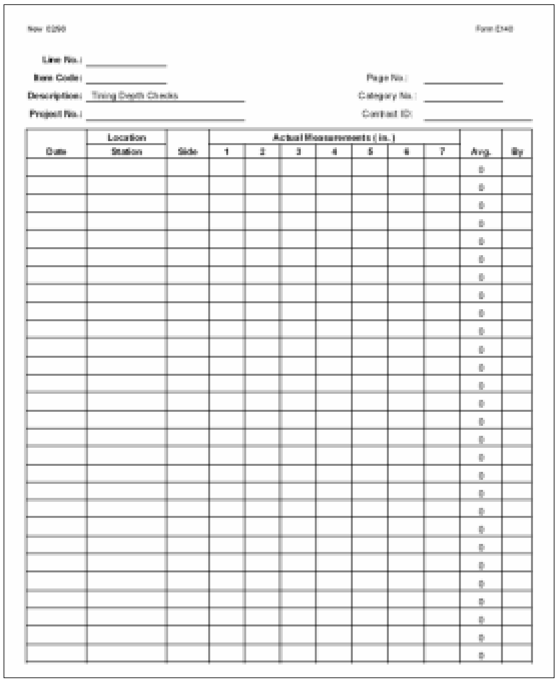



Figure 10-16  Tining depth check Form E140

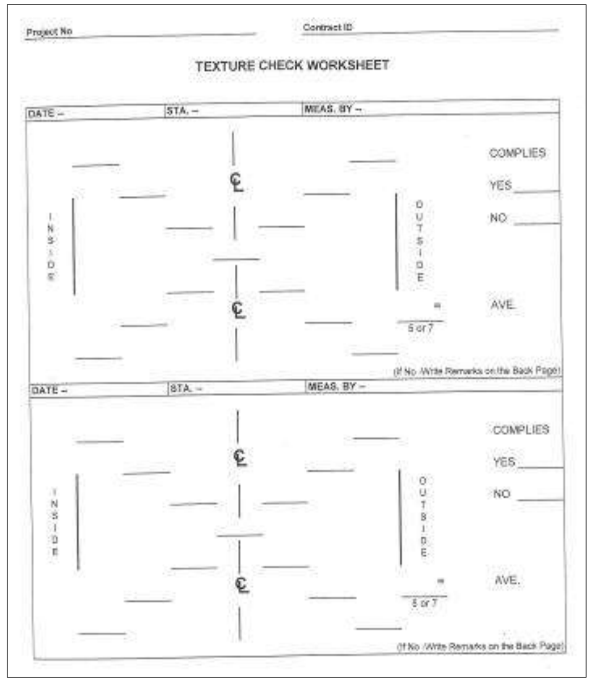



Figure 10-17  Texture check worksheet

## *D. Smoothness*

Sections 2316 & 2317
I.M. 341

The requirements for pavement smoothness are outlined in Sections 2316 & 2317.  A California type profilograph, commonly referred to as a profilometer, or an inertial profiler may be used to evaluate smoothness.  The profilometer produces a profilograph, commonly referred to as a profile trace or simply a trace.  The contractor performs the test and supplies the inspectors with the results.  The method of testing using the profilograph is outlined in I.M. 341.

**Figure 10-18 California profilograph**

**Figure 10-19 Inertial profiler**

The inspector shall review the traces, not only to look for errors in the reduction but also to look for possible gaps in the traces where smoothness results for part of the pavement may be missing

The agency will check the traces by rerunning at least ten percent of the area tested. See IM 204 Appendix E.

The PCC Grade Inspector may be the person receiving the traces from the Contractor. As stated in the specification book, each segment should be evaluated within 48 hours after placement. At the start of paving, the index should be available by the end of the day following paving until there are three consecutive days where the index for all segments would result in 100% or better payment. After three consecutive days, they are to be made available within 48 hours after each day's run. If subsequent days result in less than 100% payment the contractor is to immediately notify the Engineer and modify paving methods to achieve 100% or better pay. The inspector needs to be familiar with this specification so they know when to expect the traces and indices from the contractor.

When corrective work is required, the contractor should use diamond grinding equipment meeting the requirements of Section 2532.

**Figure 10-20 Grinding to improve smoothness**

## *E. Strength*

Article 2301.03, U
I.M. 204, 316, 328, 383

For concrete pavement, strength is tested for two purposes. One is to determine the strength for opening the pavement to traffic. The other is to determine the 28-day strength of the concrete. This is for information to those who perform the pavement design and is not a contract requirement as is often the case with other types of concrete construction

Casting of the beams and curing is critical to the accuracy of the test results. IM 328 defines this procedure, and everyone involved in this process must be familiar with the procedures. Great care needs to be taken throughout the process and the inspector needs to be very diligent to insure that proper methods are followed.

### 1. Beams

I.M. 328 explains how to make a flexural strength field specimen, commonly referred to as a beam. It is necessary to know how to properly make a beam because this may determine how soon the Contractor can utilize a section of pavement. A poorly constructed or cured beam will not give an accurate determination of the strength of the pavement.

The Grade Inspector will need to transport the beams to the plant site, usually the following day. Care should be taken when transporting beams so that they are not damaged on the way to the plant site. Any unnecessary stress, such as bouncing around in the back of a pickup, can lead to small micocracks within the beam. These beams may be less than twenty-four hours old and can easily be damaged.

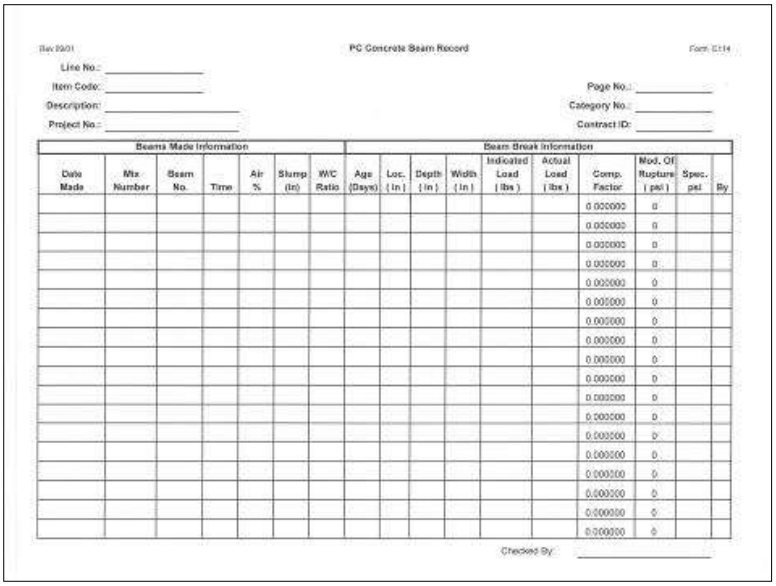
**Figure 10-21 Take care in casting, curing, and transporting beams**

**Figure 10-22 If maturity is used, beam strength is tested by the agency for information only**

The curing and testing of the beams is the responsibility of the Certified Plant Inspector. This includes the removing of the beams from the molds, cleaning and reassembling of the molds, and returning the molds to the grade. The Grade Inspector may be able to pick up the empty beam molds when they transport the beams to the plant site.

The testing of the beams is the responsibility of the Certified Plant Inspector, but the method of testing is good information for the Grade Inspector to know. I.M. 316 explains the testing procedure

Article 2301.03, U specifies the time for opening pavements. When the Contractor uses beam breaks to determine strength, both an age and strength requirement must be met before the pavement is opened.



Rev 03/01 PC Concrete Beam Record Form E114

Line No.: _____

Item Code: _____

Description: _____

Project No.: _____

Page No.: _____

Category No.: _____

Contract ID: _____

| Beams Made Information | | | | | | | Beam Break Information | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date Made | Mix Number | Beam No. | Time | Air % | Slump (in) | W/C Ratio | Age (Days) | Loc. ( in ) | Depth ( in ) | Width ( in ) | Indicated Load ( lbs ) | Actual Load ( lbs ) | Comp. Factor | Mod. Of Rupture ( psi ) | Spec. psi | By |
| | | | | | | | | | | | | | 0.000000 | 0 | | |
| | | | | | | | | | | | | | 0.000000 | 0 | | |
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Checked By: _____

**Figure 10-23 PC Concrete Beam Record Form E114**

## 2. Maturity

Article 2301.03, U allows the contractor to use the maturity method to determine the opening strength. When the contractor chooses this option, only the strength of the concrete is used to determine pavement opening. No time restriction is imposed. The contractor must perform the maturity testing but the inspector will monitor the process. IM 383 describes the process.

**NOTE:** When maturity is used, the agency is still responsible to open the pavement to traffic. The contractor's maturity test provides that information, but it is the agency that will determine that strength has been reached and then will give the contractor permission to use the new pavement.

The maturity process involves casting 12 beams at the plant site and developing a strength/maturity curve. Then temperature probes are placed in the slab, from which the temperature is monitored and the strength determined.

**Figure 10-24 Casting maturity beams at the plant site**

At least two probes are placed in a day's paving. If shadows from trees or other obstructions are present which make the solar energy different in different parts of the day's pavement placement, more probes may be necessary.

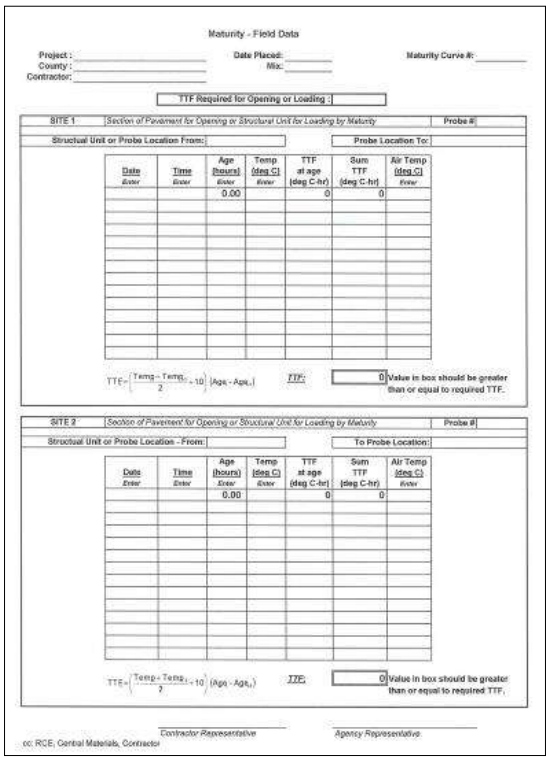
The probes need to be clearly marked so as to insure that they are not disturbed. The sawing operation sometimes is performed at night and it is easy to have them accidentally pulled out if they are not clearly marked out.

Commonly checks of the maturity probes are made in the morning when work begins and again in the late afternoon before work is stopped for the day. The inspector should accompany the contractor's person when checking the maturity readings often enough to

be satisfied that readings are appropriate. If the weather is fairly consistent, the opening time will remain about the same from day to day. Big changes in temperature during the first two days after paving will have a significant effect on the development of the strength of the concrete.

**Figure 10-25 Maturity probe in slab**

**Figure 10-26 Checking temperature with hand held thermometer**



Maturity - Field Data

Project : _____ Date Placed: _____ Maturity Curve #: _____
County : _____ Mix: _____
Contractor: _____

TTF Required for Opening or Loading : _____

SITE 1 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | Probe #

Structural Unit or Probe Location From: _____ Probe Location To: _____

| Date Enter | Time Enter | Age (hours) Enter | Temp (deg C) Enter | TTF at age (deg C-hr) | Sum TTF (deg C-hr) | Air Temp (deg C) Enter |
|---|---|---|---|---|---|---|
| | | 0.00 | | 0 | 0 | |

$TTF = \left(\frac{Temp_i + Temp_{i-1}}{2} - 10\right)(Age_i - Age_{i-1})$ TTF: 0 Value in box should be greater than or equal to required TTF.

SITE 2 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | Probe #

Structural Unit or Probe Location - From: _____ To Probe Location: _____

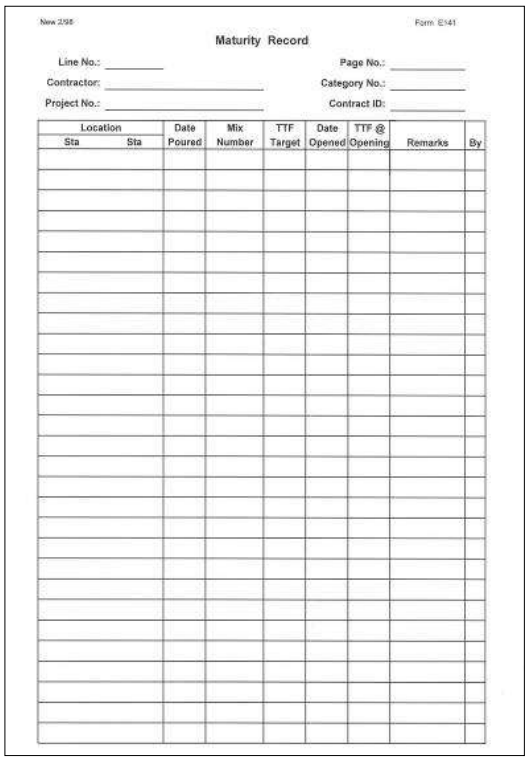
| Date Enter | Time Enter | Age (hours) Enter | Temp (deg C) Enter | TTF at age (deg C-hr) | Sum TTF (deg C-hr) | Air Temp (deg C) Enter |
|---|---|---|---|---|---|---|
| | | 0.00 | | 0 | 0 | |

$TTF = \left(\frac{Temp_i + Temp_{i-1}}{2} - 10\right)(Age_i - Age_{i-1})$ TTF: 0 Value in box should be greater than or equal to required TTF.

*Contractor Representative* *Agency Representative*

cc: RCE, Central Materials, Contractor

**Figure 10-27 Maturity field data form**



New 2/98 Form E141

Maturity Record

Line No.: _____ Page No.: _____
Contractor: _____ Category No.: _____
Project No.: _____ Contract ID: _____

| Location Sta | Location Sta | Date Poured | Mix Number | TTF Target | Date Opened | TTF @ Opening | Remarks | By |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**Figure 10-28 Maturity Record Form E141**

## *F. Steel Placement*

Article 2301.03, E
Road Standard PV-101
Construction Manual 9.26 & 9.27

The centerline joints will have tie steel placed by: mechanical insertion, hand methods during construction, or supported by chairs prior to paving. Chapter 9.27 outlines the procedure and requirement for checking the placement of this steel, both in the plastic concrete and in the hardened slab. This is important to assure that the proper placement is being accomplished. The bars need to be centered across the longitudinal joint. They need to be reasonably level and perpendicular to the centerline, although the tolerances are not as precise as for dowels since these bars are deformed and the pavement does not slide on them. Chapter 9.27 also discusses the number of bars required per panel.

Care by the Contractor and timely inspection should eliminate problems during construction. If a problem does arise and it is not detected until the concrete has hardened, corrective repairs may be required.

**Figure 10-29 Marking tie bar locations**

**Figure 10-30 Out of tolerance/missing tie bars**

Two common methods that can be used to repair misplaced or omitted steel are the slot method for both transverse and longitudinal joints and the cross-stitch method for longitudinal joints.

The slot method simply involves cutting a slot approximately half the depth of the pavement, placing a bar in the slot and filling the slot with a grout or epoxy material.

A cross-stitching repair procedure is often used for tie bar repair. It involves drilling a hole on a very flat angle such that it crosses the joint or crack and does not protrude out the bottom of the slab. Epoxy is injected into the hole, and a bar is then inserted.

**Figure 10-31 Cross-stitch repair of random cracks**

**Figure 10-32 Cross-stitch repair of missing tie steel**

## *G. Coring*

Articles 2301.04 and 2301.05
I.M. 346, 347

Cores shall be taken from PCC pavement to determine pavement thickness, the thickness index for each section, and the amount of payment the Contractor will receive. The Agency will identify the limits of each section and the random location of each core. The Inspector will witness core drilling, take immediate possession of the cores, and determine and record core lengths. I.M. 346 outlines the procedure that is to be followed in order to determine the core locations.

### 1. Locating Cores

The Inspector will first assign all cores a number. Core numbers should be consistent with the District number system.

The locations are then marked on the road. These should be placed as accurately as possible to insure the proper location. A significant amount of money can be riding on the core results.

The inspector and contractor should check to insure there is not a dowel bar or a traffic detector loop in the pavement in that location. If so, the inspector shall approve the moving of the core location slightly in order to miss the obstruction.

The Inspector will also go along with the Contractor while they are cutting the cores. This is to verify that they cut them at the right locations and are marked with the proper numbers. Also, check to see if there are any deficient cores.

The Inspector will take possession of the cores, measure them, and make arrangements to deliver them to the District Lab.

**Figure 10-33 Coring for thickness**

## 2. Deficient Areas

A core is deficient when it measures 1 in. (25 mm) or more short of plan length. Extra cores will be taken, each way of the original location, at 60 ft (18 m) intervals until a core of the proper length is found. The deficient area will be removed and replaced by the Contractor. The extra cores are not used in the Thickness Index calculations.

## 3. Length Evaluation

To measure the cores, a calipering device is used. This is better known as "9-pointing the core" because the core is measured in nine places. I.M. 347 explains how to do the measuring in detail.

I.M. 346 specifies how to calculate the Thickness Index by hand using a calculator with standard deviation formula (n-1). This may be okay for small projects, but not for large, more complex ones. There is a computer program for these calculations that is available from the Materials Office. It is recommended that it be used for all projects.

Compare the Thickness Index with the Payment Schedule in Article 2301.05. This will give the Percent Payment. Payment will be a percentage of the contract Unit Price.

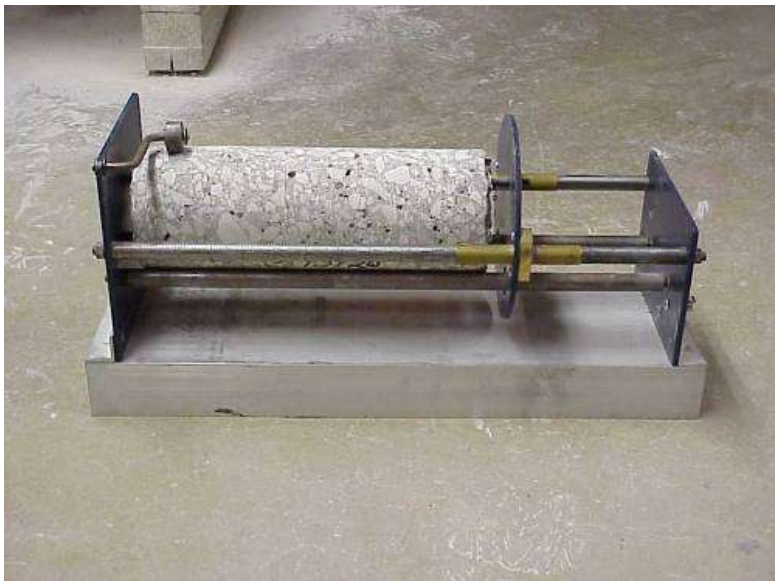


**Figure 10-34 Nine-point core length measuring device**

## 4. Reporting

The computer program produces a report that will accompany the cores when delivered to the District Materials Lab. Distribution of this report will be made after the Independent Assurance measurements are added.

## 5. MIT Scan T2

An alternative method to measure pavement thickness is now becoming commonplace on many projects. It utilizes Magnetic Imaging Tomography (MIT) to scan steel plates placed upon the base material prior to paving to determine the pavement thickness. See the current developmental specification for requirements.

**Figure 10-35 Non-destructive thickness measuring device**

# CHAPTER 11
# ASSOC. CONST. ACTIVITIES

# Chapter 11 Associated Construction Activities

Once the pavement is placed, there are other activities that must be accomplished before the roadway can be opened to traffic. These are a part of the paving contract and therefore are a part of the project and the inspection duties. The following sections describe the earth shoulder construction, longitudinal subdrain construction, and the granular shoulder construction. This is the order that they are normally accomplished.

## *A. Earth Shoulder Construction.*

Section 2123,

Construction of earth shoulders adjacent to new PCC pavements should begin shortly after pavement has reached maturity and has been opened to the contractor's vehicles. Specification 2123.03, B states that "Adequate organization and equipment shall be assigned to this work so that the major portion of shouldering work may be completed within six days after the pavement or base is released by the engineer to the contractor for shoulder work. Active enforcement of this specification encourages timely completion of project and helps shed water to the foreslope and ditch area instead of trapping it in the subgrade trench.

Completion of earth shoulder work prior to subdrain operations ensures direct contact between the porous trench and bottom of granular shoulder. Contract documents will show typical details and quantities and contract items to be used for this work.

Class 10 or specified material is hauled in dump trucks or scrapers to desired locations. Material is spread and leveled with a dozer or motor patrol and compacted as per specifications. Then shoulder areas are trimmed to desired elevation by a motor patrol. The shoulder area is now ready for subdrain operations.

**Figure 11-1 Depositing and spreading earth shoulder material**

**Figure 11-2 Compacting earth shoulder material**

A common problem that both the contractor and the inspector must watch closely is the difficulty in blading and compacting the shoulder material immediately next to the edge of the pavement without damaging the edge. The motor patrol and roller can bump into the edge of the slab and chip off the top edge of the concrete. The inspector needs to watch for this type of damage and have the contractor change procedures if it occurs frequently.

**Figure 11-3 Shoulder after compaction and prior to final finishing**

**Figure 11-4 Chipped pavement edge**

## *B. Longitudinal Subdrains*

Sections 2502, 4143, 4141, 4131, 4109
Road Standard RF-19C, & RF-19E

The construction of shoulder subdrains will consist of furnishing and installing subdrain of the size shown in the contract documents. The subdrain will be installed at the locations and to the grades and elevations shown in the contract documents.

Pipe for subdrains will be of the size and type shown in the contract documents and will meet requirements of Section 4143. Perforated corrugated polyethylene tubing and fittings will be used. The tubing will be marked with AASHTO M252. The tubing will be perforated with slots. Circular perforations will not be approved.

As per Standard Road Plan, RF-19E, subdrain outlets will be 6 inches (150 mm) corrugated metal pipe meeting requirements of Section 4141 or 4 inches (100 mm) corrugated walled PE or PVC pipe with an appropriate coupler.

### 1. Excavation

The trench for the subdrain is constructed adjacent to the edge of the pavement. It normally is dug with an excavation machine that creates a trench of the proper width and depth.

**Figure 11-5 Excavation of subdrain trench**

## 2. Placement

Placement of the tubing and porous backfill is usually accomplished with a piece of equipment called a mule. The mule feeds the tubing down to 3 inches (75 mm) from the bottom of the trench. The porous backfill is then dumped from the trucks onto a conveyor belt that conveys it into the mule and in turn filters around the tubing and fills the trench. The vibrators are pulled along with the mule. When the tubing is fed down through the mule, it has a tendency to stretch. The elongation of the tubing should not exceed five percent.

Maximum consolidation will be determined by a trial section, approximately 100 feet (30 m) long. Compaction on this section will continue until maximum consolidation is achieved. Trench rollers will have a minimum trench wheel mass of 2700 kg (6000 pounds).

**Figure 11-6 Placement of subdrain and porous backfill**

## 3. Porous Backfill

Porous backfill material will meet requirements of Section 4131. Aggregate for this material will be either crushed stone or gravel free of clay. The aggregate will meet gradation requirements for Gradation No. 29 of the Aggregate Gradation Table found in Section 4109.

The aggregate for backfill will be wet prior to installation. The Engineer may require a surface application of water.

The aggregate is placed differently according to the depth of the subdrain. For a 2 foot (0.6 m) depth subdrain the aggregate will be placed in one lift. The lift will be compacted with a vibratory compactor, narrower than the trench, to maximum consolidation. For a 3 foot (0.9 m) depth subdrain the aggregate will be placed in one lift. The lift will be compacted with a vibratory compactor and an approved trench roller, narrower than the trench, to maximum consolidation. For a 3.5-foot (1.1 m) or greater depth subdrain the aggregate will be placed in two lifts of approximately equal thickness. The first lift will be compacted with a vibratory compactor narrower than the trench. The second lift will be compacted with a vibratory compactor and an approved trench roller, narrower than the trench, to maximum consolidation.

**Figure 11-7 Trench roller**

## 4. Outlets

Outlets through the shoulder will be installed as shown in the contract documents at approximately 500-foot (150 m) intervals. Additional outlets will be placed at the low point of a vertical curve. The Engineer may adjust outlet locations. Outlets will be covered with porous backfill, and Class A crushed stone will be placed over the porous backfill. This material will be compacted by tamping or vibration. The outlet of all subdrains will be covered with a rodent guard described in Section 4143. It is important to note that there are two types of rodent guards for subdrain outlets and that each has its specific use. The RF-19E Road Standard shows both the Grate and Removable Fork type outlets and explains that the Removable Fork type outlets should be used when a recycled PCC subbase is placed under the pavement. This is required to prevent buildup of precipitates that can occur on the mesh type outlet when recycled PCC bases are used. Each location will be marked with an orange metal fence post meeting requirements of Article 4159.09. Only one metal fence post will be required to mark the location of a double outlet.

Standard Road Plan, RF-19E, shows the construction of subdrain outlets.

**Figure 11-8 Outlet placed to toe of foreslope**

**Figure 11-9 Outlets on patio blocks and marked by metal post**

## 5. Restoring the shoulder

Shoulder subdrain work will include restoration of the shoulder and foreslope area. Unpaved shoulders will be finished with a minimum depth of 4 inches (100 mm) of granular shoulder material and compacted. Shoulders paved with HMA will be finished with a minimum depth of 6 inches (150 mm) of HMA base or better. They shall be compacted in an initial 4-inch (100-mm) lift and a final lift, which restores the surface flush with not more than 1/4 inch (5 mm), above the adjacent pavement surface. Each lift will be thoroughly compacted with a minimum of three passes with a single vehicle tire loaded to 6000 pounds (2700 kg) and no wider than the trench, or by equivalent compaction with an approved trench roller.

When subdrains are constructed on existing roads, and when removal of the excavated material is required, the material will be loaded directly into the transporting vehicle. If the contract documents do not designate an area to place this material, the Contractor will find his own disposal area.

**Figure 11-10 Outlet covered with granular material**

## C. Granular Shoulders

Section 2121

Construction of granular shoulders usually will begin after the shoulder area has been restored after subdrain operations. Granular material is hauled in dump trucks to the desired locations. Material is placed on top of the earth shoulder, usually with the aid of a shouldering machine. Then shoulder material is compacted as specified.

The final shape of top of shoulder is attained by blading with a motor patrol. Depth of material, cross slope of completed shoulder, compaction, and condition of the earth shoulder are controlling factors to a quality finished product. Generally the granular shoulder work is performed near the end of a project as the top of granular shoulder is the finished product and is highly visible to the traveling public.

As with the earth shoulder construction, the contractor must take care so as not to damage the edge of the new pavement. The final finish roller should not be driven on the slab and be very careful to make sure the roller is not driven partially on the slab edge. This will almost assuredly cause damage to the edge of the pavement.

**Figure 11-11 Granular material placed with shouldering machine**

**Figure 11-12 Granular shoulder ready for final lift**

Figure 11-13 Final shoulder finish with compaction and brooming of slab

Figure 11-14 Roller partially on pavement causing edge damage

### *D. Paved Shoulders*

Section 2122

Often, on more heavily travelled roadways such as the Interstate system or four-lane divided roadways, fully or partially paved shoulders are placed. There are many benefits realized by placing paved shoulders on higher volume roadways. Paved shoulders improve safety by eliminating edge rutting adjacent to the travelled way as well as providing a paved surface to regain control of an errant vehicle that leaves the roadway. Often rumble strips are placed in paved shoulders. This helps to reduce frequency of run off the road crashes.

Paved shoulders can be either Hot Mixed Asphalt (HMA) or PCC. In recent years, contractors have been given the option of bidding one or the other. This is called paved shoulder alternates.

Construction of paved shoulders begins after subdrain placement and shoulder subgrade restoration are complete. Typically six inches of Special Backfill is placed under paved shoulders as a support layer for the pavement. Paved shoulder thicknesses range from six to eight inches for HMA and seven inches for PCC.

Many of the same inspection procedures should be followed for paved shoulders as are for mainline pavement. Subgrade elevation and cross slope should be checked prior to Special Backfill placement as well as checking the top of Special Backfill prior to placement of the paved shoulder material. For PCC shoulders, a Class A or Class C concrete mixture is allowed. The contractor may also elect to use the same concrete mixture as was used for the mainline paving. For the most part, all of the requirements in Section 2301 that applied to the mainline pavement, are also applicable when placing paved PCC shoulders.

Similar to granular shoulder placement, damage to the edge of the PCC pavement is a concern when placing HMA shoulders. Carelessness on the part of the contractor can create a significant amount of damage and result in serious price adjustment and/or costly repairs.

Construction Manual 2.53 and Appendix 2-34 N provide guidance on price adjustment and repair of PCC pavement edge damage.

**11-15 PCC Shoulder Placement**

**11-16 HMA Shoulder Placement**

**11-17 Compaction of HMA can damage edge of PCC**

**11-18 PCC Pavement Edge Damage**

# CHAPTER 12
# URBAN PAVING

# Chapter 12 Urban Paving

Paving in an urban situation offers unique challenges not always encountered on typical paving projects. Utilities, staging and accesses are much more critical issues to the agency, contractors, property owners, and the traveling public.

**Figure 12-1 Utility conflicts can cause major delays**

Prior to starting an urban paving project, check the information from the right of way contract for each property owner and compare any specific request from the owners to plan information, particularly with regard to entrances. Also become familiar with the locations of intakes, manholes and sidewalks, as they will all require some type of special shaping.

Urban projects will usually have a base consisting of special backfill or modified subbase. This allows the contractor to utilize the base as a haul route for concrete delivery. This haul route in turn creates its own set of problems as the inspector must monitor the condition of the base to avoid rutting. Dowel bar placement is done just prior to the paving operation. Placement of subdrains will usually occur prior to paving, as drains are underneath the slab in most urban situations.

In addition to the numerous physical limitations on projects, there are also the environmental restrictions that come into play. Most Cities restrict the disposal of concrete washout material from ready mix trucks. It is important that washout from these vehicles be disposed of properly.

Figure 12-2  Delivery of ready mix from closed lane

Figure 12-3  Containment of concrete washout

## *A. Boxouts*

On urban paving projects you will become very familiar with boxouts and gaps while placing pavement. Boxouts will generally occur at intake/manhole locations, side street connections and at pavement width change locations. Also temporary access for property owners can result in gaps in pavement.  The contractor will usually form a boxout by staking steel forms in place. Then rock is normally placed in the boxout to prevent the intended gap from filling with concrete as the paver passes by. It is important that the forms be checked for accuracy of placement and checked for stability, as the paving machine will exert a lot of force on forms as it passes by.

Figure 12-4  Boxouts in multilane paving

After the paving machine passes by, the contractor should dig concrete and rock out of the boxout to insure that dowel bars and forms are in the proper locations. Later in the project the side road will be placed or a subcontractor will fill in manhole boxouts.

Jointing around boxouts is very important. Irregular shapes often require additional joints in order to prevent cracks from forming. Sometimes the pavement jointing must be modified in order to accommodate the jointing required by the boxout.

**Figure 12-5 Boxout for utility access**

**Figure 12-6 Crack resulting from poor jointing**

## *B. Curbs*

Urban projects will usually always have curb and gutter. When machine paving, the contractor will have a curb-shaped template attached to paving machine pan to form the curb. This typical pavement section requires additional inspection of gutter flowline elevations to prevent problems of water ponding instead of flowing to intakes and manholes. Also, driveway and sidewalk curb cuts will require modification of the normal curb section by hand finishing. Median and stop sign islands will require special shaping of the curb section by hand finishing as well. Close attention should be given to the plan details for location and type of joints to insure that the contract requirements are being met.

**Figure 12-7 Hand placement of curb**

## *C. Hand Pours*

Urban paving projects typically have a very large percentage of hand pours versus rural projects. Much of the pavement is placed by hand methods simply because the design, physical constraints, staging, or other factors make the work more conducive to hand placement versus machine placement. Examples of this would be reconstruction of an intersection while maintaining traffic or short placements at driveways or accesses where mainline paving was gapped to maintain access to private property. In other instances, such as irregular areas, hand placement methods may be the only option. In either case, it is important to remember some of the fundamentals of placing concrete pavement by hand methods.

**Figure 12-8 Irregular shapes are constructed using hand pours**

## 1. Subgrade/Subbase Prep

The most important thing to remember when talking about subgrade and subbase preparation for concrete pavements is uniformity. It is important that the subgrade soils and subbase materials be uniform materials at a uniform density. The first step in ensuring uniformity should be to check the area for soft spots. Often there is a significant amount of underground work such as storm and sanitary sewer, intakes, and utility relocation that occurs on a project leading up to the paving operations. It is important to check the subgrade to insure that it is stable and firm and that no soft spots remain from prior underground work.

## 2. Form Placement

Forms for hand placement should be clean and free of debris, dirt, or hardened concrete. They should be straight and true with minimal deviations. Forms should be oiled prior to concrete placement to prevent concrete from adhering to the form which could lead to spalling or chipping when removed.

The forms should be adequately anchored and properly supported to prevent movement during placement. There should not be any clumps or irregularities underneath the forms. A great deal of force will be exerted on the forms during placement and it is important that the forms remain true to line and grade.

Forms should match the thickness of the pavement to be placed. They should be set to the proper line and grade. Accuracy of form placement can be checked in a similar manner as checking string line for slip form operations; the form line can be eyeballed to identify any obvious deviations.

**Figure 12-9 Steel forms in place for hand pour**

When placed in curved sections, forms should be checked to insure that they have been set to the proper radius. Forms should also be checked to insure that the pavement will be built to the proper cross slope to allow drainage. Mainline paving is typically placed before intersection returns and radius. It is important to check the existing pavement to insure that it was built to the correct elevation. If the pavement was not built to the correct elevation, then adjustments to the grade and or cross slope may be necessary to insure that proper drainage is provided.

**Figure 12-10 Forms should be checked to ensure proper drainage**

## 3. Objects in or Under Pavement

When the subgrade or subbase will not be used as a haul road for delivery of concrete to the paving operation, fixtures within the pavement should be placed well ahead of the start of paving. Boxouts for intakes and utility accesses, fixtures that are cast in place, traffic signal handholes and preformed loops, CD baskets (when used), tie bars, and wire fabric should all be in place at the start of paving to minimize disruptions in the progress of the work.

**Figure 12-11 Placement of tie bars and CD baskets prior to paving**

## 4. Concrete Placement

There are several types of machines that may be used when placing concrete pavement by hand methods. Most often a vibratory type screed or a tube type roller screed will be used. Occasionally a bridge deck finishing machine may be used. Each of these types of screeds does impart some vibration into the slab, but use of supplementary vibration is recommended for most placements and necessary for thicker placements (greater than 9 inches) and reinforced pavements.

**12-12 Roller Screed**

**12-13 Vibratory Truss Screed**

Because each of these types of screeds is much smaller than a slip form paver, it is important to place concrete evenly in front of them to allow them to uniformly strike off the concrete and produce a smooth surface. While placing concrete from the chute of the delivery truck does place the concrete close to the desired location,

typically additional manipulation is necessary. Vibrators should never be used for this as they can cause segregation when used to move concrete. Only shovels should be used to move concrete to provide a uniform head in front of the screed.

### 5. Finishing

When finishing pavements placed using hand methods, it is important to remember that all concrete adjacent to forms must be edged using an edging tool. This is important because edging rounds the corner of the slab and provides a break between the forms and the concrete, preventing tearing or spalling of the concrete when the form is removed.

Fixtures in the pavement should also receive special attention during finishing to ensure that they blend in with the surrounding pavement and will not create a bump, dip, or a snag point for snow removal equipment.

## *D. Obstructions*

Due to the confined work areas on urban projects, paving beside, around, and over obstacles often cannot be avoided. These obstructions can be anything from utilities and trees to historic landmarks. The general rule for these situations is to make everyone aware of potential conflicts before construction begins in order to avoid as many problems as possible.

The agency needs to consider the clearance needed to accommodate the paver track and the clearances needed for other equipment. If the back of curb will fall too close to obstructions that can be moved, those arrangements need to be made long before the contractor arrives on the project site. Delays in the construction can result if utilities, for instance, are not moved in a timely manor. As much lead-time as possible should be given in order to avoid a conflict.

**Figure 12-14 Pavement edge next to utility access**

**Figure 12-15 Pave around the pole**

Additional gaps, boxouts and pavement joints may be required for machine clearances. Also consideration needs to be given to the elevation of adjacent objects, such as fire hydrants. The final elevations should be adjusted to coordinate with the paving elevation.

**Figure 12-16 Fire hydrant placed too high**

## *E. Jointing*

Correct jointing is critical for a quality and long lasting pavement. Care should be taken to see that the plans are followed in regards to joint spacing and placement. Most plans will show a standard or typical joint spacing and will have additional details for intersections. It's a good idea to layout intersections and driveways first and then transition back to standard spacing for mainline joints. Despite taking all precautions

possible pavement joints can still end up in the wrong location. Whenever possible, adjust the location of planned joints to match existing joints in order to minimize random cracking. Extreme cases can require removal and replacement to correct deficiencies.

**Figure 12-17 Longitudinal joints mismatched**

## *F. Access Locations*

When the project first begins, the inspector and the contractor need to check the plans and then physically compare the sidewalk and driveway locations to the plan locations. This needs to be done early. That way there is enough time to coordinate any of the abutting pavements with the new slab and proposed joints before the paving operation begins. Often they may involve redesigning the connection if the existing pavement is at a different elevation than what was shown on the plans. It can be embarrassing if the new drive does not lead to the garage door!

**Figure 12-18 Driveway jointing does not match mainline**

**Figure 12-19 Jointing for acesses must be carefully considered**

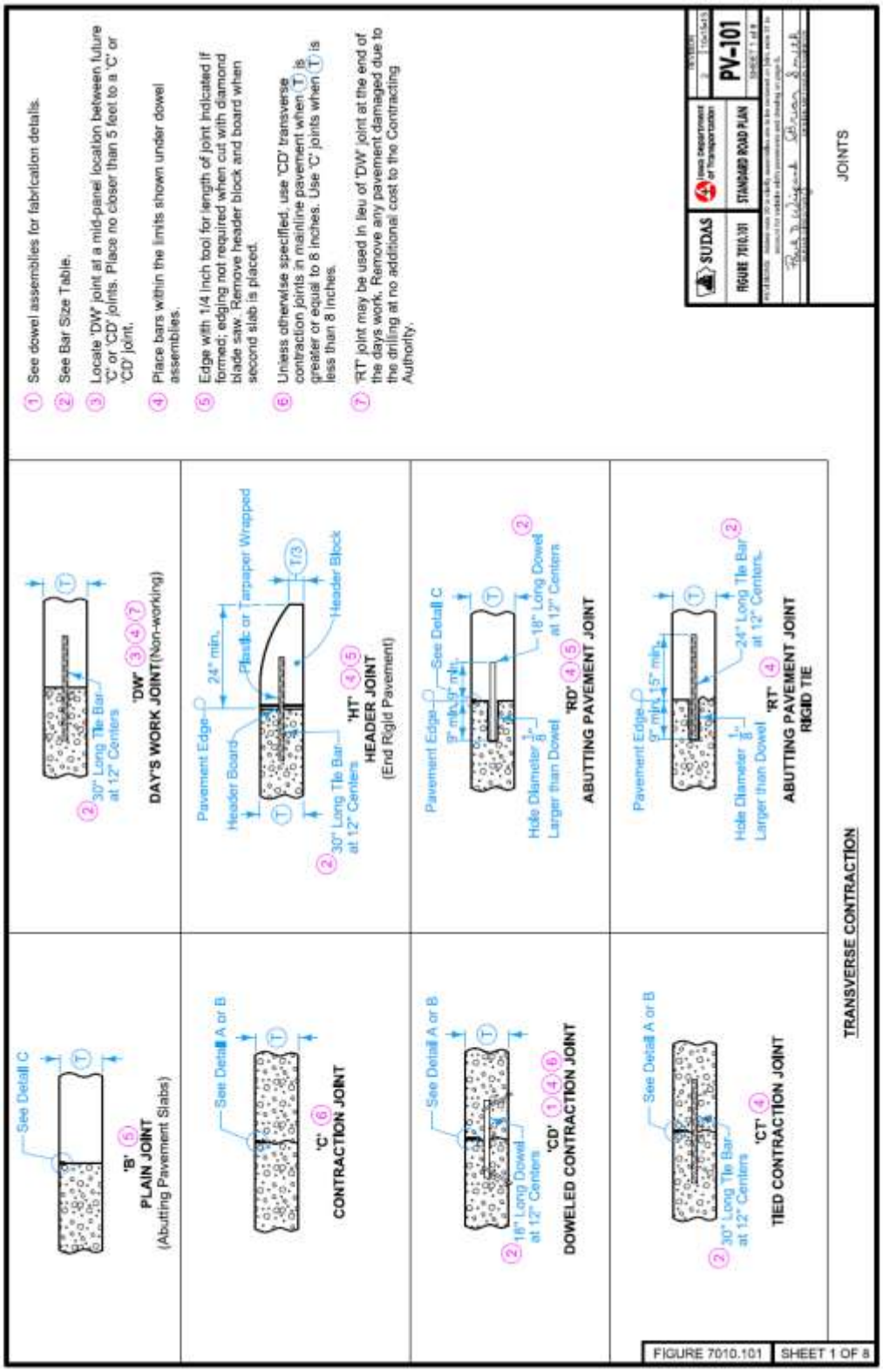
# APPENDIX A
# RESOURCES

# Appendix A Resources

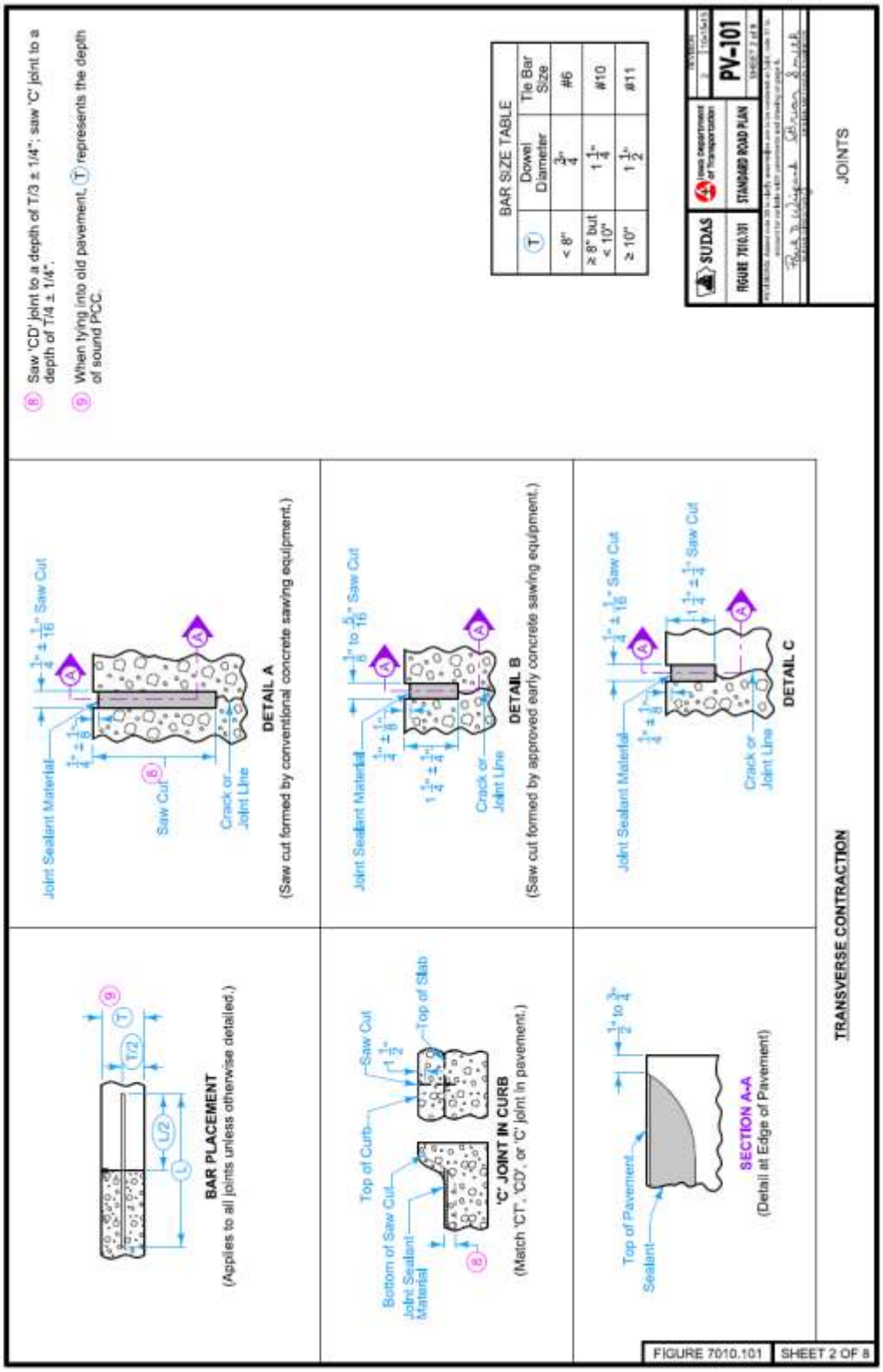
***INSPECTOR'S TOOL KIT***

SPECIFICATION BOOK
SUPPLEMENTAL SPECIFICATIONS
ROAD STANDARDS
MATERIALS I.M.'S
COPY OF FORMS OR SMALL BOOK
PEN OR PENCIL
CALCULATOR
AIR METER
SLUMP CONE
BEAM BOXES
BUCKETS
SQUARE NOSE SHOVEL
RAGS
RUBBER GLOVES
CAN OF SPRAY PAINT
MAGIC MARKER
SMALL TROWEL
NUMBERS FOR STATIONING
6' RULER – ENGLISH/METRIC
4' LEVEL
STRING
VIBRATOR CHECKER
PAVEMENT DEPTH CHECKER
TIRE DEPTH GAUGE – CHECKING TEXTURE
HARD HAT
SAFETY VEST
WATER
SNACK FOOD
SUN BLOCK

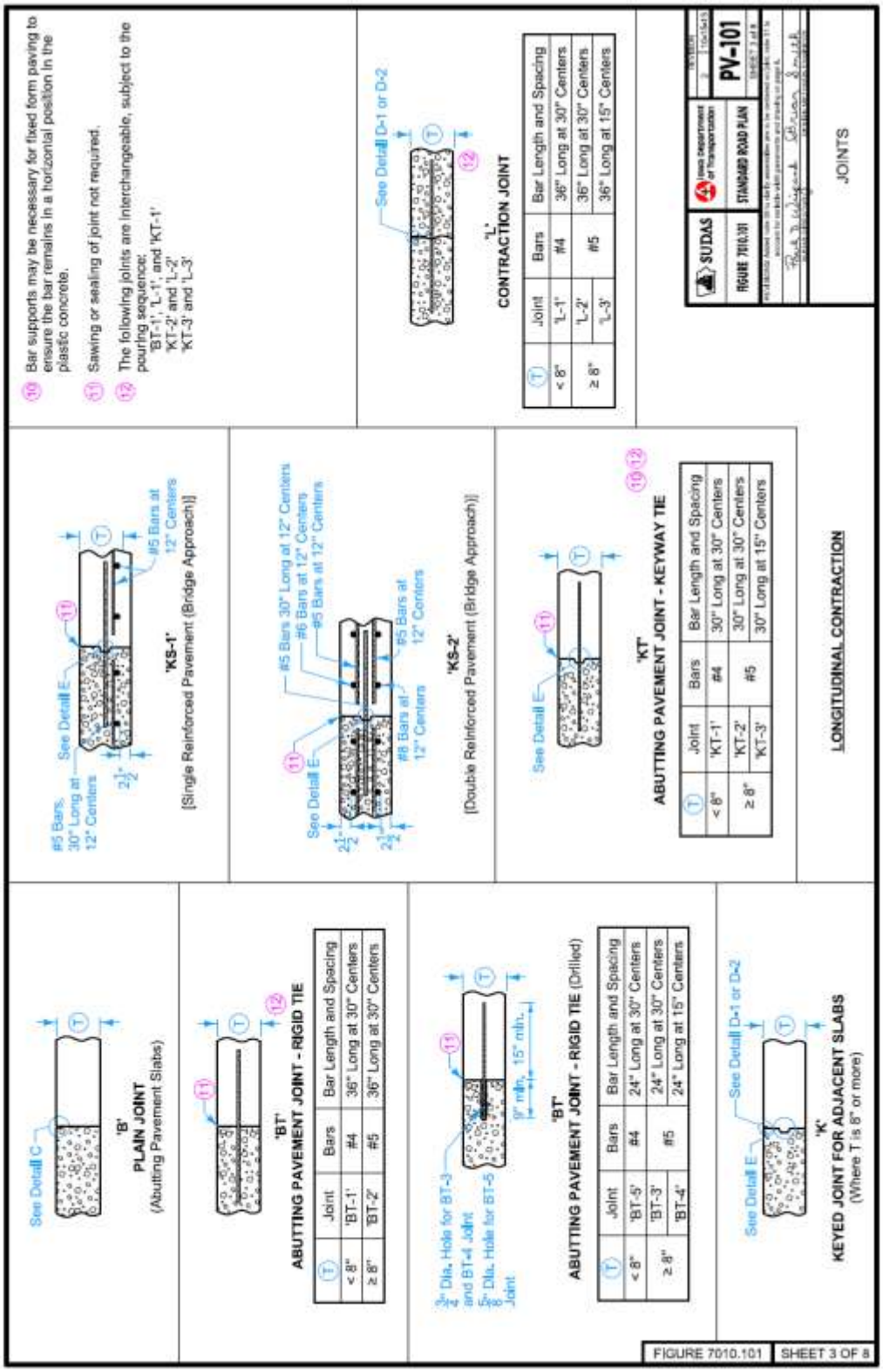
***PV-101***


1 See dowel assemblies for fabrication details.
2 See Bar Size Table.
3 Locate 'DW' joint at a mid-panel location between future 'C' or 'CD' joints. Place no closer than 5 feet to a 'C' or 'CD' joint.
4 Place bars within the limits shown under dowel assemblies.
5 Edge with 1/4 inch tool for length of joint indicated if formed; edging not required when cut with diamond blade saw. Remove header block and board when second slab is placed.
6 Unless otherwise specified, use 'CD' transverse contraction joints in mainline pavement when T is greater or equal to 8 inches. Use 'C' joints when T is less than 8 inches.
7 'RT' joint may be used in lieu of 'DW' joint at the end of the days work. Remove any pavement damaged due to the drilling at no additional cost to the Contracting Authority.
SUDAS
FIGURE 7010.101
IOWA DEPARTMENT of Transportation
STANDARD ROAD PLAN
PV-101
JOINTS
See Detail C
'B' 5
PLAIN JOINT
(Abutting Pavement Slabs)
See Detail A or B
'C' 6
CONTRACTION JOINT
See Detail A or B
2 18" Long Dowel at 12" Centers
'CD' 1 4 6
DOWELED CONTRACTION JOINT
See Detail A or B
2 30" Long Tie Bar at 12" Centers
'CT' 4
TIED CONTRACTION JOINT
2 30" Long Tie Bar at 12" Centers
'DW' 3 4 7
DAY'S WORK JOINT (Non-working)
Pavement Edge
Header Board
24" min.
Plastic or Tarpaper Wrapped
T/3
Header Block
2 30" Long Tie Bar at 12" Centers
'HT' 4 5
HEADER JOINT
(End Rigid Pavement)
Pavement Edge
See Detail C
9" min.
9" min.
Hole Diameter 1/8" Larger than Dowel
2 18" Long Dowel at 12" Centers
'RD' 4 5
ABUTTING PAVEMENT JOINT
Pavement Edge
9" min.
15" min.
Hole Diameter 1/8" Larger than Dowel
2 24" Long Tie Bar at 12" Centers
'RT' 4
ABUTTING PAVEMENT JOINT
RIGID TIE
TRANSVERSE CONTRACTION
FIGURE 7010.101
SHEET 1 OF 8

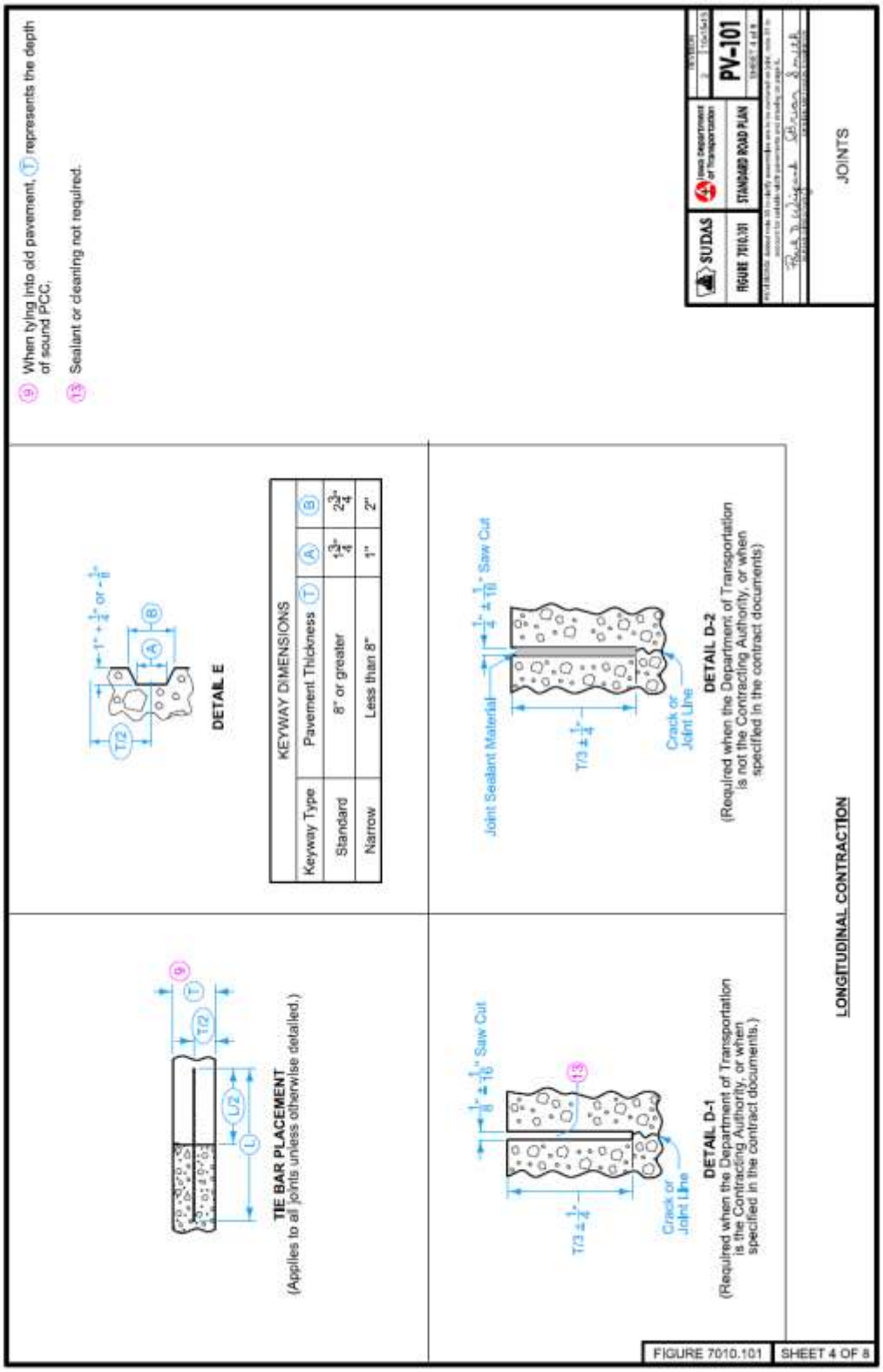
***PV-101***


(8) Saw 'CD' joint to a depth of T/3 ± 1/4"; saw 'C' joint to a depth of T/4 ± 1/4".
(9) When tying into old pavement, (T) represents the depth of sound PCC.
BAR SIZE TABLE
(T) | Dowel Diameter | Tie Bar Size
< 8" | 3/4" | #6
≥ 8" but < 10" | 1 1/4" | #10
≥ 10" | 1 1/2" | #11
SUDAS
FIGURE 7010.101
Iowa Department of Transportation
STANDARD ROAD PLAN
PV-101
JOINTS
Joint Sealant Material
Saw Cut
Crack or Joint Line
DETAIL A
(Saw cut formed by conventional concrete sawing equipment.)
DETAIL B
(Saw cut formed by approved early concrete sawing equipment.)
DETAIL C
BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)
Top of Curb
Top of Slab
Bottom of Saw Cut
'C' JOINT IN CURB
(Match 'CT', 'CD', or 'C' joint in pavement.)
Top of Pavement
Sealant
SECTION A-A
(Detail at Edge of Pavement)
TRANSVERSE CONTRACTION
FIGURE 7010.101
SHEET 2 OF 8

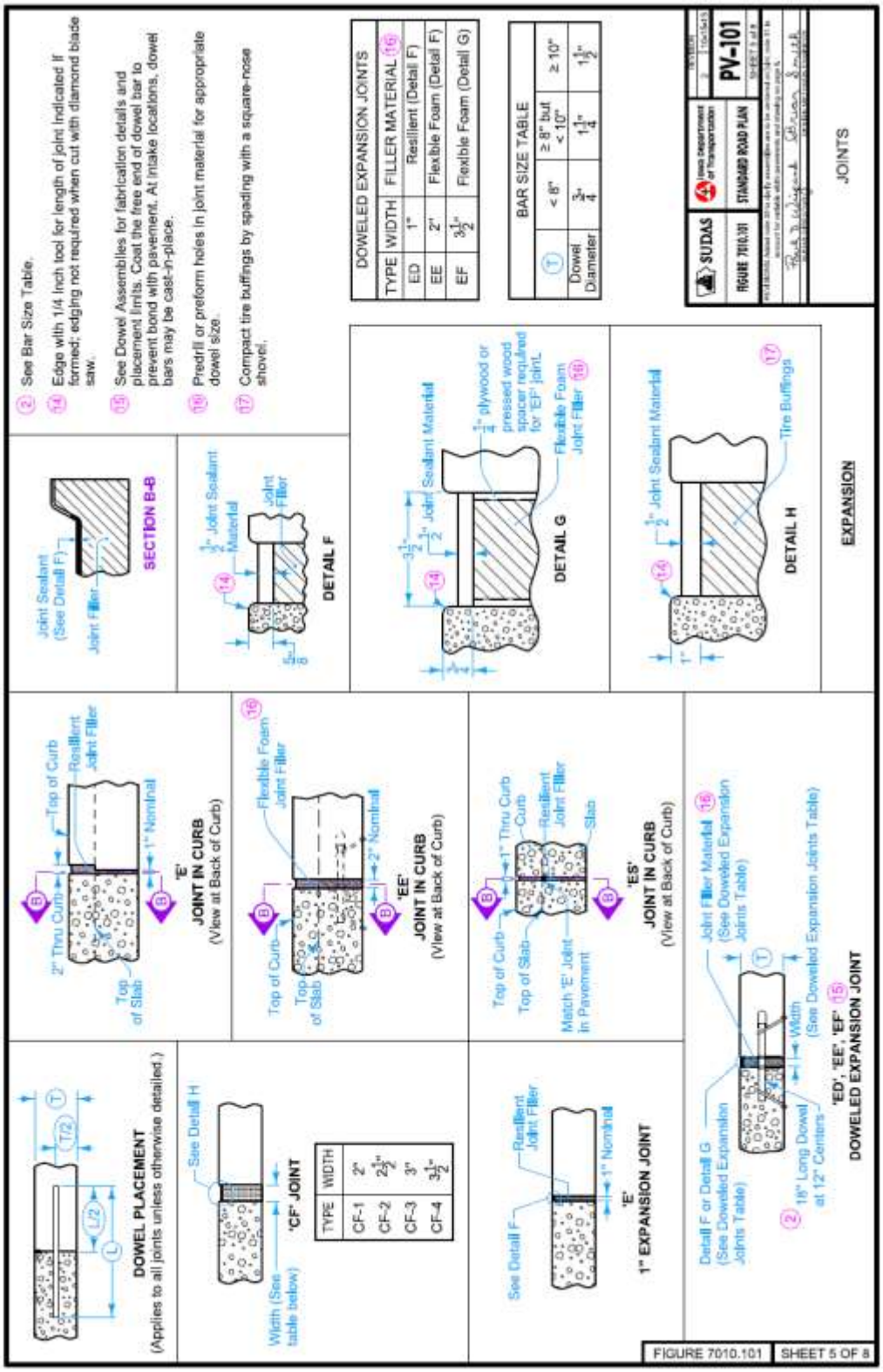
***PV-101***


10 Bar supports may be necessary for fixed form paving to ensure the bar remains in a horizontal position in the plastic concrete.
11 Sawing or sealing of joint not required.
12 The following joints are interchangeable, subject to the pouring sequence:
'BT-1', 'L-1', and 'KT-1'
'KT-2' and 'L-2'
'KT-3' and 'L-3'
See Detail C
'B'
PLAIN JOINT
(Abutting Pavement Slabs)
See Detail D-1 or D-2
'L'
CONTRACTION JOINT
T Joint Bars Bar Length and Spacing
< 8" 'L-1' #4 36" Long at 30" Centers
≥ 8" 'L-2' 'L-3' #5 36" Long at 30" Centers 36" Long at 15" Centers
See Detail E
#5 Bars, 30" Long at 12" Centers
#5 Bars at 12" Centers
'KS-1'
[Single Reinforced Pavement (Bridge Approach)]
#5 Bars 30" Long at 12" Centers
#6 Bars at 12" Centers
#5 Bars at 12" Centers
#6 Bars at 12" Centers
#5 Bars at 12" Centers
'KS-2'
[Double Reinforced Pavement (Bridge Approach)]
'KT'
ABUTTING PAVEMENT JOINT - KEYWAY TIE
T Joint Bars Bar Length and Spacing
< 8" 'KT-1' #4 30" Long at 30" Centers
≥ 8" 'KT-2' 'KT-3' #5 30" Long at 30" Centers 30" Long at 15" Centers
LONGITUDINAL CONTRACTION
'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE
T Joint Bars Bar Length and Spacing
< 8" 'BT-1' #4 36" Long at 30" Centers
≥ 8" 'BT-2' #5 36" Long at 30" Centers
3/4" Dia. Hole for BT-3 and BT-4 Joint
5/8" Dia. Hole for BT-5 Joint
9" min. 15" max.
'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE (Drilled)
T Joint Bars Bar Length and Spacing
< 8" 'BT-5' #4 24" Long at 30" Centers
≥ 8" 'BT-3' 'BT-4' #5 24" Long at 30" Centers 24" Long at 15" Centers
See Detail D-1 or D-2
See Detail E
'K'
KEYED JOINT FOR ADJACENT SLABS
(Where T is 8" or more)
SUDAS
FIGURE 7010.101
IOWA DEPARTMENT of Transportation
STANDARD ROAD PLAN
PV-101
JOINTS
FIGURE 7010.101
SHEET 3 OF 8

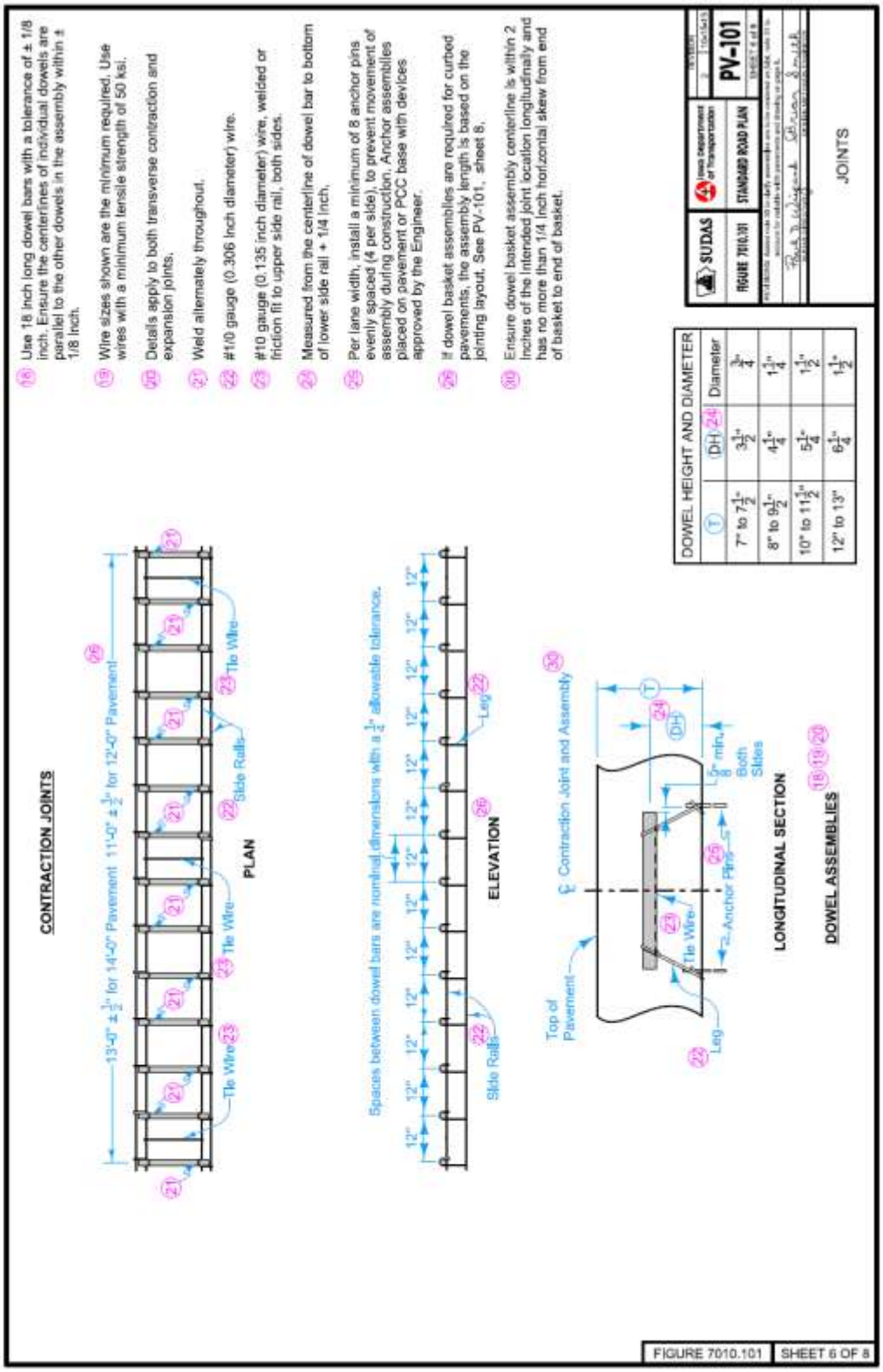
***PV-101***


9 When tying into old pavement, T represents the depth of sound PCC.
13 Sealant or cleaning not required.
SUDAS
FIGURE 7010.101
STANDARD ROAD PLAN
PV-101
JOINTS
DETAIL E
KEYWAY DIMENSIONS
Keyway Type
Pavement Thickness T
A
B
Standard
8" or greater
1 3/4"
2 3/4"
Narrow
Less than 8"
1"
2"
TIE BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)
Joint Sealant Material
Saw Cut
Crack or Joint Line
DETAIL D-2
(Required when the Department of Transportation is not the Contracting Authority, or when specified in the contract documents)
DETAIL D-1
(Required when the Department of Transportation is the Contracting Authority, or when specified in the contract documents.)
LONGITUDINAL CONTRACTION
FIGURE 7010.101
SHEET 4 OF 8

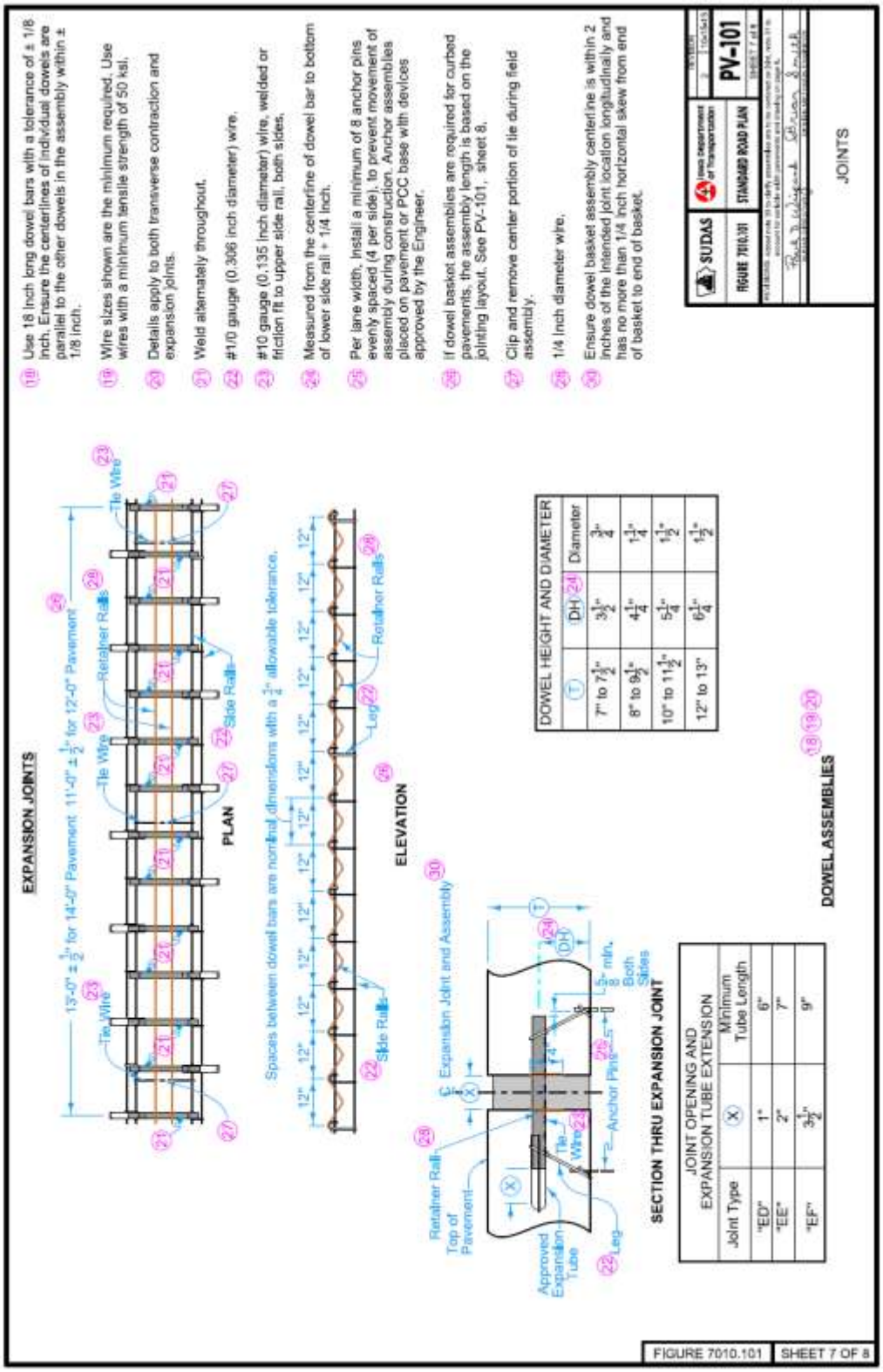
***PV-101***


(2) See Bar Size Table.
(14) Edge with 1/4 Inch tool for length of joint indicated if formed; edging not required when cut with diamond blade saw.
(15) See Dowel Assemblies for fabrication details and placement limits. Coat the free end of dowel bar to prevent bond with pavement. At intake locations, dowel bars may be cast-in-place.
(16) Predrill or preform holes in joint material for appropriate dowel size.
(17) Compact tire buffings by spading with a square-nose shovel.
DOWELED EXPANSION JOINTS
TYPE | WIDTH | FILLER MATERIAL (16)
ED | 1" | Resilient (Detail F)
EE | 2" | Flexible Foam (Detail F)
EF | 3 1/2" | Flexible Foam (Detail G)
BAR SIZE TABLE
(T) | < 8" | ≥ 8" but < 10" | ≥ 10"
Dowel Diameter | 3/4" | 1 1/4" | 1 1/2"
SUDAS
FIGURE 7010.101
STANDARD ROAD PLAN
PV-101
JOINTS
Joint Sealant (See Detail F)
Joint Filler
SECTION B-B
1/2" Joint Sealant Material
Joint Filler
DETAIL F
3 1/2"
1/2" Joint Sealant Material
1/4" plywood or pressed wood spacer required for 'EF' joint.
Flexible Foam Joint Filler (16)
DETAIL G
1/2" Joint Sealant Material
Tire Buffings
DETAIL H
EXPANSION
2" Thru Curb
Top of Curb
Resilient Joint Filler
1" Nominal
Top of Slab
'E' JOINT IN CURB (View at Back of Curb)
Flexible Foam Joint Filler (16)
Top of Curb
Top of Slab
2" Nominal
'EE' JOINT IN CURB (View at Back of Curb)
1" Thru Curb
Curb
Resilient Joint Filler
Slab
Top of Curb
Top of Slab
Match 'E' Joint in Pavement
'ES' JOINT IN CURB (View at Back of Curb)
(T/2)
(T)
(L/2)
(L)
DOWEL PLACEMENT
(Applies to all joints unless otherwise detailed.)
See Detail H
Width (See table below)
'CF' JOINT
TYPE | WIDTH
CF-1 | 2"
CF-2 | 2 1/2"
CF-3 | 3"
CF-4 | 3 1/2"
Resilient Joint Filler
See Detail F
1" Nominal
'E' 1" EXPANSION JOINT
Joint Filler Material (16) (See Doweled Expansion Joints Table)
Detail F or Detail G (See Doweled Expansion Joints Table)
(2) 18" Long Dowel at 12" Centers
Width (See Doweled Expansion Joints Table)
'ED', 'EE', 'EF' (15) DOWELED EXPANSION JOINT
FIGURE 7010.101
SHEET 5 OF 8

## *PV-101*


CONTRACTION JOINTS
13'-0" ± 1/2" for 14'-0" Pavement 11'-0" ± 1/2" for 12'-0" Pavement
Tie Wire
Side Rails
PLAN
Spaces between dowel bars are nominal dimensions with a 1/4" allowable tolerance.
12"
Leg
ELEVATION
℄ Contraction Joint and Assembly
Top of Pavement
Tie Wire
Anchor Pins
5" min. Both Sides
Leg
LONGITUDINAL SECTION
DOWEL ASSEMBLIES
DOWEL HEIGHT AND DIAMETER
(T) | (DH) | (24) Diameter
7" to 7 1/2" | 3 1/2" | 3/4
8" to 9 1/2" | 4 1/4" | 1 1/4
10" to 11 1/2" | 5 1/4" | 1 1/2
12" to 13" | 6 1/4" | 1 1/2
SUDAS
FIGURE 7010.101
Iowa Department of Transportation
STANDARD ROAD PLAN
PV-101
JOINTS
FIGURE 7010.101
SHEET 6 OF 8

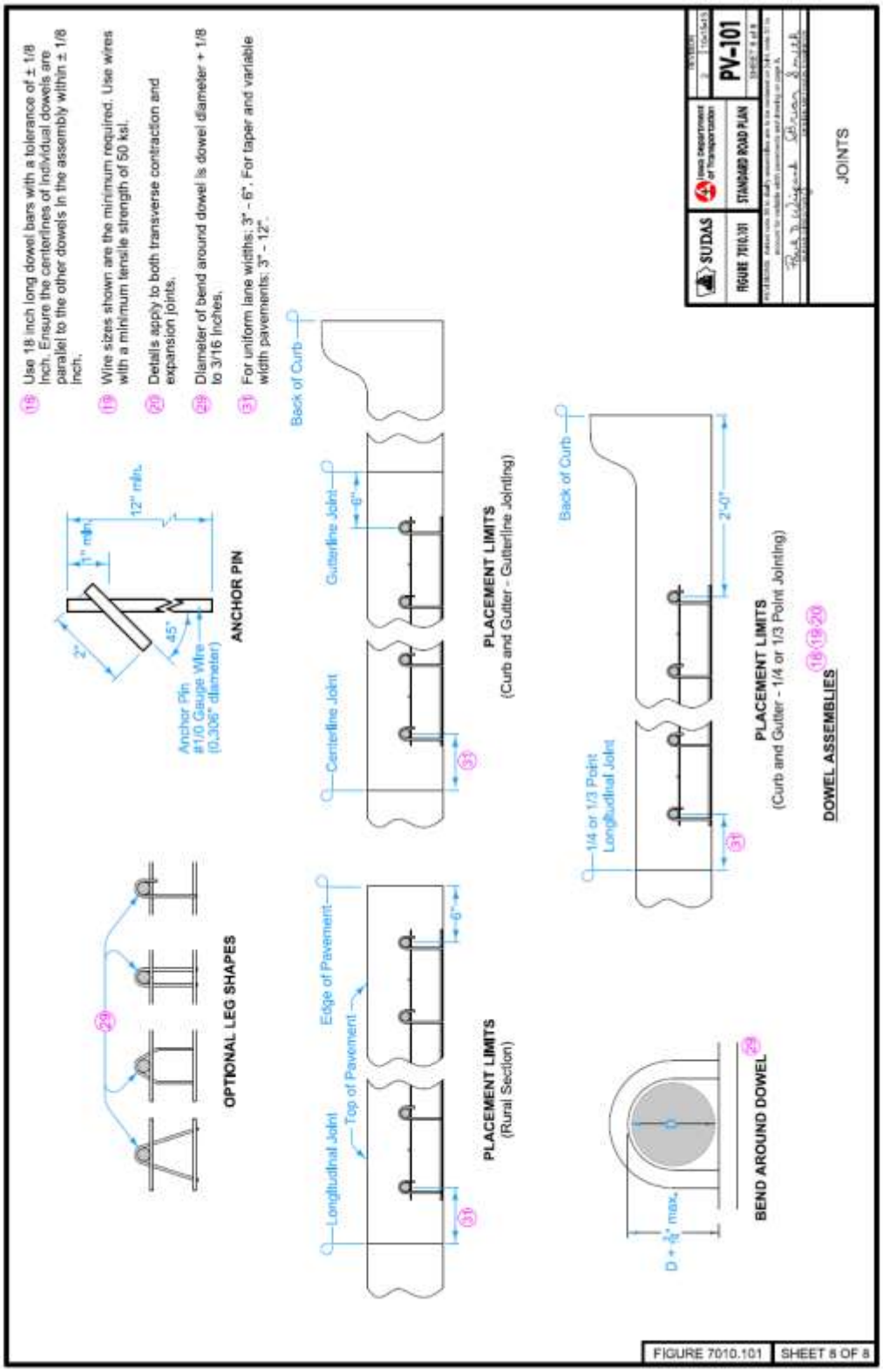
***PV-101***




| DOWEL HEIGHT AND DIAMETER | | |
|---|---|---|
| (T) | (DH) (24) | Diameter |
| 7" to 7½" | 3½" | ¾" |
| 8" to 9½" | 4½" | 1¼" |
| 10" to 11½" | 5¼" | 1½" |
| 12" to 13" | 6¼" | 1½" |

| JOINT OPENING AND EXPANSION TUBE EXTENSION | | |
|---|---|---|
| Joint Type | (X) | Minimum Tube Length |
| "ED" | 1" | 6" |
| "EE" | 2" | 7" |
| "EF" | 3½" | 9" |

***PV-101***


18 Use 18 inch long dowel bars with a tolerance of ± 1/8 inch. Ensure the centerlines of individual dowels are parallel to the other dowels in the assembly within ± 1/8 inch.
19 Wire sizes shown are the minimum required. Use wires with a minimum tensile strength of 50 ksi.
20 Details apply to both transverse contraction and expansion joints.
29 Diameter of bend around dowel is dowel diameter + 1/8 to 3/16 inches.
31 For uniform lane widths: 3" - 6". For taper and variable width pavements: 3" - 12".
12" min.
1" min.
2"
45°
Anchor Pin
#1/0 Gauge Wire
(0.306" diameter)
ANCHOR PIN
29
OPTIONAL LEG SHAPES
Back of Curb
Gutterline Joint
6"
Centerline Joint
31
PLACEMENT LIMITS
(Curb and Gutter - Gutterline Jointing)
Edge of Pavement
Top of Pavement
Longitudinal Joint
6"
31
PLACEMENT LIMITS
(Rural Section)
Back of Curb
2'-0"
1/4 or 1/3 Point
Longitudinal Joint
31
PLACEMENT LIMITS
(Curb and Gutter - 1/4 or 1/3 Point Jointing)
D + 1/8" max.
BEND AROUND DOWEL 29
DOWEL ASSEMBLIES 18 19 20
SUDAS
Iowa Department of Transportation
STANDARD ROAD PLAN
PV-101
FIGURE 7010.101
JOINTS
FIGURE 7010.101
SHEET 8 OF 8

## *Form E109 Sub Grade/Final Check*

Rev 1/97 Form E109

**Subgrade/Final Grade Check**

Line No.: _____

Item Code: _____ Page No.: _____

Description: _____ Category No.: _____

Project No.: _____ Contract ID: _____

| Date | Location Sta | (Lane) (Side) | Distance (Ft.) | | | | | | | By |
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## *Pre-Pave Checklist*

Date _____

Project No: _____ Job _____

### PRE-PAVE PAVER CHECKLIST

**PAN**

____ Crown Cylinder Retracted - If No Crown
____ Eccentrics Flat - If No Crown
____ Edgetip Adjustment
____ Width Adjustment
____ Stringlined - Profile and Float Pan
____ Mounts Tightened
____ Lead in Pan
____ All Adjustments Tight
____ Cracks Sealed
____ Stringline Pan

**TAMPER BARS**

____ Eccentrics in Time
____ Depth Set
____ Clamps Tack Welded
____ Drive Linkage Tight

**VIBRATORS**

____ All Working and Tachometered
____ Set Level and Straight
____ Correct Spacing
____ Adjusted R.P.M. on Panel
____ Lift Bar in Working Order

**SENSORS**

____ Elevation & Offset
____ Sensors Nulled
____ Wand Tension Correct
____ Arrow Pointing Up
____ Arm Mounts Solid (Braces if Necessary)
____ Elevation Wands Pointing Slightly Back
____ Alarm Systems Working

**STEERING AND TRAVEL**

____ Tracks Parallel
____ Track Tension
____ Steering Cylinders at 5" (CAT 550)
____ Steering Ram Wedges
____ Check Posi-Track for Operation

**STEEL INSERTION**

____ Proper Spacing and Depth
____ Correct Spacing Wheel
____ Adjust for Speed and Vibration (If Used)
____ Check Operation
____ Keyway and Tiebar Equipment Set Correctly

**AUTO FLOAT**

____ Leveled and Set
____ Lubricated
____ Travel Distance Set (Speed, Oscillation)
____ Float Section Adjusted Flat-Ends Up 1/16"

**MISCELLANEOUS**

____ Fenders Mounted
____ Legs Cleaned and Greased
____ Proper Guards in Place
____ Check Auxiliary Pressure - 2,000 to 2,300 p.s.i. if Auto Float
____ Check for Pressure Drops
____ Check Accumulators (Charge, Check Valves, Unloader Valves)
____ Check Call Valves on Suction Lines (Full On)
____ Fuel, Oil, Coolant, Belts
____ Check Miscellaneous Wiring for Shorts
____ Oil Down
____ Cleanliness of Paver

Prepared By: _____

Reviewed By: _____

## *Form 830213 Project Information/Paver Inspection*

Form 830213

10-07

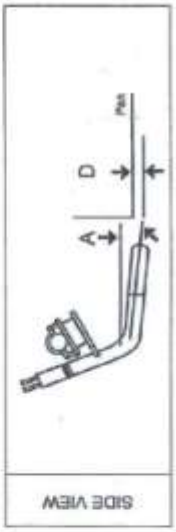
**Iowa Department of Transportation**

Project Information/Paver Inspection

| | | | |
|---|---|---|---|
| Date | Project Number | | Contract Number |
| Location | | | County |
| Project Inspector | | Paving Foreman | |
| Type/Model of Paver | | | |
| Type/Mounting Location of Tie-Bar Inserter | | | |
| Location of Tie-Bar Inserter from Pavement Edge | | | |

Note: If any information changes during the project, a new form needs to be completed.

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spacing (in) | | | | | | | | | | | | | | | | | | | | | | | | |
| Paving Direction | | | | | | | | | | | | | | | | | | | | | | | | |
| Cumulative Total | | | | | | | | | | | | | | | | | | | | | | | | |
| Vibrator No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Freq X 100 | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |
| Freq X 100 | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |
| Freq X 100 | | | | | | | | | | | | | | | | | | | | | | | | |
| Station | | | | | | | | | | | | | | | | | | | | | | | | |




| | |
|---|---|
| Angle | (A)= |
| Depth (in.) | (D)= |

General Notes:

1. Spec Limits – Refer to specification 2301.
2. Spacing not to exceed 16". Centerline spacing may be increased to 30" max due to physical limitations of paver such as mounting bracket locations; spacing should not be increased for tie steel insertion or lack of adequate number of vibrators.
3. When vibration monitoring is used, check and record frequency on a minimum of two vibrators daily.
4. When vibration monitoring is not used, check and record frequency of each vibrator twice daily.

## *Form 830212 Ready Mix Concrete*

Form 830212
10-95

**READY MIX CONCRETE**

_____ Plant

Truck No. _____ Ticket No. _____

Date _____ Des. No. _____

Proj. No. _____

Mix No. _____ Retarder/Water Reducer? ☐ Yes ☐ No

Conc. This Truck _____ C.Y./m³

Air agent added this truck _____ oz./mL

Time Batched _____ Discharged _____

Rev. Mixed *(Plant)* _____ Grade _____

Water *(gal./L or lbs./kg This Truck)* 8.33lbs./gal.

| | | | |
|---|---|---|---|
| In Aggregate | _____ gal./L | _____ | lbs./kg |
| Added *(Plant)* | _____ gal./L | _____ | lbs./kg |
| Subtotal | _____ gal./L | _____ | lbs./kg |
| Added Grade | _____ gal./L | _____ | lbs./kg |
| TOTAL WATER | _____ gal./L | _____ | lbs./kg |

Maximum Water Allowed _____ gal./L _____ lbs./cy or kg/m³

Air _____ Slump _____

Plant Insp. _____

Receiving Insp. _____

## Form E137 PCC Pavement Field Page

New 2/98

# PCC Pavement Field Page

Form E137

Line No.: _____

Item Code: _____

Description: _____

Project No.: _____

Page No.: _____

Category No.: _____

Contract ID: _____

| Date | Station | | Lane | Mix No. | Time | | Length (ft) | Width (ft) | Estimated CY Today | Used ( CY ) | | Est. Used ( % ) | Slip or Fixed (S / F) | Cold Wethr (Y / N) | By |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | | Start | Stop | | | | Today | To Date | | | | |
| | | | | | | | 0.00 | | | | 0.00 | 0.0 | | | |
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## Form E115 Air and Slump Tests

Rev 9/06

Form E115

### Air and Slump Tests

Line No.: _____

Page No.: _____

Contractor: _____

Category No.: _____

Project No.: _____

Contract ID: _____

| Date | Location | Mix Type | Air (%) | Witnessed Quality Control Test (X) | Slump (In) | Application | Remarks | By |
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## *Form E110 Depth Checks*

Rev 1/97 Form E110

**Depth Checks**

Line No.: _____

Item Code: _____ Page No.: _____

Description: _____ Category No.: _____

Project No.: _____ Contract ID: _____

| Date | Location Sta | Sta | (Side) | Req'd Depth | Actual Depth (Inches) | | | | | | | By |
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## *Form E111 PC Concrete Items Checklist*

Rev 1/97 Form E111

**PC Concrete Item Check List**

Line No.: _____

Item Code: _____

Description: _____

Project No.: _____

Page No.: _____

Category No.: _____

Contract ID: _____

| Date | Location Sta | Location (Side) | Basket (x) | Tie Bars Plastic (x) | Tie Bars Hard (x) | Vibrator (x) | Air & Slump (x) | Depth (x) | Width (x) | Yield (x) | Slope (x) | Texture (x) | Mix Temp. (°F) | Protect. (Y/N) | Cure Rate (gal/sy) | By |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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## Form E114 PC Concrete Beams Record

Rev 09/01 | PC Concrete Beam Record | Form E114

Line No.: _____

Item Code: _____

Description: _____

Project No.: _____

Page No.: _____

Category No.: _____

Contract ID: _____

| Beams Made Information | | | | | | | Beam Break Information | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date Made | Mix Number | Beam No. | Time | Air % | Slump (in) | W/C Ratio | Age (Days) | Loc. ( in ) | Depth ( in ) | Width ( in ) | Indicated Load ( lbs ) | Actual Load ( lbs ) | Comp. Factor | Mod. Of Rupture ( psi ) | Spec. psi | By |
| | | | | | | | | | | | | | 0.000000 | 0 | | |
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Checked By: _____

## *Form E141 Maturity Record*

New 2/98 Form E141

**Maturity Record**

Line No.: _____ Page No.: _____

Contractor: _____ Category No.: _____

Project No.: _____ Contract ID: _____

| Location | | Date | Mix | TTF | Date | TTF @ | | |
|---|---|---|---|---|---|---|---|---|
| Sta | Sta | Poured | Number | Target | Opened | Opening | Remarks | By |
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## *Form M142 Maturity Field Data Recording Sheet*

**Maturity - Field Data** Form M142

**Project :** _____ **Date Placed:** _____ **Maturity Curve #:** _____
**County :** _____ **Mix:** _____
**Contractor:** _____

**TTF Required for Opening or Loading :** [ ]

**SITE 1** *Section of Pavement for Opening or Structural Unit for Loading by Maturity* **Probe #** [ ]

**Structual Unit or Probe Location From:** [ ] **Probe Location To:** [ ]

| Date<br>*Enter* | Time<br>*Enter* | Age (hours)<br>*Enter* | Temp (deg C)<br>*Enter* | TTF at age (deg C-hr) | Sum TTF (deg C-hr) | Air Temp (deg C)<br>*Enter* |
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$$TTF = \left(\frac{Temp + Temp_{-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

***TTF:*** [ ] **Value in box should be greater than or equal to required TTF.**

**SITE 2** *Section of Pavement for Opening or Structural Unit for Loading by Maturity* **Probe #** [ ]

**Structual Unit or Probe Location - From:** [ ] **To Probe Location:** [ ]

| Date<br>*Enter* | Time<br>*Enter* | Age (hours)<br>*Enter* | Temp (deg C)<br>*Enter* | TTF at age (deg C-hr) | Sum TTF (deg C-hr) | Air Temp (deg C)<br>*Enter* |
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$$TTF = \left(\frac{Temp + Temp_{-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

***TTF:*** [ ] **Value in box should be greater than or equal to required TTF.**

cc: RCE, Central Materials, Contractor

*Contractor Representative*

*Agency Representative*

## *Form E140 Tining Depth Checks*

New 02/98 Form E140

**Line No.:** _____

**Item Code:** _____ Page No.: _____

**Description:** Tining Depth Checks Category No.: _____

**Project No.:** _____ Contract ID: _____

| Date | Location Station | Side | Actual Measurements ( in. ) 1 | 2 | 3 | 4 | 5 | 6 | 7 | Avg. | By |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0 | |
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# Form 800240 Daily PCC Plant Report

PCC Plant Report

| Date of Placement | Location From | Location To |
|---|---|---|
| Mix 1 | | |
| Mix 2 | | |
| Mix 3 | | |
| Mix 4 | | |
| Mix 5 | | |

Project No.: _____ Contract ID: _____ Report No.: _____

Plant Name: _____ County: _____ Date This Report: _____

Contractor: _____ Temp. (°F) Min: _____ Date Of Last Report: _____

Weather: _____ Temp. (°F) Max: _____ Structures Des. No: _____

| Check Mix( x ) | | Check One( x ) | | SEND |
|---|---|---|---|---|
| Central | | Paving | | (Daily) |
| Ready | | Structure | | (Weekly) |
| | | Incidental | | (Weekly) |
| | | Patching | | (Weekly) |

| | Mix | Batched (CY) | % Of Est. Used | Fine Aggregate Moist. (%) | Fine Aggregate T-203 Sp. G. | Fine Aggregate Wt. SSD (lbs) | Intermediate Aggregate Moist. (%) | Intermediate Aggregate T-203 Sp. G. | Intermediate Aggregate Wt. SSD (lbs) | Coarse Aggregate Moist. (%) | Coarse Aggregate T-203 Sp. G. | Coarse Aggregate Wt. SSD (lbs) | Actual Quantities Used Per cy ( in pounds ) Cement | Fly Ash | GGBFS | Fine | Inter. | Coarse | Water In Agg. | Water Plant | Water Grade | Avg w/c Ratio | Max w/c Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | |

| Coarse | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | Comply Y/N |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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| Conc. Treatment | (X) | lb / cy |
|---|---|---|
| Ice | | |
| Heated Water | | |
| Heated Materials | | |

| Batched Check One (X) | Today | Week | Total To Date |
|---|---|---|---|
| Concrete (CY): | | | |
| Cement (tons): | | | |

| Intermediate | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | Comply |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | NA |
| | | | | | | | | | NA |
| | | | | | | | | | NA |

| | Brand / Source | Rate | Lot Number |
|---|---|---|---|
| Air Entraining: | | | |
| Water Reducer: | | | |
| Retarder: | | | |
| Calcium Chloride: | | | |
| Superplasticizer: | | | |

| Fine | 1/2" | 3/8" | #4 | #8 | #16 | #30 | #50 | #100 | #200 | Comply Y/N |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
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| | | | | | | | | | | |

| | Type | Sp. Gr. | Source |
|---|---|---|---|
| Cement: | | | |
| Fly Ash: | | | |
| GGBFS: | | | |

| Adjusted % Passing Calculated Combined Gradation | 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #16 | #30 | #50 | #100 | #200 | Within Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| | Source | T-203 A # | Grad. No. |
|---|---|---|---|
| Coarse: | | | |
| Intermediate: | | | |
| Fine: | | | |

Remarks _____

C.P.I.: _____ _____

Monitor: _____ _____

Distribution: ____ DME ____ Proj. Eng. ____ Plant

## *Form 821283 PCC Gradation Test Report – Verification*

Iowa Department of Transportation

Office of Materials

PCC GRADATION TEST REPORT - VERIFICATION

| Check Mix(es) | | Check One(s) | |
|---|---|---|---|
| Control | | Paving | |
| Ready | | Structure | |
| | | Incidental | |
| | | Patching | |

Project No.: _____ Contract ID: _____ Report No.: _____

County: _____ Date This Report: _____

Mix ID: _____ Date Of Last Report: _____

Structures Des. No: _____

Contractor: _____ Plant Name: _____

| COARSE AGGREGATE | | | | | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOURCE: | | | | | 37.5 mm | 25 mm | 19 mm | 12.5 mm | 9.5 mm | 4.75 mm | 2.36 mm | 75 um | Comply |
| T-283 A# | | AGG % | Date Sampled | Sendors No. | Sample ID | | | | | | | | Y/N |
| GRAD NO.: | | | | | | | | | | | | | |
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| INTERMEDIATE AGGREGATE | | | | | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOURCE: | | | | | 37.5 mm | 25 mm | 19 mm | 12.5 mm | 9.5 mm | 4.75 mm | 2.36 mm | 75 um | Comply |
| T-283 A# | | AGG % | Date Sampled | Sendors No. | Sample ID | | | | | | | | Y/N |
| GRAD NO.: | | | | | | | | | | | | | N/A |
| | | | | | | | | | | | | | N/A |
| | | | | | | | | | | | | | N/A |
| | | | | | | | | | | | | | N/A |
| | | | | | | | | | | | | | N/A |

| FINE AGGREGATE | | | | | 1/2" | 3/8" | #4 | #8 | #16 | #30 | #50 | #100 | #200 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOURCE: | | | | | 12.5 mm | 9.5 mm | 4.75 mm | 2.36 mm | 1.18 mm | 600 um | 300 um | 150 um | 75 um | Comply |
| T-283 A# | | AGG % | Date Sampled | Sendors No. | Sample ID | | | | | | | | | Y/N |
| GRAD NO.: | | | | | | | | | | | | | | |
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| COMBINED AGGREGATE GRADATION | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.5" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #16 | #30 | #50 | #100 | #200 | Within Target | Coarseness Factor | Workability Factor | GMC PAY ZONE |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | Lot Average - VERIFICATION | | | 0 |
| | | | | | | | | | | | | Lot Average - CONTRACTOR | | | |

Remarks _____

Distribution: ____ DME ____ Proj. Eng. ____ Contractor

Monitor: _____ Cert No. _____

## *Form 830245 Noncompliance Notice*

Form 830245
4-96

**Iowa Department of Transportation**

**NONCOMPLIANCE NOTICE**

Contractor _____ Project No. _____

County _____ Accounting ID No. _____ Date _____ Time _____

To: _____ _____ _____
(Name) (Title) (Signature)

You are hereby notified that the following observation and/or test noted _____

_____

_____

and is a violation of Article _____

The test data value is _____

_____

_____

and the specification limits are _____

_____

Additional tests may be performed.

The violation identified in this notice shall be ceased and/or corrected. This may require a modification of current practices or removal and replacement of materials, including labor, at no cost to the Contracting Authority.

You are to determine corrective action necessary.

You are to determine if you wish to discontinue operations until the violation is corrected or additional tests confirm or refute this failing test.

Remarks: _____

_____

_____

Correction: _____

_____

_____

Signed: _____
Inspector

**Distribution:** White Copy - Contractor, Canary Copy - Project Engineer, Pink Copy - Inspector

***Pavement Worksheet***

Page No _____

## Pavement Worksheet

Project No: _____ Contract ID: _____

| DATE | STA. | STA. | EDGE SLUMP | WIDTH | CY/CM³ REGISTERED | CY/CM³ BATCHED | % YIELD | RUNNING TOTAL | RUNNING % YIELD | INSP. INITS. |
|---|---|---|---|---|---|---|---|---|---|---|
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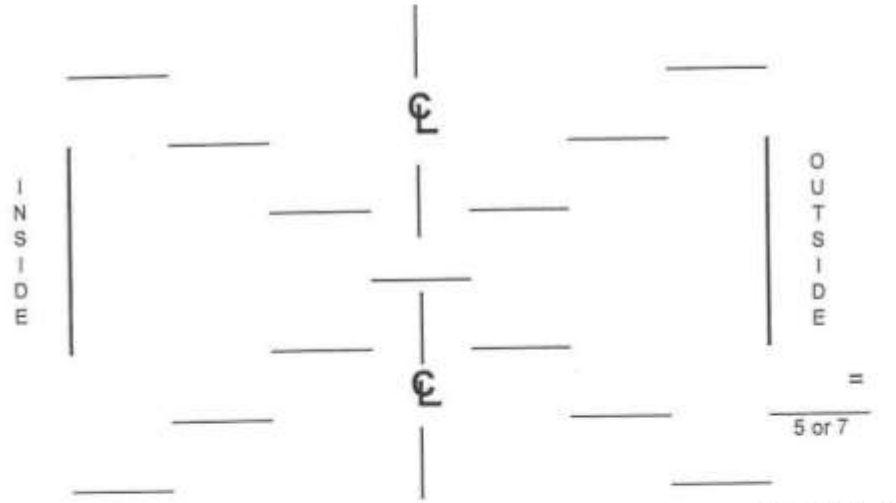
REMARKS _____

***Texture Check Worksheet***

Project No _____ Contract ID _____

## TEXTURE CHECK WORKSHEET

| DATE -- | STA. -- | MEAS. BY -- |
|---|---|---|




COMPLIES

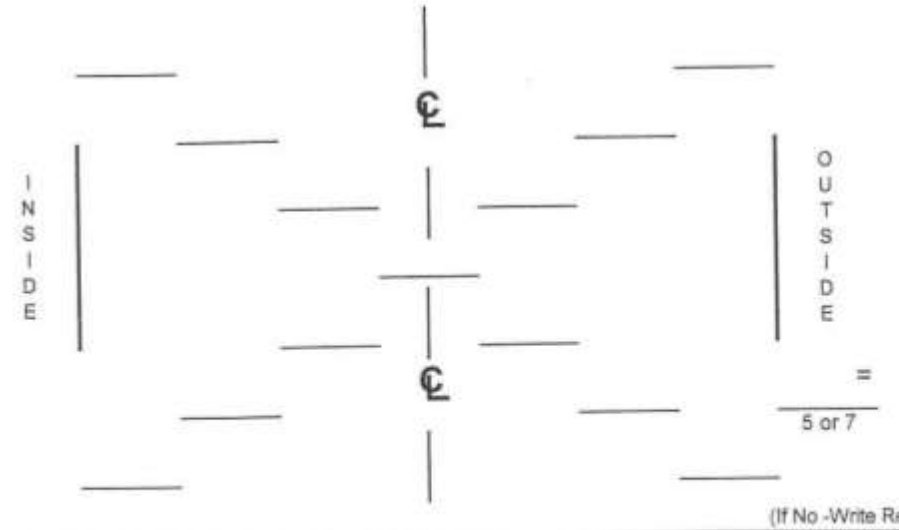
YES _____

NO _____

= _____ / 5 or 7 AVE.

(If No -Write Remarks on the Back Page)

| DATE -- | STA. -- | MEAS. BY -- |
|---|---|---|




COMPLIES

YES _____

NO _____

= _____ / 5 or 7 AVE.

(If No -Write Remarks on the Back Page)

***Joint Check Worksheet***

Page No _____

Project No _____ Contract ID _____

JOINT CHECK WORKSHEET

| DATE | STA. | ℄ | TRANS | DEPTH | WIDTH | SAND BLASTED | SEAL | REMARKS | INSP. INITS. |
|---|---|---|---|---|---|---|---|---|---|
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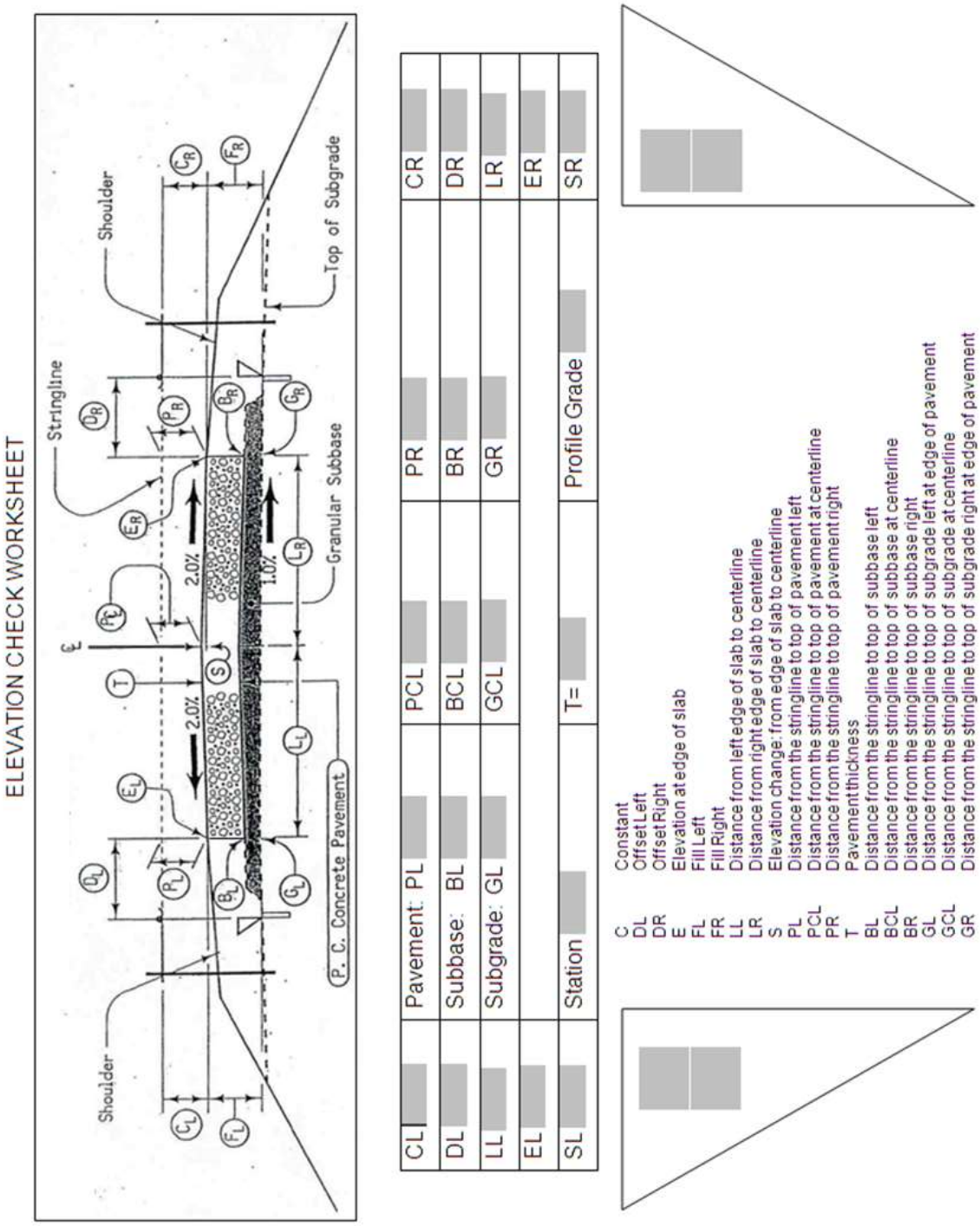
NOTE

## *Elevation Check Worksheet*



# APPENDIX B
# CHECKLIST

# Appendix B PCC Paving Field Inspection Checklist

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| **Prior to Concrete Placement** | | | | |
| Check proof rolling of subgrade | Everywhere prior to final trimming of subgrade. | | Specification 2301.03, B, 3 all PCC paving<br>Specification 2115.03, B, 2 Modified Subbase | All subgrades should be proof rolled with a sheep's foot roller no more than 1 week prior to trimming of the final grade. In addition, when Modified Subbase is used, the subgrade is to be proof rolled with a loaded truck to identify soft spots, etc. |
| Check stringline | As needed | | | Prior to checking subgrade and subbase cross slope and elevation, check to ensure that the stringline is properly placed relative to the paving hub. This can be done simply by measuring from the paving hub up to the stringline. Make sure to factor in the contractor's machine constant when measuring. |
| Check trimmed subgrade | 10/mile (IM-204) | Form E109 | Specification 2109.03, A, 10 plus or minus 0.05 foot | Check to ensure subgrade is trimmed to the proper cross slope and elevation. Usually checked by placing string across subgrade from stringline to stringline and measuring down to top of subgrade. When stringline is not available, a survey rod and level may be used. Laser levels have been used but are less common. GPS rovers have also been used, but are not accurate enough to measure within the specification tolerances. |
| Make sure the contractor is not driving haul vehicles on granular subbase | As needed | | Specification 2111.03, E | The specification prohibits the contractor from driving on the granular subbase material. This is a concern because excessive haul traffic on the granular subbase material can cause the material to break down and generate an excessive amount of fines. This is undesirable because granular subbase is intended to be a drainable material. Haul equipment must be operated on the material for delivery and placement purposes. A reasonable expectation of the contractor is that they get on and off the material within a 500 to 1000 foot stretch. When recycled materials are used, the distance should be kept closer to 500 feet. When virgin materials are used, the distance can be extended up to 1000 feet depending upon how much breakdown of the material occurs. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check trimmed subbase (granular or modified) | 10/mile (IM-204) | Form E109 | Modified Subbase<br>Specification 2115.03 plus 0 and minus 0.05 foot<br>IM 204 Appendix C<br><br>Granular Subbase<br>Specification 2111.03, D, 4 plus 0 and minus 0.05 foot<br>IM 204 Appendix D | Check to ensure subbase is trimmed to the proper cross slope and elevation. This, along with the subgrade checks, will ensure proper subbase thickness. Usually checked by placing string across subbase from stringline to stringline and measuring down to top of subbase. When stringline is not available, a level may be used. Laser levels have been used but are less common. GPS rovers have also been used, but are not accurate. The width of the subbase should also be checked at this time to ensure that the proper placement width is being achieved. Note that subbase width typically includes an added three feet on each side of the pavement for a padline. |
| Check steel reinforcement storage | | | Specification 4151.03, G | Steel reinforcement should be stored in a manner that reduces the risk of corrosion, damage, and breakdown of epoxy coating. All reinforcement is to be stored on supports to prevent contact with the ground and extended contact with moisture. Epoxy coated bars should be covered with a non-transparent material if exposed for 2 months or more. |
| Check dowel basket placement | | Form E111 | Specification 2301.03, E<br>Specification 4151.02, B<br>Road Standard PV-101<br>Paving typicals in B sheets of project plans | Dowel baskets should be checked for spacing, alignment, proper anchorage, and adequate bond breaker coating. A quick and simple method to check alignment is to sight down the grade. Baskets that are out of alignment will be visible as the dowels will not line up. The baskets should also be checked to ensure that the dowel bars are level and parallel with each other. It is important to check alignment of dowels to ensure that the contraction joint works properly in the pavement. Once the joint is sawed and the pavement cracks, the concrete is intended to slide over the dowel as the pavement expands and contracts. If the dowels are out of alignment, the pavement cannot properly slide on the dowels which may result in random cracking. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| | | | | Baskets should be anchored with a minimum of 8 basket stakes per lane width. Dowel baskets are required to be coated with a bond breaker. Typically the bond breakers used are a bituminous material or a paraffin based material called Tectyl. Often the bituminous coating can become dry and brittle and will develop cracks in the material. If this occurs, recoating of the bars may be necessary. The contractor is not required to cut the tie wires on the baskets as long as the basket is manufactured correctly. The PV-101 road standard shows three #10 gauge wires on the basket. If more than three wires are provided, only three may be left uncut. One final check that should be made for dowel baskets is to check that the contractor has marked the center of each end of the basket to identify the location of the basket for purposes of sawing. this is typically done by placing a basket stake off each end of the basket along with a paint mark. |
| Inspect the finishing machine | Once each paver and when information changes. | Form 830213 | Specification 2301.03, A, 3<br>Construction Manual Appendix 9-3 | A few days prior to start of paving, several checks should be made on the paver, and form 830213 should be completed. Use this form to record vibrator spacing and angle. The paver width and cross slope should also be checked. The form can also be used to record vibrator frequency checks during paving. |
| Check paver vibration monitoring system | | | Specification 2301.03, A, 3, a<br>Vibration monitoring required for all projects with mainline paving quantities greater than 50,000 square yards | Discuss layout of vibrators with contractor to confirm locations of each relative to data being recorded on monitoring system. |
| Check paver vibrator spacing | Once each paver and each time the paver width is changed. | | Specification 2301.03 A, 3, a<br>16 inch maximum spacing | Record on form 830213. Spacing may be increased due to structural limitations of finishing machine. Greater spacing should not be allowed for tie steel insertion or lack of correct number of vibrators. |
| Check paver vibrator angle | Once each paver. | | Specification 2301.03 A, 3, a<br>Vibrators should be mounted parallel to direction of paving and trailing end tilted to approximately 15 degrees below horizontal | Record on form 830213. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| **During Concrete Placement** | | | | |
| Place date in headers | Daily | | | The date should be stamped in the headers at the beginning and end of each day's run. The date should be placed in the outer 2 feet of the pavement in a position where it will not be destroyed by possible milled shoulder rumble strip placement. |
| Check subgrade/subbase moisture | As needed. | | Specification 2109.03, B<br>Specification 2301.03, B | The subgrade or subbase should be periodically checked throughout the paving day to ensure that the material is uniformly moist. Moisture should be added as needed to keep the material in a uniformly moist condition. As the subgrade or subbase material dries out, moisture will be wicked out of the concrete and can cause loss of strength and reduction in effective pavement thickness. After periods of rain, addition of moisture may not be necessary if sufficient moisture is present. |
| Check dowel baskets | Periodically | | Specification 2301.03, E | It is a good practice to periodically walk out in front of the paving train and check to make sure dowel baskets are still in proper alignment and free from contamination. Occasionally baskets can become damaged or contaminated with mud or other debris during handling and placement. These baskets should be cleaned and repaired or removed and replaced. |
| Check joint layouts | As needed | | Specification 2301.03, E<br>K and L sheets in project plans | There are certain locations on a project where specific joint types and spacings are required. Areas such as turn lanes, paved crossovers, and side road connections will have a specific jointing layout included in the K and L sheets of the project plans. It is important to review the project plans and inspect the contractors jointing layout prior to placing concrete. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check concrete delivery time | At start of concrete placement and when delivery routes or distances change | Ready mix - Form 830212<br>Central batch - N/A | Specification 2301.02, C, 4 | The specification requires that concrete hauled without continuous agitation be placed within 30 minutes after batching. This time may be extended an additional 30 minutes when a retarder is used with approval of the Engineer. Concrete hauled with continuous agitation must be placed within 90 minutes after batching. When using ready mix concrete, the time batched should be included on Form 830212 (Ready Mix Concrete) when received on grade. After discharge, the discharge time should also be recorded on the form. For central batch concrete, haul routes and haul times should be discussed with the contractor prior to placement. Factors such as delays due to heavy traffic (i.e. - rush hour in an urban area) should be discussed along with possible alternate haul routes. Haul times should be observed and recorded in the daily diary for the project. |
| Check and document water added on grade | Each load | Form 830212 | Specification 2301.02, C, 4 | Record water added to each load on the ready mix ticket for that load. Total water added to all loads for the placement should be totaled and reported to the plant inspector for inclusion on the plant report. |
| Check concrete placement operation | Periodically | | Specification 2301.03, F<br>Specification 2301.03, J | Concrete should be placed in a manner that minimizes segregation and disturbance of reinforcement. When a belt placer is being used, check to make sure that a deflector is in place and being used. This will help to minimize segregation. During hand placements, hand operated vibrators should not be used to move the concrete. They should only be used for consolidation purposes.<br><br>Concrete placement should also be monitored to ensure that concrete does not sit on the grade for more than 30 minutes before consolidation and finishing. This is to ensure that the concrete is plastic and workable when consolidated and finished by the finishing machine. |
| Test slump of plastic concrete | Minimum 1/700 CY<br>Minimum of 1 test per placement | Form E115<br>Form E111 | Specification 2301.02, B, 3<br>Slip form paving N/A<br>Non-slip form paving 0.5" to 4"<br>IM 204 Appendix E, IM 317 | There are no slump requirements for slip form pavement since the ability of the pavement to hold a slipped edge governs slump. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Test entrained air content of plastic concrete | Minimum 1/700 CY<br>Minimum 1/100 CY for transit mix<br>Minimum of 1 test per placement | Form E115<br>Form E111 | Specification 2301.02, B, 4<br>Slip form paving target of 8% with a tolerance of plus or minus 2%<br>Non slip form paving target of 7% with a tolerance of plus or minus 1.5%<br>IM 204 Appendix E, IM 318, IM 327, IM 527, IM 530<br>Construction Manual 9.63 | As concrete is placed, consolidated, and finished, air entrainment is lost. It is desirable to have an entrained air content of approximately 6% after finishing. The specification limits for air content are set up to account for air loss during placement and finishing. Air tests should occasionally be run behind the paver to confirm that the anticipated air loss is occurring and that the desired air content is achieved. It is recommended that air loss through the paver be checked once per day for the first three days of paving on a project. After that, checks should be made weekly to confirm the amount of air loss through the paver.<br><br>It is important that verification tests for air content are random. Testing frequency must be random in order for the test to be valid. Testing should not be performed at regular intervals or at fixed times each day. On QM-C projects, verification testing should not be timed to match contractor quality control testing. |
| Observe and record contractor quality control air tests | As requested by contractor | Form E115 | Construction Manual 9.63 | Contractors are only required to perform quality control (QC) testing on QM-C projects. However, if the contractor elects to perform QC testing on a non-QM-C project, testing should be witnessed and documented, when requested by the contractor. Form E 115 includes a column indicating whether a test is a witnessed QC test or not. Witnessing and documenting contractor QC tests is important because it may reduce the amount of non-compliance and/or testing that a contractor may be responsible for when non-complying material is identified. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check concrete mix temperature | Daily when near specification limits | Form E111 | Specification 2301.03, S<br>Minimum 40 degrees F at time of placement | It is important to check concrete temperatures in the early spring and late fall to ensure that the minimum mix temperatures are achieved. Early spring is the more critical time to ensure minimum mix temperatures since the subgrade/subbase as well as all of the mix ingredients are much colder after the winter. Typically mix temperatures are not an issue in the late fall as the mix ingredients are usually warmer than the ambient air temperatures.<br><br>While Iowa does not have an upper limit for concrete mix temperatures, temperatures should be taken and recorded when complications with air entrainment or finishing are encountered during hot weather. |
| Check pavement width and cross slope | At start of paving and when paving widths change | Form E111 | Specification 2301.03, A, 3<br>Specification 2301.03, F and G<br>Paving typicals in B sheets of project plans | Similarly to checks made on the finishing machine prior to start of paving, the pavement itself should be checked to ensure that the proper width and cross slope are provided. Cross slope checks can be accomplished by running a stringline across the pavement from one stringline to another. Measurements can then be made down from the stringline to top of pavement at centerline and both pavement edges to determine the cross slope of the pavement. |
| Check depth of plastic concrete | Daily | Form E111<br>Form E110 | Specification 2301.03, A, 3<br>Paving typicals in B sheets of project plans | Typically contractors check the thickness of the pavement in the plastic concrete to ensure that they are paving plan thickness or thicker. This activity should be observed by the grade inspector or the grade inspector should perform the checks on their own if the contractor is not. |
| Check concrete yield | 1/1000 CY | Form E 137<br>Form E111 | | Comparison should be made between the cubic yards of concrete batched and the cubic yardage of concrete required for a given area of pavement. Typically the quantity batched will be between 103% and 106% of the quantity required. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check paver vibrator frequency | 2/day | Form 830213<br>Form E111 | Specification 2301.03, A, 3 | It has been proven that excessive vibration can cause significant entrained air loss in concrete, and can result in non-durable concrete and premature deterioration. For this reason, vibration should be monitored very closely on every project.<br><br>The specifications require contractors to use vibration monitoring systems for all slip form paving on projects with quantities 50,000 square yards and greater. These systems record significant information such as vibration rate, station location, paver speed, etc. The systems have a display that shows the vibration rate for each individual vibrator. When a vibration monitoring system is in use, inspectors should still check the vibration rate of individual vibrators by hand to ensure that the monitor is accurate. Vibration monitoring data is required to be submitted to the Engineer. This information should be reviewed on a regular basis to ensure that vibrators are run within the specification limits.<br><br>For projects less than 50,000 square yards and no vibration monitors, each vibrator on the paver should be checked twice per day to ensure that the vibrator is within the allowable tolerances.<br><br>The paver operator should never be allowed to adjust the paver vibrator rates prior to or during vibration rate checks. |
| Check hand operated vibrator frequency | Once per unit | Form E111 | Specification 2301.03, A, 3 | The specification requires the vibration rate of vibrators used for hand finished pavement to operate between 3500 vpm and 6000 vpm. This should be checked for each vibrator used prior to the first hand pour. Document the check in the daily diary and on Form E111. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check centerline tie steel insertion in plastic concrete | Daily | Form E111 | Specification 2301.03, E<br>Road Standard PV-101 | The final location and alignment of tie steel should be checked in the plastic concrete behind the finishing machine. Often a hack saw blade or trowel is inserted into the concrete at centerline to determine the location and depth of centerline tie steel. Once located at centerline, the depth and alignment of the ends of the bar should also be checked to ensure that the bar is not shifted horizontally or vertically out of alignment. Spacing of tie bars can be determined by observing the frequency of insertion on the finishing machine. |
| Check finishing operation | Periodically | | Specification 2301.03, H | The primary purpose for hand finishing behind the finishing machine is to remove small imperfections in the final pavement surface and provide a uniform surface. The surface of the slab should be observed behind the finishing operation to determine if finishing operations are adequate. Occasional "bug holes" are permissible, but should be kept to a minimum. Overfinishing is also undesirable as it can affect pavement smoothness and potentially cause a loss of entrained air at the surface. A balance must be reached between the positive and negative effects of finishing.<br><br>During finishing, free water may not be added to the surface of the pavement. A small amount of water may be added to a burlap drag attached to the back of the finishing machine. A good indicator that too much water is being added to the burlap drag is the presence of bubbles off the trailing end of the burlap. Another indicator that excessive water has been added to the burlap is the collection of excessive amounts of mortar by the floats. When excessive amounts of mortar are collected, this material should be wasted over the edge of the pavement and not finished into the surface. Addition of water to the burlap should be restricted. |
| Check structural rumble strip placement (when required) | Periodically | | Road Standard PV-11 | Check spacing and depth of structural rumble strips in plastic concrete. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check texture placement in plastic concrete | Periodically | Form E140<br>Form E111 | Specification 2301.03, H<br>Construction Manual 9.40 | Microtexture should be placed using artificial turf, coarse carpet, or burlap. Placement of microtexture roughens the pavement surface and provides grip for tires to assist with stopping.<br><br>Macrotexture (tining) can be placed either longitudinally or transversely (longitudinal tining is most common). Macrotexture is placed to provide a break in the pavement surface to allow water to escape from under tires during a rain and reduce the tendency for hydroplaning. When tining is placed transversely, a 4 to 6 inch gap centered around each transverse joint is to be left untined. Longitudinal tining should be straight and as parallel to centerline as possible. The depth of tining should be kept at or slightly less than the specified 1/8" target to minimize noise created by tires interacting with the pavement surface. When tining is placed longitudinally, a 2 to 3 inch gap centered around each longitudinal joint is to be left untined. Some contractors have attempted to leave a single tine in the center of the gapped area as a marker for their sawing operation. This practice should not be allowed due to concerns about alignment of the centerline sawcut and raveling. |
| Check cure brand and lot number | Periodically | | | White pigment cure is typically delivered to a project in reusable totes. The totes should periodically be inspected to ensure that the proper brand and lot number of the cure are identified on the tote. The lot number should also be cross checked with the list of approved lots of cure found on the Office of Materials web site. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
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| Check cure placement | Periodically for uniformity of coverage<br>Daily for yield | Form E111 | Specification 2301.03, K | The specifications require cure placement within 30 minutes after finishing. Timing of cure placement should be observed throughout each day to ensure that this requirement is being met. The specification also allows an extension of the 30 minute requirement when weather and/or mix properties require an extended period before curing. This is allowed to ensure tining can be placed at the proper depth. If a mix is still too plastic within the 30 minutes after finishing, it is not desirable to proceed with tining and curing if the tining depth will be too deep.<br><br>Cure placement should be checked to ensure uniformity of application. Streaks should be minimal and areas of visible gray should be recured. Yield checks should be performed daily based upon total cure applied throughout the days run and the total square yardage of pavement cured including the sides of the pavement. If forms are used to support the edge of pavement, the pavement edge should be cured by hand if the forms are removed prior to the pavement reaching opening strength. |
| Place station markers in plastic concrete | Each station | | | Station markers should be placed in the outside two feet of the mainline pavement and in a position where they will not be removed or destroyed by possible milled shoulder rumble strip placement. If a station marker happens to fall on a transverse joint location, shift the marker to avoid falling on the joint. Place station markers facing outward so they can be read from the shoulder. |
| Check cold weather protection | When used | Form E137<br>Form E111 | Specification 2301.03, K<br>Specification 2301.05, J | Monitor forecast temperature conditions to determine if cold weather protection will be necessary during curing. Table 2301.03-1 identifies the required covering necessary based on forecast low temperatures. The table also includes conditions under which the cold weather protection may be removed. Quantities of cold weather protection must be tracked and recorded since payment is made to the contractor for providing it (see 2301.05, J). |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Cast concrete beams to determine pavement opening strength | Two per day when maturity is not used to determine opening strength | Form E114 | Specification 2301.03, U<br>IM 328<br>IM 316 | On projects in which the contractor chooses not to use maturity to determine pavement opening strength, opening strength is determined based upon a combination of time and flexural strength. Two beams are cast daily. Beams should be cured similarly to the pavement and stored on site overnight. The following day the beams can be moved to plant inspectors lab for further curing until broken. Care should be taken in handling the beams to avoid detrimental cracking that may cause low strength results. |
| Cast concrete beams for pavement design purposes | One set of two beams every 10,000 CY | N/A Beams tested in Central Materials | IM 328<br>QM-C Developmental Specification | On QM-C projects, inspectors should cast one set of two beams every 10,000 CY. These beams are to be delivered to Central Materials to be tested for 28 day flexural strength. Information obtained from testing of these beams is used to assist in future pavement designs. |
| Monitor maturity probe placement on projects where maturity is used to determine pavement opening strength | Daily | Form E141<br>Form M142 | Specification 2301.03, U<br>IM 383 | On projects in which the contractor chooses to use maturity to determine opening strength, the contractor is responsible for placement of the maturity probes and taking temperature readings. However, probe placement should be observed to ensure the temperature readings accurately reflect the temperature of the pavement. For instance, if portions of the pavement are in shaded areas, additional probes should be placed there as that pavement will gain temperature and strength more slowly than the unshaded areas. Maturity probe locations should be recorded on Form E141. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| **After Concrete Placement** | | | | |
| Report water added on grade to plant inspector | Daily/each placement | Form 830212 | IM 527 | The plant inspector is required to report average water/cement ratio for each placement on the project plant report. When using ready mix concrete, this requires water added on the grade to be tracked and reported back to the plant inspector. Water added on grade should be reported to the plant inspector on a daily basis to allow timely completion of the plant report. |
| Check milled rumble strip placement | | N/A | Road Standard PV-12 and PV-13 | Milled rumble strips may be placed on the shoulder or centerline of the roadway. They are placed in the hardened concrete after opening strength is achieved. Rumble strip placement should be checked to ensure proper spacing, depth, and location requirements are being met. |
| Check saw cuts | Daily | Joint Check Worksheet | Specification 2301.03, N<br>Road Standard PV-101<br>K and L sheets in project plans<br>Construction Manual 9.20 | Saw cuts should be checked daily to ensure proper depth, width, layout, straightness, and spacing. It is important to keep in mind that even though the joint layout may be correct during placement, the saw crew may not saw joints at the correct locations. Occasionally saw cutting errors are made in irregular areas due to lack of adequate marking of the joint layout in the plastic concrete. This may result in the saw operator not knowing where and/or what type of joints to saw. Saw cuts should also be checked to make sure the saw operator is pulling up the blade before reaching the edge of pavement as shown on the PV-101 standard. This is important for early entry sawing as the backward rotation of the saw blade can "blow out" the edge of the pavement if the saw cut is not stopped short of the pavement edge. |
| Check joint filling | Daily | Joint Check Worksheet | Specification 2301.03, P<br>Road Standard PV-101<br>Construction Manual 9.20 | Joints should be checked to ensure that they are properly cleaned before filling, and joint filler should be placed to the proper level. Unless otherwise approved, joint filling should only be performed when pavement and ambient air temperatures are above 40 degrees F. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
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| Check texture placement in hardened concrete | Daily | Form E140 | Specification 2301.03, H<br>Construction Manual 9.40 | In addition to the checks made in plastic concrete, macrotexture should also be checked in the hardened concrete. The depth of the tining should be checked to ensure that it falls within the specification requirements. The procedure outlined in Construction Manual 9.43 should be followed to determine compliance with tining depth requirements. |
| Review initial contractor smoothness information | Daily until 3 consecutive days of 100% pay or better | N/A | Specification 2317<br>Specification 2316<br>IM 341 | The contractor is required to submit smoothness information daily until they have paved for three consecutive days resulting in 100% payment or better. There are several reasons for this requirement. First is to identify if there are equipment or process issues causing placement problems in the paving operation. It is not desirable to allow the contractor to continue paving if acceptable smoothness levels are not being achieved. This requirement also may identify problems in the contractor's smoothness evaluation. It also gives inspection staff the opportunity to review the contractor's profilograph settings to make sure they are correct. |
| Review final contractor smoothness information | After submittal of final profilograph reports and traces | N/A | Specification 2317<br>Specification 2316<br>IM 341 | The contractor is required to submit all final profilograph reports and traces to the Engineer within 14 days after completion of paving. After receipt of all final reports and traces, the information should be reviewed to ensure that all sections of pavement have been evaluated. In addition, the smoothness information should be evaluated to determine if the incentive or disincentive requested by the contractor is accurate. |
| Determine time for opening pavement for use | Daily/as needed | Form E114 | Specification 2301.03, U<br>Form E141 | The contractor is responsible for curing and breaking beams to determine time of opening. The contractor is also responsible for placing probes, taking temperature readings, and calculating TTF when maturity is used. However, the Engineer is responsible to determine if a section of pavement may be opened to traffic. For this reason, beam break and maturity information should be obtained from the contractor and reviewed prior to opening pavement to traffic. Maturity information should be recorded on Form E141. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| Check longitudinal tie steel placement in hardened concrete | Spot check in each day's run | Form E111 | Specification 2301.03, E<br>Road Standard PV-101<br>Construction Manual 9.26 and 9.27 | Check tie steel in hardened concrete to ensure proper alignment and that the correct number of bars are included in each panel (see Construction Manual 9.27). This check is important to determine that the bars are centered across the joint, level, and perpendicular to centerline. Tie steel checks in hardened concrete are typically made using a survey pin finder. |
| Determine pavement thickness | Once per project | | Specification 2301.04 and 2301.05<br>IM 346 and 347 | There are several steps to take In evaluating pavement thickness. First, random core locations for each section of pavement, as defined by IM 346, should be obtained from District Materials. Then the core locations should be marked on the pavement. Taking of the cores must be witnessed by inspection staff and inspectors must take immediate possession of the cores after removal from the pavement by the contractor. Cores should then be measured according to IM 347 and a thickness index determined for each section of pavement. After measurement, the cores should be delivered to District Materials for assurance testing. |

# PCC Paving Field Inspection Checklist

| Duty | Frequency | Record Checks | Specification/Resource | Commentary |
|---|---|---|---|---|
| **General** | | | | |
| Check traffic control | When travelling on the project | | | Even though traffic control checks are a responsibility of the contractor, if problems or deficiencies are observed, inform the contractor when the observations are made so that corrections can be made in a timely manner. |
| Check contractor's traffic control daily diary | As needed | N/A | Specification 2528.1, C | The contractor is required to check traffic control and record significant information. It is a good practice to review the contractor's diary occasionally to ensure that documentation is being recorded as required. For instance, after noting damaged signing or deficiencies in the traffic control devices or setup, review the daily diary to ensure the deficiencies and the remedies are recorded. |
| Monitor the project for fugitive dust | Daily | N/A | Specification 1107.07, E | The contractor is responsible for controlling fugitive dust on the project. When dust is being generated and leaving the project site, the contractor should be reminded of their responsibility to control dust and a request should be made to take measures to do so. In urban areas, it is even more critical that dust be controlled as property owners will be more sensitive to dust generated by the project. |
| Monitor contractor haul roads | Daily | N/A | Construction Manual 2.12 | The contractor is required to submit a request for haul road designation for roads used to haul materials for the project. Once designated as a haul route, the contractor is expected to use the haul route for the designated purpose. The contractor's operations should be observed daily to ensure that haul traffic is using the appropriate, approved haul routes. |
| Issue noncompliance notices | When noncompliance occurs | Form 830245 | | The owner is obligated to notify the contractor in writing when noncompliance occurs. This is done using Form 830245. Noncompliance notices should be issued as quickly as practical after observation of the noncompliance to give the contractor ample time to take corrective action. The noncompliance notice also provides a written record of notification being provided to the contractor. |