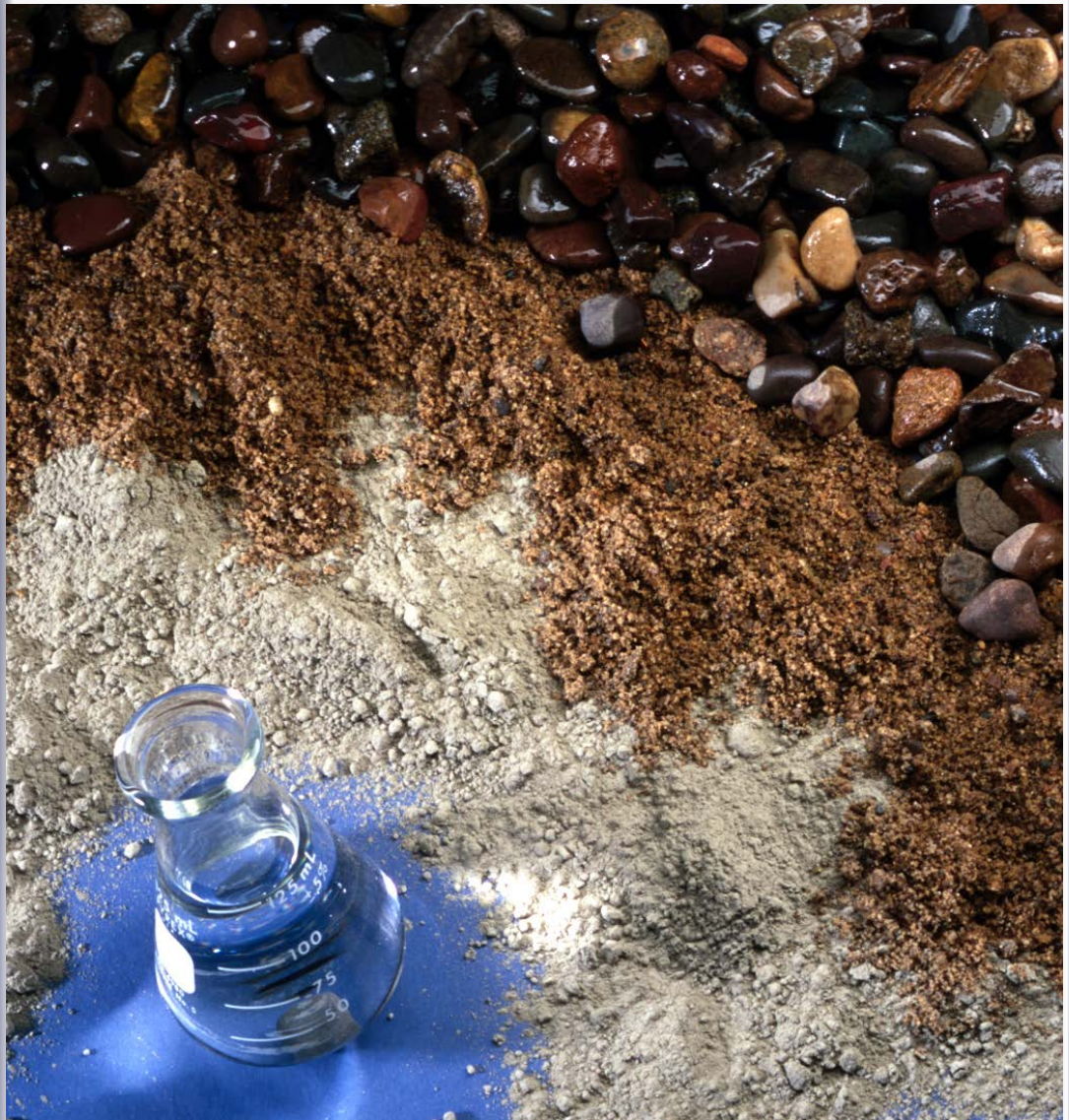
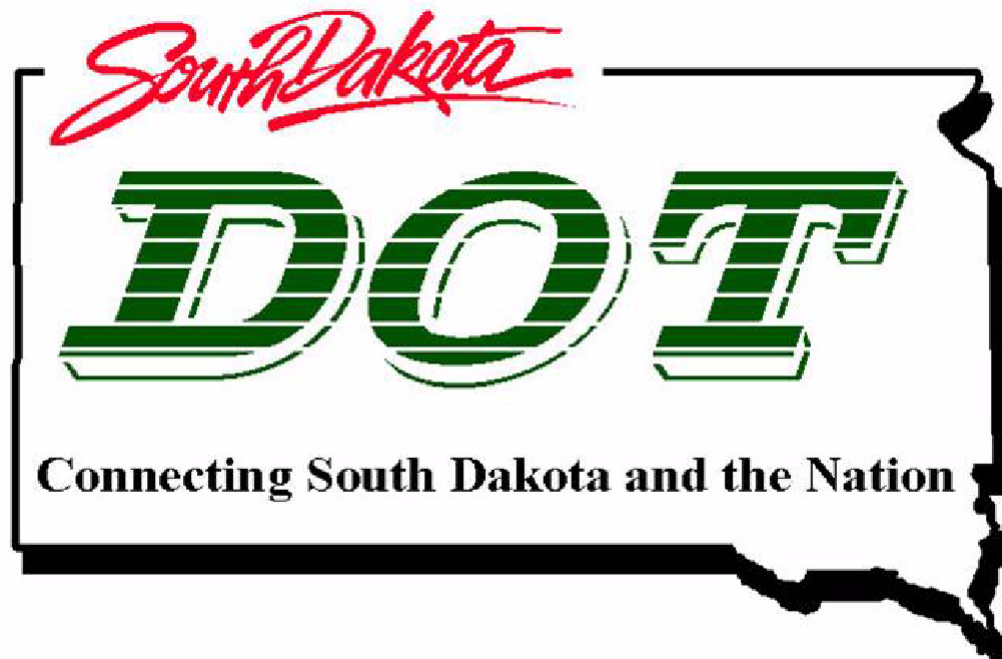


**FY2020**

# **CONCRETE PLANTS**





DEPARTMENT OF TRANSPORTATION

## CONCRETE PLANTS

PREPARED BY THE DOT STATE-WIDE LABORATORY ACCREDITATION TRAINING GROUP  
AND THE BUREAU OF PERSONNEL

**2020**

# Disclaimer

The information in this training manual is intended for training purposes only and does not take precedence over the SDDOT Standard Specifications for Roads and Bridges, the SDDOT Materials Manual, or any SDDOT Policies and Procedures.

## **Additional Information:**

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Forms found at:

M:\DOT\Common\All DOT Forms

Approved Products website

address: From SDDOT Internet

Homepage

Home>Doing Business>Certification & Accreditation>Approved Products

Class A45 Mix Designs:

U:\ms\Materials- SDDOT Access\ConcMixDesigns\ContractorMixDesign.xlsx

28.35 grams/ounce

Density of water = 8.34 lbs/gal.

Density of water = 62.43 lbs/cu

ft

(These numbers may vary when dealing with asphalt testing)

Replace cement with equal Fly Ash 1:1

Minimum to replace - 15%, Maximum to replace - 25%

Rule of thumb for splitting

samples: Coarse aggregates

within 500 grams Fine aggregates

within 30 grams

1 bag of cement = 94

lbs 1 cwt = 100 lbs

Extra bag of cement - add 4 gallons of water

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# YOUR JOB

## The Concrete Inspector

**A** good inspector is conscientious in obtaining a quality job.

**Know** the specifications thoroughly, including the reason for each requirement. Only if you know the reason for each specification requirement, will you be able to use good judgement.

**You did not** write the specification. The man who did may have had good reasons for inserting provisions which you do not think necessary or advisable. Discuss these provisions privately with your superior if you wish. But, until he has approved a change, see that the written specifications are followed.

**Be consistent** in your inspection. Insist upon specification results from start to finish. Leave nothing to chance. An erroneous method is more easily corrected the first time it is practiced than after it becomes a habit. A reputation of being slack is quickly attained but difficult to overcome. A reputation of being severe and unreasonable breeds contempt for an inspector's instructions.

**Your job** is a full-time man-sized job. The first and last work of the day are the most likely of all to be defective and to require your complete attention. Be there when work starts in the morning and when it ends in the evening. Let nothing occur during the day without your full knowledge.

**Instructions and suggestions** should be given to foremen, superintendent, or the contractor only. However, such minor items

needing corrections as form alignment, local high subgrade, etc., may be called to the attention of the particular workmen responsible.

**Don't Argue!** Base your decisions on judgement that reflects coolness, fairness, impartiality, and a thorough knowledge of the work at hand. If a decision is questioned, don't let that weaken your conviction, but signify your willingness to refer to your superiors for further interpretation.

**Be friendly** with everyone on the job: Be familiar with no one. Familiarity dulls the edge of an inspector's authority. Do not waste workman's time by carrying on conversations with them.

**Aid the Contractor** at every opportunity so long as the specifications are not violated, or the quality of the work impaired.

**Be courteous** to visitors. Future paving depends upon a public good will. Do not prejudice the public against road improvements by flippant answers to what may seem foolish questions.

**Do not** try to magnify your own importance by telling outsiders of the errors you have corrected. The quality of the completed pavement will measure your ability and will be your strongest testimonial.

16 February 1999  
SD ACPA Annual Concrete Pavement  
Workshop Sioux Falls, SD

## INTRODUCTION

### The Role of the Concrete Plant Inspector

A concrete plant inspector is a person whose occupation requires training in the technique of making concrete. Architects, engineers, and contractors are involved in the application of scientific principles to practical ends such as the planning, design, construction, and operation of efficient and economical concrete structures and pavements. The plant inspector assists these people by controlling the manufacture of concrete to meet their needs. A definition of a concrete plant inspector could be "a person who has demonstrated a fundamental knowledge of concrete materials, proportioning and adjustment of concrete mixtures and performance and interpretation of field tests for purposes of quality control." A person can be proud to have earned the title "Concrete Plant Inspector."

### Communications and Attitude

Communication is one of the most important aspects of an inspector's job. Communication is essential to ensure that the project is properly managed. The inspector helps the contractor anticipate problems and helps find ways to resolve them. The inspector is friendly but firm and impartial in making decisions when dealing with the Contractor and his/her personnel.

One of the most important steps in establishing communications is the preconstruction meeting. These meetings are held before the beginning of any major construction project. At the meeting, the inspector becomes acquainted with the contractor's key personnel. Attendees will discuss the plans and specifications for the project, traffic control techniques, and define lines of authority.

The inspector is proactive by understanding the project from the contractor's point of view. The inspector does not permit reduced quality in order to increase the contractor's productivity. An inspector influences the construction process to obtain the best possible results. He/ she cannot watch any particular situation passively. If an inspector has a suggestion for changing a procedure to improve the quality and efficiency of the work, he/she does not hesitate. This benefits both the Department and the Contractor.

The inspector's attitude is especially important. Offer assistance while being careful not to supervise construction. Inspectors must avoid giving the impression that they control the work. An inspector should never issue a direct order to the Contractor's workers. The inspector must never assume supervision of the work. Their task is to judge the quality of work that is performed by methods that meet specifications. Failure to do this can cause legal problems later.

## **Qualifications of the Inspector**

An inspector's qualifications are expected to exceed those of the concrete plant worker. The inspector must be honest and conduct him/herself in a fair, straightforward manner. When under stress, the inspector must still be able to maintain personal composure and make good decisions. He/she must have keen common sense for making competent decisions. The inspector must be frank and sincere in relationships with people and be a skilled diplomat able to handle tough situations without arousing hostility. Above all, he/she must be observant and be capable of keeping neat, concise and accurate records.

Technical study and/or construction experience is necessary to perform well as an inspector. The inspector must be able to perform accurate mathematical calculations. It is essential that he/she knows how to read and understand plans, specifications, and other contract documents. The inspector should understand the basic engineering principles of roadway design and should be familiar with the characteristics of construction materials. He or she needs to know the principles of material testing as well as how to interpret the test results.

A concrete plant inspector must have a thorough working knowledge of concrete plants, but also have a broad general knowledge of concrete materials, concrete production and construction procedures. Practical experiences with concrete mix productions, roadway construction and concrete laboratory testing is a valuable asset.

If all the qualifications of an inspector could be reduced to four, they would be:

1) knowledge, 2) common sense, 3) observational skills, and 4) courtesy.

**Knowledge** - The inspector should be familiar with the materials, equipment and concrete pavement and structure construction procedures. The more knowledgeable the inspector, the better prepared he/she is to perform his/her duties. The inspector should be familiar with the technical aspects of construction, equipment operation and policy. The inspector should make frequent use of this and other manuals to ensure accurate tests and checks.

**Common Sense** - While common sense is no substitute of knowledge, it is the means by which an inspector can interpret specifications to enforce their intent. Common sense grows out of knowledge and cannot be learned from a book.

**Observational Skills** - It is important for an inspector to look carefully at everything going on around the site. "Seeing," means thinking carefully about what the eyes observe. Then corrections, documentation, and testing are more accurate.

**Courtesy** - A major part of the inspector's job is to inform the contractor when conditions are unsatisfactory or when the specifications are not being met. The inspector is encouraged to provide suggestions to improve operations. Yet the inspector's manner of presenting the comments can cause a poor relationship. Experience shows that it is not what is said as much as the way it is said that is important. Gruff, bossy, and sarcastic comments are unacceptable from any inspector, even if given in answer to a contractor's aggravating remarks. Be friendly, courteous and positive.

## **Sampling and Testing**

Sampling and testing are methods of evaluating the quality of the work. The inspector must know which sampling to do at the plant. The inspector must also know how to correctly sample and where the procedures can be verified. The inspector must make sure that every sample is identified with the proper information. The inspector must be equally as confident and knowledgeable about prescribed testing procedures and documentation of tests. Follow the Materials Manual guidance.

## **Typical Plant Site Duties**

- Sampling cement or fly ash
- Sampling and testing aggregates
- Verifying batch weights of mix
- Verify correct mechanical operation of the plant
- Storing and testing hardened concrete specimens
- Testing samples
- Keeping records
- Conducting oneself in a safe manner

## **Records**

One of the most important functions of the inspector is to keep accurate records and document thoroughly. Records and reports are necessary to determine that contract requirements have been met so that payments can be made to the contractor. Records and reports should be kept current and submitted on schedule. They should be neat, complete and legible.

The inspector is given standard forms for routine reporting. The forms may require daily, weekly or monthly entries. Report forms include such items as date, location of the work, weather conditions, test results, equipment being used, idle equipment, source of materials, production rates and so forth.

In addition to the standard forms, the inspector should keep a written or electronic diary of activities at the plant site. It should contain such information as weather conditions, important conversations, visitors on the site, verbal orders received, unusual incidents, equipment breakdowns, length of work stoppages, number of persons and types of equipment affected by work stoppages, and any changes in the appearance of the materials. Any item of significance should be recorded.

The importance of entries listed in the inspector's diary cannot be overemphasized. The information is a reference that can be used to perform similar future work or in case of legal action. More importantly, it can give clues for investigators in case the job fails.

Records and reports are used to determine quantities of materials for payment. They ensure that the contractor is paid fairly. The basis for calculation of material quantities, such as field measurements, should be indicated on the inspector's report. The quantity records must be complete and accurate. The quantities of materials wasted or rejected should be identified so those totals can be checked by audit.

## **Plant Inspector Equipment and Materials**

The Plant Inspector, in addition to what is available from the field lab, needs these few items:

- Stop Watch
- Specifications Book referenced in the project plans
- Mix Design Sheet for the project
- Set of Plans for the project
- A Materials Manual
- Lined tablet and pencils

- Project Diary or electronic data recorder
- Concrete Plants Manual
- Hand held calculator
- Measuring device
- DOT Forms (1, 2, 3, 4, 13, 14, 25, 35, 57, 68, 98A, and 293)

## **Summary**

The role of the inspector is to see that the plans and specifications are followed. This requires that the inspector be honest, sincere, knowledgeable and courteous. It also requires that he/she develop the skill of observation and use common sense. In addition, the inspector must be able to keep neat, concise, accurate work records.

The inspector's responsibility is to inform the contractor any situation in which the plans and specifications are not being followed. The inspector does have the authority to reject or not recommend payment for any work that does not meet job requirements. The inspector does not have the authority to supervise the contractor's workers or to give orders.

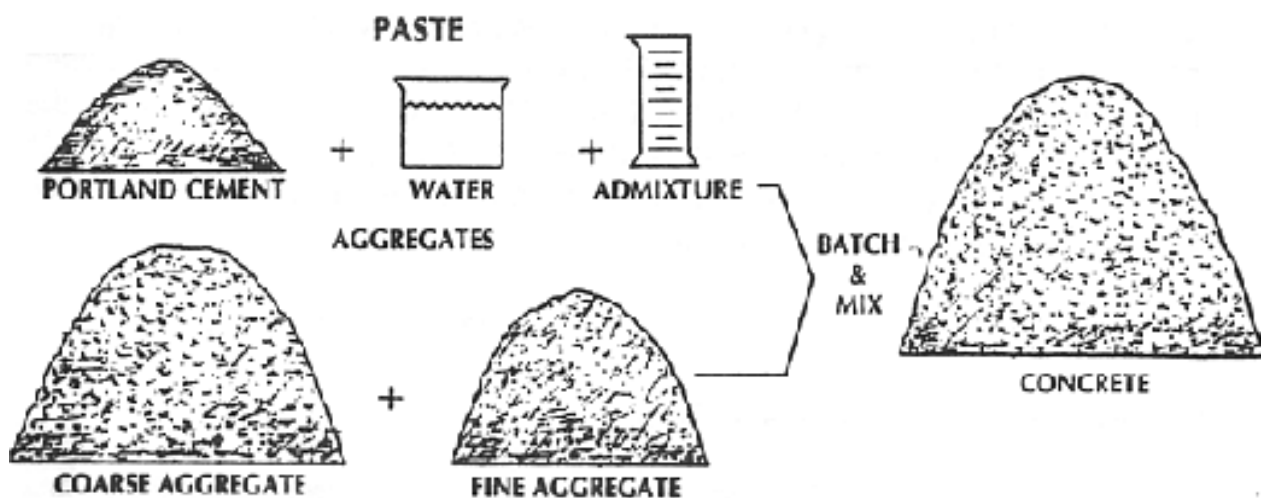
To maintain good working conditions the inspector must have a relationship with the contractor in which both parties understand and respect each other's viewpoints.

To do a professional job, the inspector must want to do a good job, know how to do it, and then go about it in a professional manner.

## CONCRETE BASICS AND MATERIAL STORAGE AND HANDLING

### Components of Concrete

Figure 2.1 Concrete Components



Mixing cement, water, and aggregate (Figure 2.1) make Portland Cement Concrete. By weight, most concrete is made up of about 15% cement, 7% water, and 78% aggregate. The cement and water form a “glue like” paste. The paste must be spread evenly over every piece of aggregate. Through a chemical reaction called “hydration,” the paste hardens and binds the aggregates. By adding a small amount of air, strong and durable concrete is produced. In many cases, practices resulting in production and placement of high-quality concrete can be performed as economically as those resulting in poor concrete. A basic requirement in all concrete handling is that both quality and uniformity of the concrete, in terms of water- cement ratio, slump, air content and homogeneity, must be preserved.

### Cement

Cement holds the aggregates together (**750**). It also determines the strength of the concrete. A simple recipe for Portland cement could be as follows: take one cup of crushed limestone; add one- half cup of clay or pulverized shale; add a pinch of sandstone or iron ore; mix thoroughly and grind up fine. Then run the material through a rotating kiln at a temperature from 2600°F to

3000°F until the raw materials change into clinkers; cool the clinkers; add one tablespoon of gypsum and grind very fine into Portland cement.

An important principle to remember about the cement-making process is the dehydration (drying out) of the materials by using intense heat. When the cement is later mixed with water, the process reverses to hydration (combining with water) and the cement-water paste will become hard as rock.

On a 70°F day, the first phase of the hydrating process (called the initial set) will occur in one or more hours. If the temperature is more than 70°F the hydration will occur at a faster rate, and if the temperature is lower than 70°F it will occur at a slower rate. Department specifications call for a uniform rate of concrete delivery.

Different types of cement can be produced for various uses:

- Type I is a general-purpose cement.
- Type II cement is a Portland Cement that is used when moderate sulfate resistance or moderate heat of hydration is desired.
- Type III is a “high early strength” cement used when rapid strength is needed. About the same strength is achieved in 7 days as in 28 days with Type I cement.
- Type IV is a slower setting cement and is used for low heat during hydration.
- Type V is a high sulfate resistant cement.

**NOTE:** Cement producers are furnishing Type I-II cement that may be used for either Type I or Type II cement.

Always check the PLANS and SPECIFICATIONS for each project for the correct cement type.

Either “hundred weight” or “bags” can refer to the quantity of cement. Hundred weight is written using its abbreviation, “cwt.,” and stands for a quantity of 100 pounds. By using hundred weight instead of pounds, the numbers that are recorded are smaller.

When the contractor needs only a small quantity of cement, it is more convenient for him to have the cement delivered in bags. Each bag of cement weighs 94 pounds.

## **Water - 790**

The contractor can obtain water for mixing from various sources only one of which should be used:

- Stock dam or lake
- Stream or river
- City water system or well

If water is obtained from other than a city water system or a well, make sure that the inlet end of the pumping system is held up from the bottom of the water source so that there will be no mud or debris sucked up. The water may include the discharge from a sewage or industrial plant, so long as it meets all quality requirements. Send a water sample to the Central Testing Lab for a complete analysis.

The water used in making concrete should be free of oil, acid, injurious alkali, sugar, vegetable matter, effluent from a sewage disposal plant, and other substances detrimental to the finished product. The Central Office of Materials and Surfacing run a pH test to find out if the water can be used for concrete. They also test the water for dissolved and suspended solid material to see if these solids would be harmful to the concrete.

## Aggregates

Aggregates occupy most of the space in concrete. Aggregates can come from a wide range of material but are usually confined to:

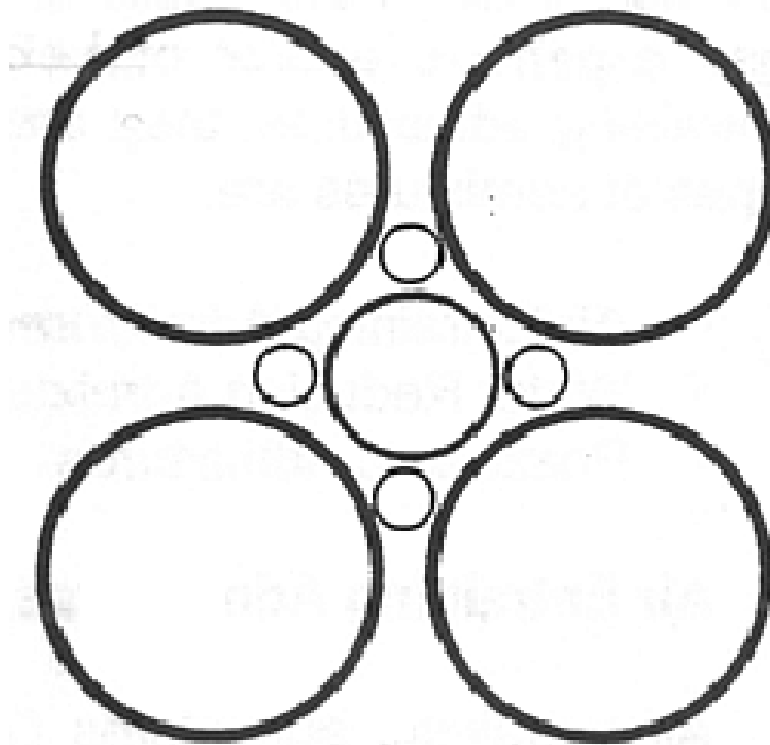
- Natural Sand
- Crushed Gravel - only used in M6 concrete
- Crushed Rock or Quarry Stone
- Expanded Shale (lightweight aggregate)

These aggregates fall into two size classes - Fine (**800**) and Coarse (**820**). The Fine Aggregate (commonly called sand) is material less than 3/8 inch in size. The Coarse Aggregate (commonly called rock) is the material larger than Number 4 sieve.

### **Aggregate Grading**

To end up with as much aggregate in a concrete mix as possible, it is necessary to separate the pieces of rock into different sizes and blend them back together. This is called grading and is usually expressed in terms of percentages larger or smaller than each of a series of sieves. It is best for these pieces of rock to be cubical or rounded.

**Figure 2.2** Aggregate Spacing and Voids



Aggregates are divided into two general sizes--coarse and fine. Aggregate with 95-100% of the material larger than a Number 4 sieve is considered to be coarse aggregate, and when 95-100% of the material is finer than a Number 4 sieve it is called fine aggregate or sand.

The aggregate or rock portion of concrete is the least expensive, so it is important to use as much of it as practical. To do this, both the coarse and fine pieces are graded into a number of different sizes (Figure 2.2) in order to occupy the most space in the concrete as is shown by the illustration.

The illustration demonstrates that if four 1-inch balls are put together, there will be enough space left in the middle for a ball about 1/2 inch in diameter. Between the 1/2-inch ball and the 1-inch balls some 1/8-inch balls could be placed and so on. If each ball is coated with a thin film of past (cement, water and air) and there is some extra paste to fill the tiny voids left, we would have concrete containing a maximum amount of aggregate and a minimum amount of paste. This concrete would cost the least.

It is obvious that we cannot expect a perfect grading, but it is a goal to strive for. Aggregate specifications should have grading limits with ranges wide enough to make it practical for an aggregate producer to screen and blend natural or manufactured aggregates on a mass-production basis and still give us good performance. The information below is from **Section 820** in the Standard Specifications.

Sieve Size	Percent Passing	
	(Size 1)	(Size 15)
1.5"	100%	-
1"	95-100%	95-100%
3/4"	-	70-90%
1/2"	25-60%	-
3/8"	-	27-53%
No. 4	0-10%	2-20%
No. 8	0-5%	0-6%

## **Admixtures**

Admixtures are added to the concrete mix to improve one or more characteristics of the plastic or hardened concrete. They help make the concrete less expensive and/or of better quality. However, with the exception of air entraining admixtures they are not used for all applications. The most common types of admixtures are:

- Air Entraining Admixtures
- Water Reducing Admixtures
- Pozzolanic Admixtures

They all must be sampled and tested in accordance with the Materials Manual. If you suspect that an admixture has frozen, consult the manufacturer's recommendations for acceptability. Check all the containers of liquid types for the manufacture date. If any of the dates are from the previous construction season, check the material to ensure it has not exceeded its shelf life. Sample the material even though it may be on the approved product list. The test results will show if the admixture still has its full strength. If the shelf life of the admixture is past, reject the material.

### **Air Entraining Admixtures**

Air entraining admixtures **(751)** are used to deliberately produce very small, uniformly spaced bubbles in the concrete mix. The use of air entrainment results in greater workability in the plastic concrete and in more resistance of the hardened concrete to cycles of freezing and thawing.

All concrete requires the use of an air-entraining agent to protect the concrete from freeze thaw deterioration. Moisture from rain, thawing snow, etc. can soak into concrete. As the moisture

freezes, it expands. Without the entrained air, freezing could cause cracking. The tiny air bubbles of air entrainment allow the frozen water to expand without exerting a cracking force.

The efficiency of the admixtures used to entrain air is affected by many factors:

**Concentration of the air entraining admixture.** Air entraining admixtures are generally available in several different concentrations. A concentrated air-entraining admixture has more active ingredients. In order to comply with Department specifications and properly control the amount of entrained air in the concrete; adjust the dosage of the air- entraining admixture accordingly.

**The presence of other admixtures.** Other admixtures can affect the efficiency of the air-entraining admixture. Some admixtures will entrain additional air or reduce the amount of air ordinarily entrained.

**Time and speed of mixing.** The efficiency of the air entraining admixture and its ability to produce bubbles of the proper size depends on the speed of the mixer and the length of the mixing cycle. Not enough air will be entrained if the mixing speed is too slow or the mixing time is not long enough.

**Water content of the concrete mix.** More water in a mix will assist the air-entraining admixture. Less water will inhibit air entrainment. Since water also affects the consistency of the mix, a more plastic consistency will generally entrain more air. However, other kinds of admixtures can significantly affect the mix consistency without changing the total water content.

**Aggregates.** The particle shape and gradation of the aggregates affects efficiency. Increases in the amounts of middle sized sands (Number 30-Number 50 sieve) increase air content. Decreases in the amounts decrease air content. Changes in the shape of the aggregate from round to angular increases the effectiveness of an air-entraining agent.

**Temperature.** More air-entraining admixture is needed for warmer temperatures. Under cool conditions concrete will entrain air more readily unless hot water is used for the mixing water.

**Cement content and fines.** Very fine material reduces the efficiency of air entraining admixtures. Conversely, the less fines in the mix, the more efficient the air entraining admixture. Fines make the paste firmer and less capable of entraining air readily. To overcome this effect, use more air-entraining admixture.

## **Other Chemical Admixtures - Section 752**

Other concrete admixtures are used that effect the setting characteristics of the concrete. The following are the various types available:

- Type A: Water reducing admixture- an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency.
- Type B: Retarding admixture - an admixture that retards the setting of concrete.
- Type C: Accelerating admixture - an admixture that accelerates the setting and early strength development of concrete.
- Type D: Water reducing and retarding admixture - an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and retards the setting of concrete.
- Type E: Water reducing and accelerating admixture - an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and accelerates the setting and early strength development of concrete.
- Type F: Water reducing admixture, high range - an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater.

- Type G: Water reducing, high range, and retarding admixture -- an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater and retards the setting of concrete.

Generally, by reducing water, the concrete becomes more durable. The Type A admixtures are more commonly used in structural, paving, and drilled shaft concrete construction. The Type F admixture is used in precast and prestressed concrete industry. The Type F can experience rapid slump loss.

Use of admixtures shall be as recommended by the manufacturer. Dosage rates should be utilized within the manufacturer's recommendations to achieve the best performance level. Manufacturer's Product Information sheets shall be furnished with the admixture.

Chloride is NOT allowed as an admixture. NEVER use chloride as an accelerator and do NOT allow chloride-based material admixtures.

Contractors can use chemical admixtures (water reducers, set retarders, etc.) with approval of the Concrete Engineer and/or the Bridge Construction Engineer prior to use. The approval process will be part of the contractor mix design submittal.

Static electricity causes cement particles in fresh concrete to form small clumps. This clumping prevents cementing action between the aggregates. Water reducing admixtures are chemicals that can minimize these electric charges and disperse cement particles more evenly.

Disbursement improves the efficiency of the cement. Cement particles no longer clump but become free to react and bond the aggregates. The water held in the clump is also released into the mix.

This released water then acts as a lubricant, making the mix more workable. Water reducing admixtures can be used in three ways:

1. Use them in a concrete mix at a fixed water and cement content. This makes the concrete easier to place. It is useful where paving must be done by hand.
2. They are sometimes used to improve the efficiency of the cement. This makes it possible to meet and maintain a specified strength with less cement. This application will depend upon the current costs of cement and admixture. Used in sufficient quantities, water reducing admixtures may be used to provide some retardation and control heat generated as the cement and water react. However, some DOT specifications do not permit admixtures to be used in this way.
3. Water reducing admixtures are sometimes used to reduce the total water content, without decreasing the workability. This method is used to obtain as much strength as possible from a given cement content.

A close look at the way admixtures are used in the applications discussed in subparagraphs 2 and 3 above, will show that in both cases the cement is being made more efficient. In one case this is done for economy and in the other for maximum strength.

Water reducing admixtures will also control other properties of the concrete, particularly time of set. Water reducers are available in formulations that can accelerate or retard the setting. Water reducing accelerators are used primarily for patching or paving in cool weather. The water reducing retarders are occasionally used in hot weather to delay the setting of the concrete.

Water reducing admixtures, like air entraining admixtures, work in combination with the cement. For this reason, manufacturers give water reducer dosages in terms of fluid ounce per cwt. (100 lbs.) of cement.

## Pozzolan Admixtures - Section 753

The most commonly used pozzolan for concrete construction is fly ash. Fly ash is a waste product resulting from the burning of powdered coal in steam driven electric generating plants. Anthracite or bituminous coals will produce Class F ash. SD Modified Class F is the only class of Fly Ash currently allowed. The difference in the chemistry of the classes gives the ashes different levels of "reactivity." Reactivity is the ability of the ash to provide cementing action when combined with water. Class F ashes react very little when mixed only with water.

Fly ash reacts with the calcium hydroxide produced by hydration. For this reason, they are used with cement in concrete construction. Fly ash will not be used when Type III cement is used **(605.3 A)**

When used in a concrete mix, pozzolans are normally added as a replacement for a certain percentage of the cement. Fly ash and other pozzolans are also lower in specific gravity than cement. Typically, they have specific gravity's ranging from 2.27 to 2.75 compared with 3.15 for cement. When Class F fly ash is used, the minimum amount of cement to be replaced is 15% and the maximum amount is 25%. The ratio of substitution of fly ash to cement shall be 1:1, by weight (605.3 C) or remove 1 pound of cement and add 1 pound of fly ash.

Pozzolans help control problems with workability in plastic concrete, particularly when the aggregates are deficient in fine material. The pozzolan provides additional fine material that helps separate the coarse aggregate particles. Fly ash, in particular, is very effective. The round shape of fly ash particles helps the coarse aggregate particles slide over each other. The major ingredient in fly ash is glass (60% to 90%). The glass consists of silica, alumina and some iron oxide. These are ingredients used to make Portland Cement, so it is not surprising that fly ash and cement should be compatible.

The value of fly ash as an admixture in concrete depends on its glass content, its fineness, and lack of combustible material (less than 6% carbon). Its water reducing characteristics are greatest if the majority of the fly ash particles are round.

Fly ash affects the job activities of the inspector. Because fly ash contains carbon and sulfates, concrete requires additional air entraining admixture and takes longer to set.

The concrete made with pozzolans sometimes is stronger than normal concrete but takes longer to develop the strength. Also, the heat generated develops at a much slower rate. These effects are due to the slightly different hydration chemistry. For this reason, the use of pozzolans is frequently discontinued in cooler weather.

The main reason the DOT adds Fly Ash to the concrete pavement mix is to reduce alkali silica reactivity (ASR) potential. Pozzolans, particularly Class F fly ash, can help minimize certain types of aggregate reactions in the concrete. Some aggregates will react with chemicals (alkalis) in the cement. These reactions cause expansion of the aggregates and, eventually, cracking of the concrete. Very fine siliceous particles in the fly ash will react with the alkalis and use them to minimize any damage to the concrete.

**NOTE:** Although excellent results can be obtained using fly ash, the concrete made with it has a history of being more variable. For this reason, the inspector should pay particular attention to his testing responsibilities and notify the project engineer of any problems.

Fly ash sampling requirements (M.S.T.R., Materials Manual) SD 401

## Material Storage and Handling

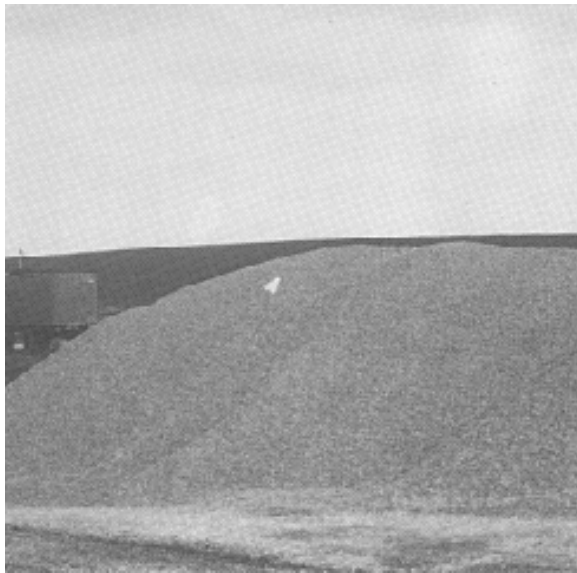
Methods of materials storage and handling depend on the contractor's operations. How the materials are stored and handled has an effect on the finished concrete.

## **Aggregates**

Stockpile locations should be on firm terrain with excellent drainage away from the stockpile(s) and concrete plant location.

Build coarse aggregate stockpiles (Figure 2.3) in layers. If they are built in a cone shape, (Figure 2.4) segregation can occur. As the aggregate rolls down the pile, the coarser material will go to the outside and bottom of the pile. The fine material will sift into the pile or stay near the top. If the contractor builds the stockpile in layers, potential gradation problems while producing concrete may be avoided. The maximum drop of the material from the conveyor shall not exceed 10 feet. **(320.3 C 1)**

**Figure 2.3** Coarse Aggregate Stockpile



**Figure 2.4** Cone Shaped Stockpile



Keep the aggregate stockpiles separate (Figure 2.5) or put a bulkhead (Figure 2.6) between them so that materials cannot mix. Only aggregate from one source goes into a stockpile.

If used, bulkheads must be the full depth of the stock pile and strong enough to stand up under operating conditions. Make sure there are no holes that would allow the material to become mixed.

Also check to see that they are strong enough to withstand material piled against one side. If the material should become mixed, the stockpile is rejected.

**Figure 2.5** Separated Stockpiles



**Figure 2.6** Bulkhead Between Stockpiles



## **Paving Concrete**

Do not use “track type dozers” on a coarse aggregate stockpile (**380.3 D**). The tracks can break down or crush the material. If the contractor is using a track type dozer on the stockpile, recommend he/she change this method and inform the Project Engineer.

The fine, and sometimes the coarse aggregate, is washed to eliminate “fines.” This means that some water will be draining from the stockpiles. Mud may get into the material. Check the stockpiles occasionally for mud. Mud will form little sand-coated balls. If mud is found, inform the contractor and the Project Engineer. Document the situation in the diary. The Project Engineer can reject the pile or require the material to be run over a screen. Check the plan note to see if sand and rock must be screened prior to use. For sand, a screen with openings no larger than one-inch square is used. The best place to do this is at the end of the conveyor where the aggregate dumps into the storage bin.

**Figure 2.7** Aggregate Screen



**Figure 2.8** Aggregate Screen



## **Structural Concrete- Section 460**

Most concrete is produced in a commercial plant. There may be multiple stockpiles, make sure the correct stockpile is being used. This plant may be producing concrete for work other than

Department projects. Aggregates may not meet the specifications for the Department project; therefore, one of two things must be done:

1. The plant owner should put up stockpiles for use on your job only.
2. Sample and test the material before any concrete is mixed.

### **Cement and Fly Ash - Sections 750 & 753**

Most cement and fly ash is delivered in bulk by railroad car or truck transport (Figures 2.9 and 2.10). Both are transferred from the cars or truck to storage silos either by conveyors or by compressed air.

Do not use cement or fly ash spilled during unloading or batching. It might be contaminated with dirt. Moisture causes "lumps." Do not use wet or lumpy cement because moisture causes hydration and low strength concrete will result.

The contractor might use a small portable batch plant on some structure projects. Bagged cement may be used. If bags of cement are used, make sure they are stored in a shed or on a raised platform under a waterproof covering. Bags should not touch shed walls and should be stacked so there are no spaces between bags.

During the middle to end of the summer, it can be common for cement that is hot to the touch to be delivered on the project. This is referred to as "hot cement". This hot cement might make it difficult to maintain fresh concrete temperatures within the maximum allowable. In addition, some of the mix parameters like setting time and water demand may also be affected depending on the severity of the hot cement.

**Figure 2.9** Unloading Cement Carrier



**Figure 2.10** Cement Truck Transport



## 3

## MATERIAL CERTIFICATIONS & SAMPLING TECHNIQUES

With samples being very small compared to the quantity they represent, it is imperative that a representative portion of material is obtained when sampling. A non-representative sample will produce test results that do not characterize the material intended. Cement, fly ash, water, aggregate, and admixtures for concrete projects are sampled and tested for compliance with specifications. For specific sample requirements, refer to the two tabs in the Materials Manual: 1)Required Samples, Tests, & Certificates and 2)Minimum Sample & Test Requirements.

### **Cement Certification**

Bulk cement is delivered by railroad car or truck. The contractor may use bagged cement. If from a non-certified supplier and no certificate of compliance is provided, sample cement before it is used - there are certain specifications cement must meet before using. The suppliers certified test results must be shown on the certificate of compliance proving the cement meets the specification.

#### **Certified Cement Plants**

A Certificate of Compliance is not required from a certified cement plant. Review concrete plants documentation to determine the identity and type of cement, and document it in the field diary.

The list of certified cement plants is on the Approved Product List.

#### **Non-Certified Cement Plants**

The manufacturer must certify that the cement being delivered will meet the specification requirements. This is done with a Certificate of Compliance (Appendix 13). In addition to the certificate of compliance the following information should appear on the bill of lading, invoice, or shipping order:

- County, Project Number, and PCN
- Date the cement was loaded and Cement Type
- Rail Car or truck number and Consignee (Contractor or Subcontractor Name)
- Manufacturer and Seal Number(s)
- Destination - Used for rail shipments to give siding locations

- Net weight of the load
- Signature of manufacturer's representative

Check the Certificate of Compliance to verify the cement matches the mix design information. Do not use the load if the type of cement is missing, or you cannot verify the manufacturer and plant location.

The Certificate of Compliance allows the cement to be used before the test results of the samples are returned. A truck transport driver should bring two copies of the certificate of compliance. For cement deliveries by railroad cars, the supplier normally will send one certificate of compliance and tack another to a board on the side of the railroad car.

A supplier may produce concrete for more than one job. This means that he has more cement than will be used on your job. Certificates are needed for all cement used, so arrange with the supplier to save all the certificates he receives. This may produce more certificates than needed but will cover all the cement that may be used on your project.

## **Fly Ash Certification**

Fly ash is a mineral admixture. Fly ash must be sampled (SD 401) since it is not on the Central Testing Laboratory's current list of approved products. A Certificate of Compliance (Appendix 13) is required for each sample collected.

## **Cement and Fly Ash Sampling Techniques**

Cement and fly ash samples must be collected and sent to the Central Materials Lab for testing to confirm specification compliance. Refer to Materials Manual SD401 for current sampling procedure and frequency. A minimum of one sample each shall be taken for every 10,000 yd<sup>3</sup> of concrete paving.

These requirements are for each type and source of cement and fly ash. If more than one type is used or the material comes from more than one source, apply these requirements to each condition.

The proper way to take a cement or fly ash sample (SD 401- Materials Manual) is to get equal amounts of material from three separate places in a load. How these equal amounts are obtained will depend on how the material is delivered and, in some cases, on how it is unloaded.

Some options for sampling cement and fly ash:

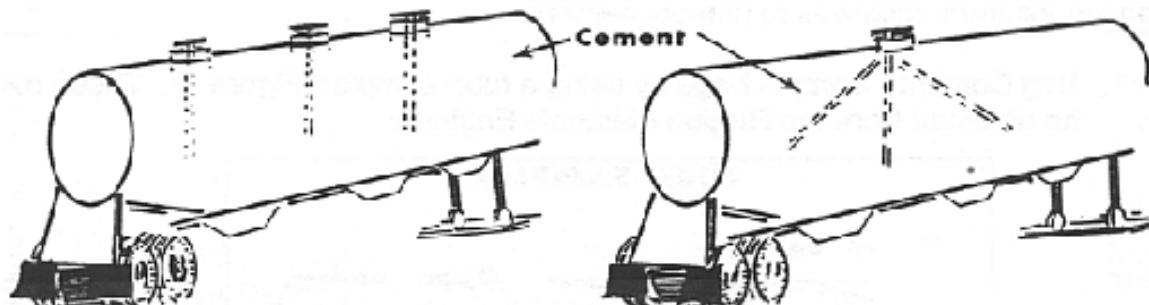
A TUBE SAMPLER (Figure 3.1) may be used to sample packaged (bagged) cement or fly ash. Select a minimum of three bags to attain the sample. Push the tapered end of the sampler into the material. After it is inserted, cover the air hole and remove from the bag. Uncover the side air hole and tap the tube sampler to release the material into a sample container.

**Figure 3.1** Tube Sampler



For bulk cement or fly ash, using a LONG SAMPLING TUBE or PROBE (typically a PVC pipe) and collecting material from at least 3 different locations will result in the most representative sample. To collect the sample, push the probe into the material and cover the end. Pull the probe out, uncover the end, and tap the probe to release the material into a sample container. If the bulk container has 3 or more hatches, get a portion of the sample from the different hatches. If there is only one hatch, sample from at least 3 different directions. (Figure 3.2)

**Figure 3.2** Sampling from Bulk Container



The GRAB METHOD is most commonly used when obtaining a cement or fly ash sample. The sample container is used to obtain the sample by “swiping” through the material multiple times at point(s) of bulk storage discharge or delivery. The grab method may be used in any environment that is safe to obtain the sample.

For all methods of collection, it is imperative to get a representative sample of the cement or fly ash. A cement sample requires 8 lbs (2 full cans) of material. For fly ash, 4 lbs (1 full can) is needed.

The cans (Figure 3.3) used for cement and fly ash samples are metal, about 6 inches high, 6 inches in diameter, and have a friction lid. Get them from the Region Materials Engineer. Use clean cans for samples. If there is any dirt, water, or other contaminants, a true test result will not be obtained.

After the cans are filled, put on the lids and seal them by wrapping a strip of masking tape around the lid. Put the sample number on the outside of the can (R.S.T.C.- Materials Manual). This will identify the sample if the data sheet gets lost. Keep the numbering of the samples consecutive.

When 2 cans are needed for the sample, put the plain number on one can, put a “B” behind it on the second can. Place the project number on the cans to help identify the sample.

**Figure 3.3** Sample Cans



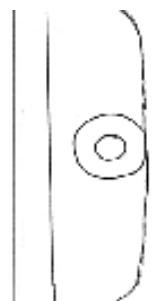
## Sample Data Sheet

Complete a Sample Data Sheet DOT-1 Form (Appendix 13) in accordance with instructions in the R.S.T.C. Section of the Materials Manual to identify the sample in the laboratory. Include the following information:

- Your name, Title, and Office
- Where to send the test results -Name, Title, and Office
- Contractor (subcontractor)
- Project Number
- PCN Number
- County
- Type of Sample
- Field Sample Number
- Date Sampled
- Quantity Represented
- Type of Cement
- Concrete Use (Paving, etc.)
- Producer's Name and Address
- Car or Truck Number
- Remarks

Put the Data Sheet into the sample data envelope (DOT-2 Form). Tape the envelope to one of the cans and tape all the cans for a sample together. Send all samples to the Central Testing Laboratory.

**Figure 3.4** DOT-2



DOT-2 (1984)

SAMPLE DATA

COUNTY \_\_\_\_\_ PROJECT \_\_\_\_\_

APPROXIMATE VOL. FILLING BATHY \_\_\_\_\_ (enter approximate volume in yds<sup>3</sup>) (in cu yds)

SAMPLE OF \_\_\_\_\_ DETERMINED BY \_\_\_\_\_

CITIZEN PRODUCER \_\_\_\_\_

NUMBER OF \_\_\_\_\_ DISTANCE FROM \_\_\_\_\_

FIELD NUMBER \_\_\_\_\_ DATE \_\_\_\_\_ LABORATORY \_\_\_\_\_

DATE MADE \_\_\_\_\_ BREAK DATE \_\_\_\_\_ AGE \_\_\_\_\_

REMARKS: \_\_\_\_\_

## Water Sampling Techniques

The quality of the water used in concrete is important. It can affect the admixtures and the strength of the concrete. Determine the source of water before producing concrete. Get a one-pint sample and send it to the Central Materials Laboratory for testing. Use plastic bottles obtained from the Region Materials Engineer. Send in the sample at least two weeks before using the water. After taking the water sample, fill out a sample data sheet DOT-1 Form (Appendix 13) in accordance with the R.S.T.C. Section in the Materials Manual.

**NOTE:** Testing is not required for water from municipal supplies except in the Belle Fourche Area (contact the Region Materials Engineer regarding this area).

There are three test requirements **(790)** water must meet before it can be used in concrete:

- The pH must be no less than 6.0 and no more than 8.6
- The total solids shall not exceed 50,000 parts per million
- The dissolved solids shall not exceed 2500 parts per million If these requirements are not

met, notify the Project Engineer.

**Important:** Request detailed analysis if you suspect the water contains discharge from a feed lot, heavily fertilized field, a sewage, or industrial plant.

Repeat water sampling during concrete production to maintain compliance. This is not necessary when using wells or city systems. The suspended and dissolved solids are not normal problems, but the pH can change during the year. The pH raises as weeds, moss, and algae grow in warm weather. This will affect water in the months of July, August, and early September. Sample the water and test the pH every four to six weeks. Test more frequently when the pH reaches 8.0. Be alert to rain as runoff can cause a change in all three tests.

## **Admixture Certification and Sampling Techniques**

### **Chemical Admixtures (Includes Air Entraining, Water Reducing, Accelerators, Retarders, etc...)**

To be approved (certified) for use on a project, a chemical admixture must be on the SDDOT Approved Products List or the contractor must provide a Certificate of Compliance from the supplier.

Sample all chemical admixtures and send to the Central Materials Lab for testing.

- One sample for each lot, type, or source.
- The material must be thoroughly stirred, air agitated, or otherwise properly mixed to disperse all settlement just prior to sampling.
- Use plastic or glass container for a sample of 8 ounces.

The MS&T system only has headings for AEA (Air Entraining Admixture) and WRA (Water Reducing Admixture), so all admixture samples that are not AEA are to be put under the WRA.

## **Aggregate Samples**

Take samples for quality and acceptance testing. Test results indicate the quality of the aggregate. Acceptance testing is performed to determine compliance with specifications. Complete the sample data sheet, DOT-1 Form.

## Quality Samples

Send samples from quality control to the Central Testing Lab two weeks before the concrete production. The test results are needed before using the aggregates and are essential for new sources. The Area Engineer may allow production without the test results if the aggregates are from a source used before. Refer to M.S.T.R.- Materials Manual for the sample size for quality testing.

## Acceptance Samples

For structural concrete, test one sample of each size aggregate used for every 200 cubic yards concrete produced (M.S.T.R.- Materials Manual). For concrete paving, test one sample of each size aggregate used for every 1000 cubic yards of concrete produced (M.S.T.R.- Materials Manual). Document the test results on the DOT-3 (Handouts 1, 2, 3), or DOT-68 (Handouts 14, 15).

Get material for a test and enough extra to make one standby sample. This is in case the test must be repeated. A spilled sample, a hole in a screen, a wrong weight can cause a repeat test. If a test fails because of material deficiency, report the sample as failing. In this case, there is no reason to test the standby portions. Action must be taken to correct the material and to sample and test again.

The amount of material needed for a sample depends on the size of material sampled. The larger the material, the more is needed for a sample. The minimum sample weights (SD 202) needed (after splitting) are:

Nominal Maximum Size of particle	Minimum Wt. of Sample Lbs.	Minimum Wt. of Sample Grams
#4	1.1	500
3/8"	2.2	1000
1/2"	5.5	2500
3/4"	11.0	5000
1"	22.0	10000
1 1/2"	33.0	15000
2"	44.0	20000

Specifications require that the minus 200 material in the fine and coarse material be mathematically combined (**820.2 D**). Take samples of the fine and coarse aggregate at the same time.

**Policy #DOT-OS-OC-3.1** -- If two of the last five (or fewer) samples fail to meet the established gradation, the following actions shall be taken: Notify the Contractor that a material deviation has been recorded. Document the deviation on DOT-18, Report of Specification Deviation. This deviation is subject to price adjustment. Suspend production of mix. Allow production to resume only after corrective measures have been taken and a sample meeting specification is obtained (Appendix 13).

## **Aggregate Sampling Techniques**

Get a sample (SD 201- Materials Manual) that represents all the material. Use samples that are a cross section of all materials to be used. As a general rule, obtain samples from conveyors and stockpiles.

### **Conveyors**

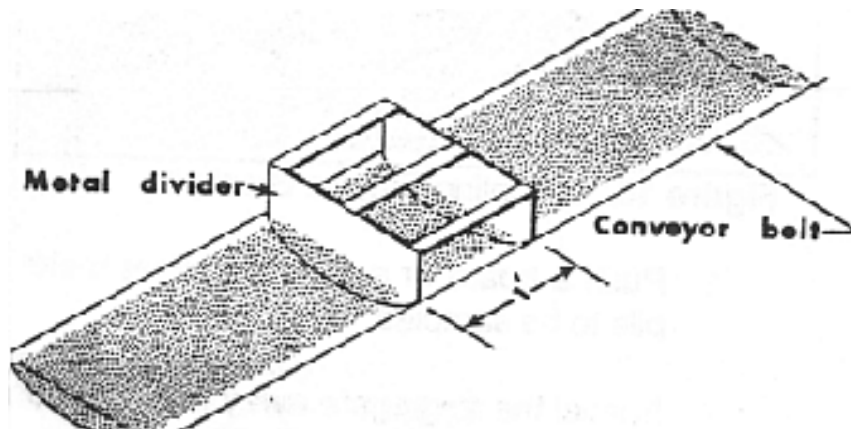
**Note: Samples shall be taken from a conveyor belt whenever physically possible.**

The flow on a conveyor is uniform and represents a cross section of material. To sample a conveyor:

1. Have the contractor stop the conveyor. Put two templates (Figure 3.5) on top of the material and push down until it rests on the belt. It will help to use a "sawing action" while pushing the templates into the material.
2. Remove all the material inside the templates for the sample. Use a brush to remove all fines from the belt.

If templates are not available, put a board or a shovel on the uphill side. This will keep the material from running down into the sample.

**Figure 3.5** Template on Conveyor Belt

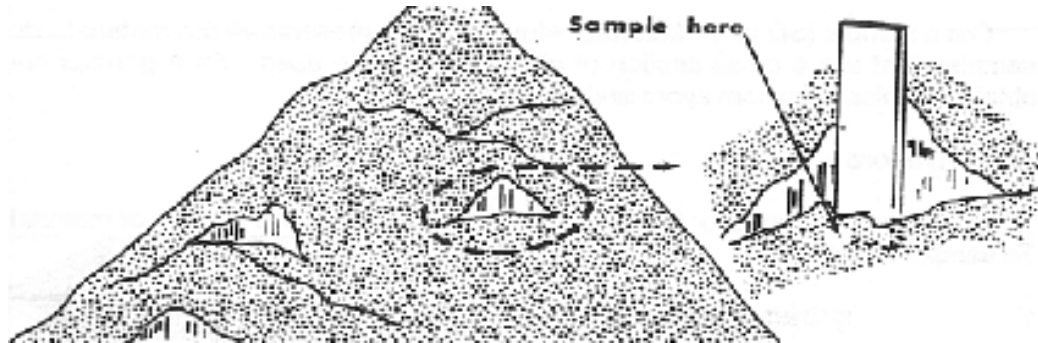


## Stockpiles

### A. Cone Shaped Stockpile.

Take care to avoid sampling segregated areas of the pile. Take approximately equal portions from the base, midpoint, and top of the pile. Before obtaining the sample at each sampling point, remove the aggregate to an approximate depth of 1 foot, and then obtain sample from the bottom of the hole. A board may be shoved into the pile just above the point of sampling to prevent segregation.

**Figure 3.6** Sampling from a Cone-Shaped Stockpile



### B. Flat Topped Stockpile.

Dig three or more shallow trenches on top of the stockpile approximately 10 feet (3 m) long and 1 foot (300 mm) wide. The bottom of the trenches shall be nearly level. Take equal portions from 3 equally spaced points along the bottom of each trench by pushing a shovel downward into the material and taking a shovelfull from each point.

### C. Stockpile (Loader Method).

Sample the material from at least three different areas around the perimeter of the stockpile. Using a front-end loader dig into pile and set aside a small pile of approximately 10 to 15 tons. Material shall be removed from stockpile in same manner in which it will be removed for incorporation into project. The operator shall roll the material from the loader bucket to reduce the amount of free fall. The additional buckets shall be obtained and dumped in the same manner and placed uniformly over the preceding pile.

The small stockpile will then be struck off to approximately half of its original height by backdragging with the loader bucket. Take the required amount of material for the sample from the exposed surface of the stockpile with a shovel taking care not to let material fall off the shovel.

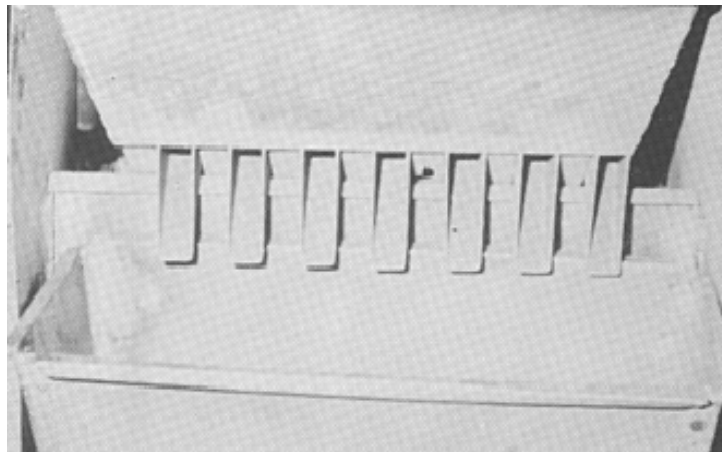
## Aggregate Sample Splitting

Most of the samples will be larger than needed to run a test. Use a Sample Splitter (SD 213-Materials Manual) to divide a large sample for testing. Refer to the Materials Manual for material sample size.

**Figure 3.7** Adjustable Sample Splitter



**Figure 3.8** Fixed Sample Splitter



A sample splitter is a device with a hopper and a series of openings on each side that divide a sample into two parts. There are two pans to catch the divided portions. There are two types of splitters. One is adjustable, having adjustable openings for varying widths. Another is a fixed splitter with openings that are not adjustable.

The size of the openings should be 50% larger than the maximum size aggregate sampled (See SD 213). If the openings are smaller, material may build up and plug the chutes. Then the sample will not be split evenly. The sample will not be split evenly if the splitter does not have the same number of openings on each side. For fine aggregate, a splitter having 1/2" chutes can be used if the entire sample will pass a 3/8" sieve.

EXAMPLE: If testing aggregate with a maximum size of 1.5", the opening should be approximately 2.25" wide (this would be 2.5" on the splitter).

Each pan should have the same gradation. Note these three items:

1. No chutes can be plugged.
2. Use a brush to clean the chutes, to prevent sticking.
3. Pour the sample evenly into the hopper.
  - a. Put the sample in a pan about the size of the hopper and slowly turn the pan over into the hopper.
  - b. Stand at one end of the splitter and pour the sample into the center of the hopper. While pouring, move the flow back and forth along the length of the hopper.

**PROBLEM:** If sampling aggregate with a maximum size of one-inch, how much material should be obtained and what size openings are needed in the splitters?

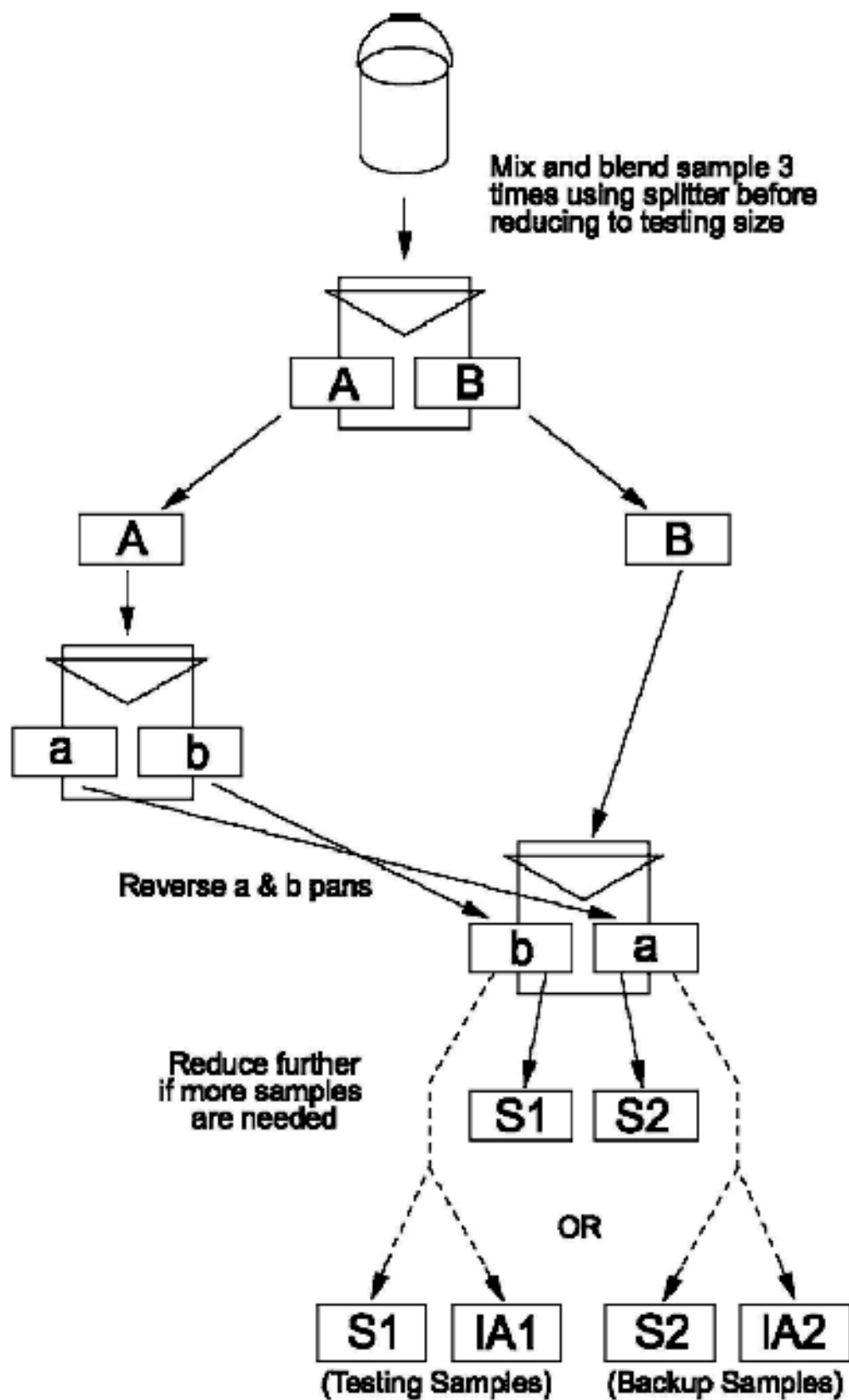
Sample size\_\_\_\_\_. Opening size\_\_\_\_\_.

Process a sample through the splitter more than once. There is a chance that the sample will not be split evenly. Split it and then combine the portions for the last split. There will be a close correlation between the sample tested and the standby samples.

M. S. T. R- Materials Manual provides information on the sample quantities by type for the mix design.

Figures 3.9 and 3.10 show how a sample should be split.

**Figure 3.9** SD 213 Sample splitting - 1 container



**Figure 2**

Figure 3.10 SD213 Sample Splitting - 2 containers

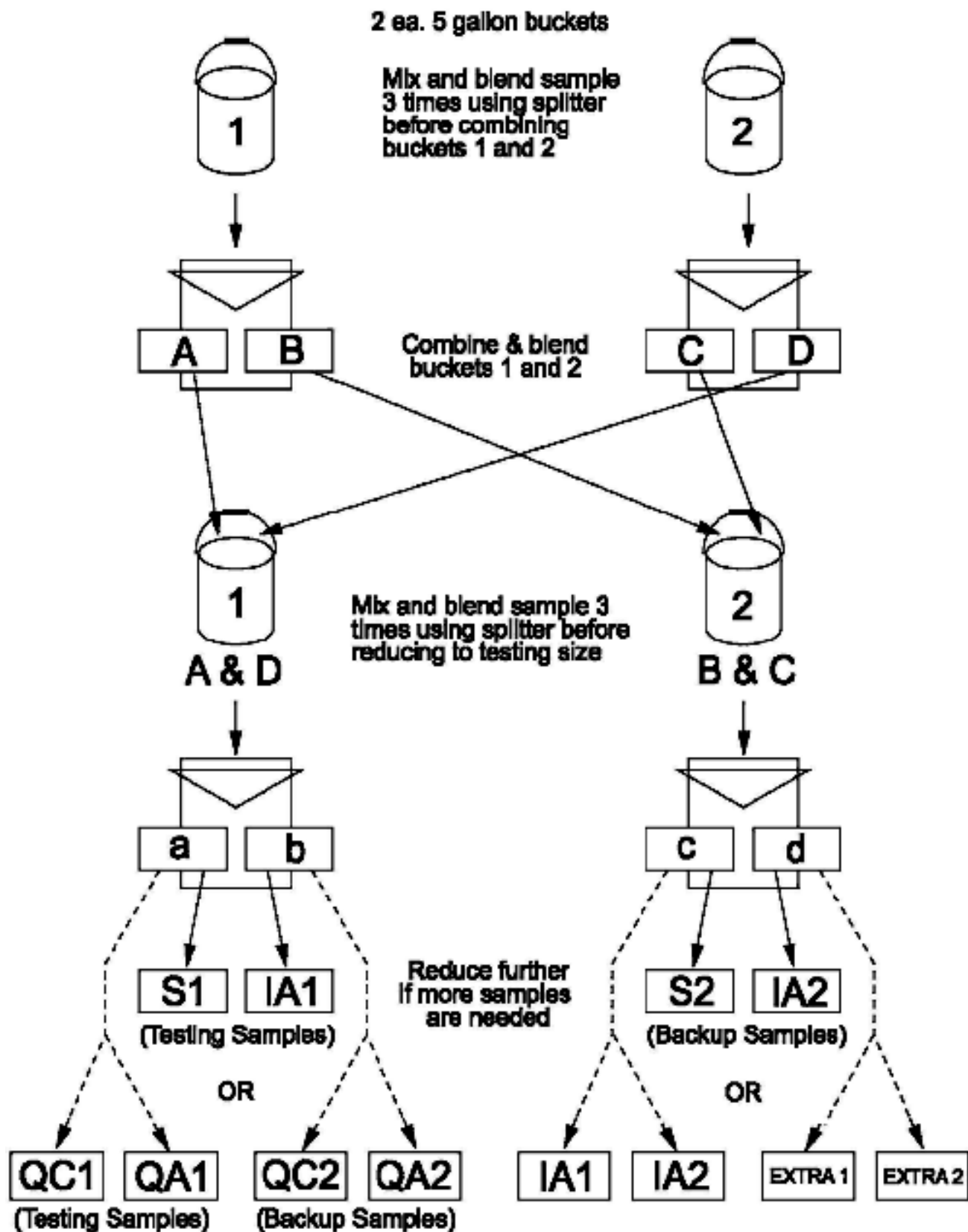


Figure 3

# 4

## CONCRETE PLANTS

A concrete plant is a factory. The product manufactured is uniform fresh concrete. It is essential that there be an uninterrupted flow of the concrete from the plant to the construction site. This will provide concrete uniformity and will facilitate a high-quality construction.

If a Contractor is using concrete from more than one source, all materials must come from the same suppliers. In these situations, good communication is essential to deliver a steady flow of concrete to the site.

The following are required for concrete to flow uninterrupted to the construction site and for materials to be uniform from batch to batch:

1. A site large enough to store materials for continuous operations.
2. A layout that permits all construction and delivery traffic to flow freely in and out of the plant site.
3. Equipment that is kept in good operating condition.
4. Competent plant and equipment operators who are well supervised.
5. Storage and handling procedures for all materials.
6. Good communications between the concrete plant and the placing operation.

DOT inspectors and contractor personnel who will take the initiative to anticipate a problem and make the effort to determine a solution before the problem causes a slowdown or stoppage of concrete production.

The key to quality and uniformity is using proper proportioning, consistency and a quality control program. All materials must be measured accurately. The word “batch” means either the assembly or mixture of all the ingredients used in one concrete mixing operation. For example, one truck mixer load or one plant mixer cycle in a central mix paving plant is a batch.

It is important to proportion each batch of materials to obtain strength and durability. The proportions of aggregate have considerable effect on the workability of the fresh or “plastic” concrete. Any error made in measuring these materials will also cause a variation in strength. Control the measurement of materials within narrow limits.

Although there are many kinds, shapes, and sizes of concrete plants, they all are of two general types: Batching Plants and Mixing Plants.

A concrete supplier checklist (DOT-294 - Appendix 12) must be completed for each concrete plant used on a project. An air quality permit must be also obtained for each plant used on a project.

## **Non-Computerized Batching Plant Inspection**

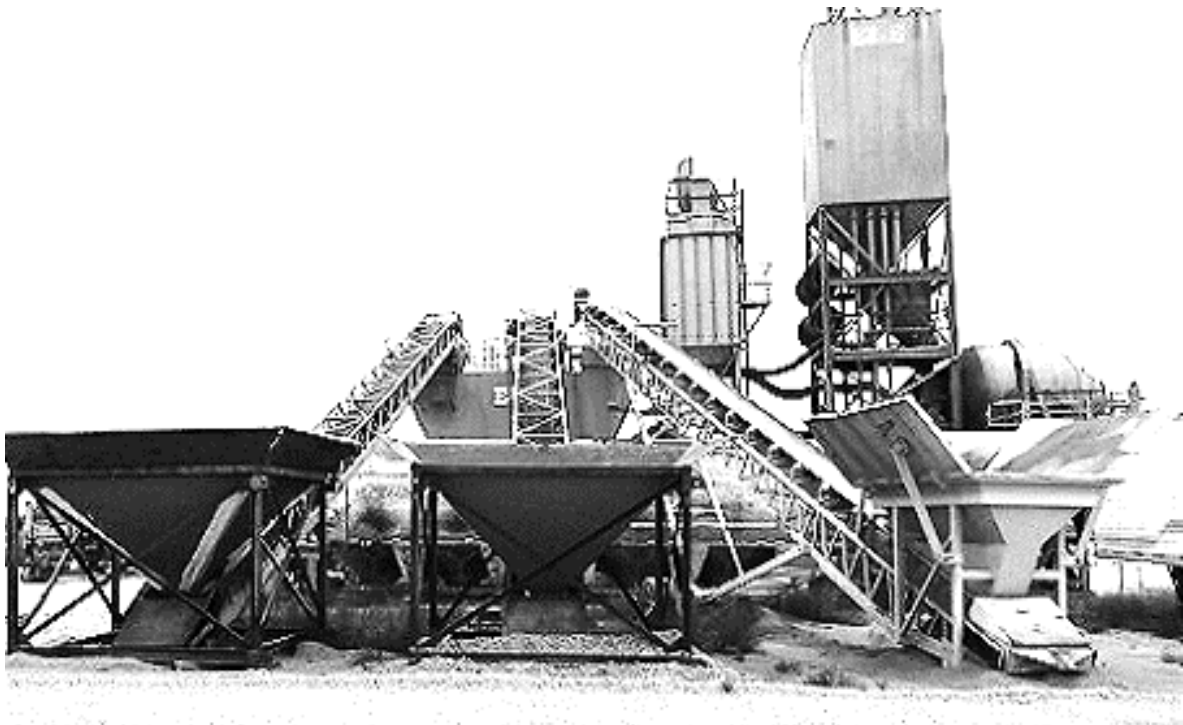
A batching plant measures the materials needed for a “batch of concrete.” A batch is the amount of material that is to be mixed at one time. The mixing is done in one of three places: at the batching site, on the way to the job site, or at the job site.

A concrete mix is proportioned not only to meet the requirements of strength, durability, and workability, but also to produce a certain volume of concrete. The purpose of batching equipment is to meter the quantity of each material into the mixer so that the correct volume of concrete is produced.

Thorough mixing of concrete is accomplished when the materials are charged into the mixer at about the same time. This is possible because of the partial blending of materials, which occurs as they enter the mixer. Before the materials can be put into the mixer, each must be measured. This is accomplished by dropping material from the storage bin into a weighing hopper.

Common hoppers, called cumulative batchers, batch by weight and are frequently used by redi-mixed concrete producers for aggregates. Cement is normally weighed separately. These cumulative batchers weigh materials one after another in a common weight hopper suspended from a single weight scale-lever system. Multiple batchers sizes range from one to ten cubic yards or more. They can be arranged to handle 2, 3, 4 or more different details.

**Figure 4.1** Hoppers at Batching Point

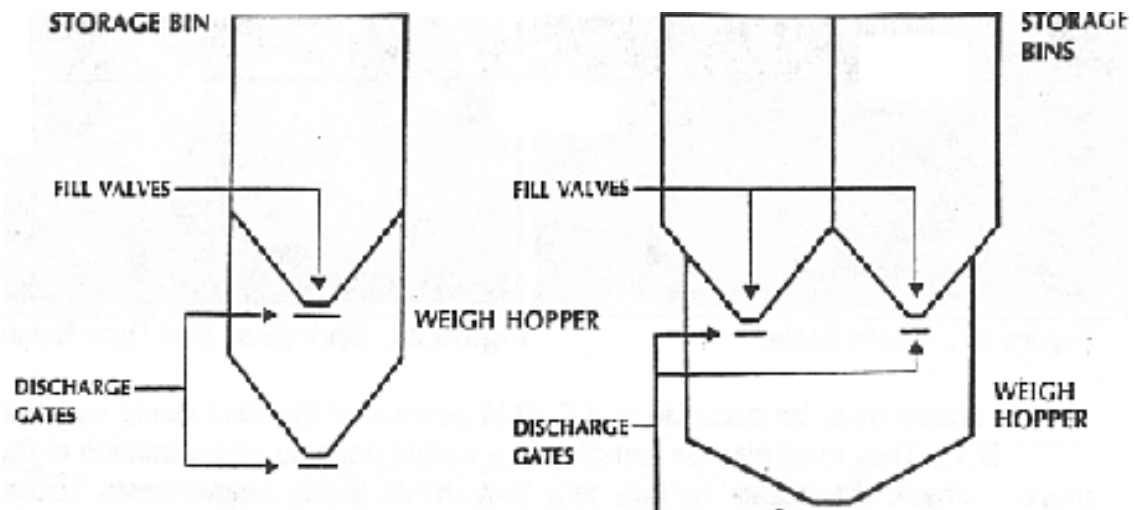


**Figure 4.2** Conveyor Carrying Aggregate to Hopper



The batching plant must be on a level, solid base to prevent the twisting and binding of parts. This will cause problems with the scales, which in turn will not weigh correctly. Concrete footings make the best base. The contractor can use other bases as long as the plant is solid and remains level.

**Figure 4.3** Diagram of Two Types of Hopper Systems



### **Scales/Load Cells**

The scales/load cells are an important part of a batch plant. If they are not working properly, the following can occur: the volume cannot be controlled, moisture adjustments will be difficult, the slump could vary, or the strength could be low.

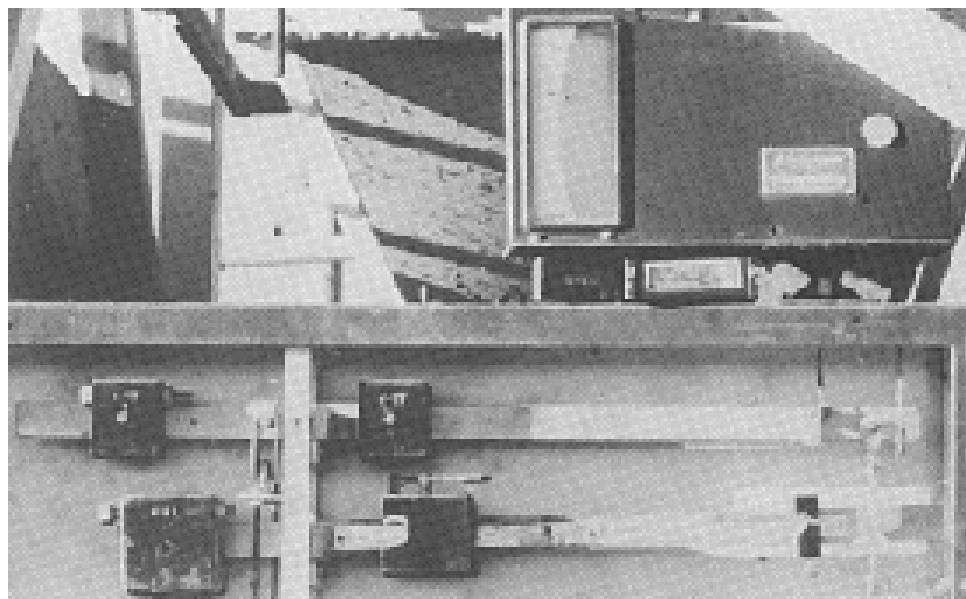
**Figure 4.4** Modern Digital Control Center



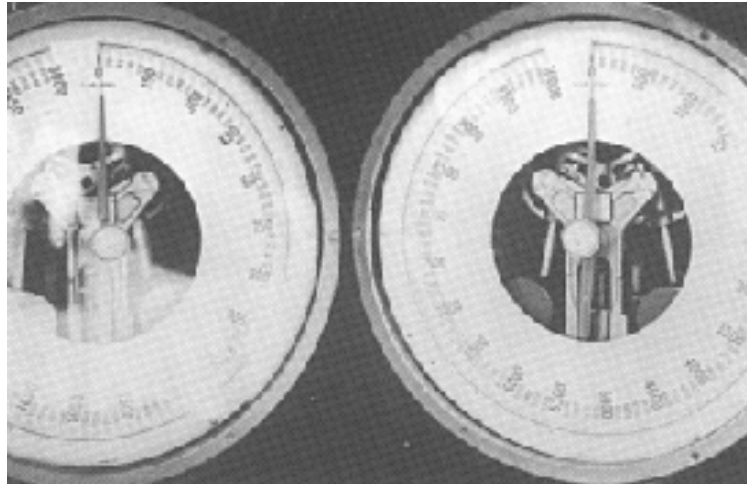
**Figure 4.5** Load Cell for Digital Scale



**Figure 4.6** Beam Scale



**Figure 4.7** Springless Dial Type Scale



Graduations on the scale or load cell must be no larger than 0.1% of the total capacity. **(380.3 B 1)**

The scales/load cells must be accurate to 1/2 percent of the load being weighed. **(380.3 B 1)** They must also be sensitive to a weight equal to one graduation of the device. Check the scales to see that they meet these requirements before producing concrete.

Since the scales used for batch plants often have capacities of 30,000 pounds or more, they must be checked by a qualified private scale inspector. It is up to the contractor to contact these people and set a date for checking the scales. Be present while this is being done. After the scales are checked and they meet requirements, enter the following in the plant diary:

- Date the check was made
- Name of the person making the check
- A statement that the scale met requirements

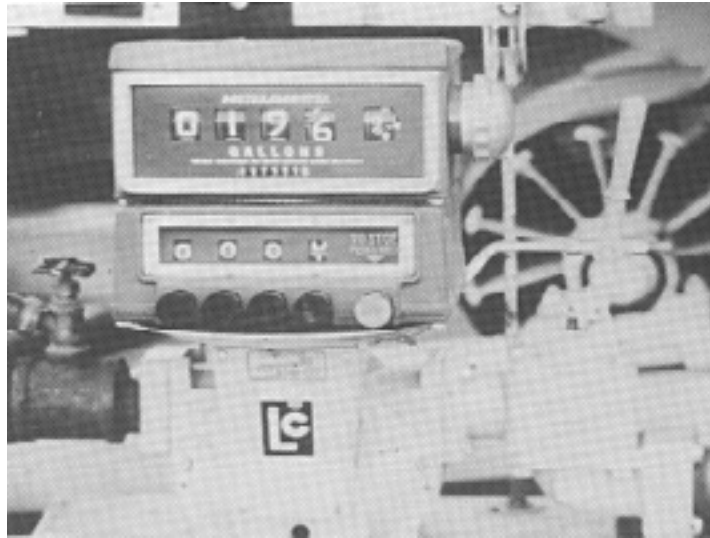
The scale inspector checks the scales of most Redi-Mix plants annually. The scales will not need to be checked if they have a scale inspector's seal that is less than 1 year old, and the plant has not moved since the seal was issued. If the plant does not have a recent seal or it has been moved, it must be checked. **(9.1 H)**

Occasionally the contractor may use a small batching plant for structural concrete. If the plant does not produce more than a few cubic yards of concrete, the Engineer may order other means to check these scales. There are times when weighing will be affected by wind. The wind may cause the hoppers to rock back and forth, causing vibrations in the lever arms. These vibrations cause the scale to bounce making it hard to weigh. Should wind cause such problems, have the contractor put up a shelter to protect the hoppers **(380.3 B 1 and 460.3 C 1)**

## **Water Meters**

Meters sometimes measure mixing water. These meters must measure water with a tolerance  $\pm 1$  percent of the quantity **(380.3 B 1 and 460.3 C 1)**. The insides of a meter are delicate. Long use, sand, or dirt can damage it causing incorrect readings.

**Figure 4.8** Water Meter



Check meter accuracy by weighing the water pumped through it. If the water weighed is within  $\pm 1$  percent of the meter setting, the meter is acceptable for use. If the accuracy falls outside the  $\pm 1$  percent limit, make adjustments or draw an “output” curve.

Some contractors have a Certificate of Calibration for their water meters. This can be used in place of actually checking the meter if:

- The meter is sealed.
- The Certificate shows the serial number of the meter, date of calibration, and states that the meter is accurate within a range of error of not over  $\pm 1$  percent.

This calibration will be considered good for a period of one year from date of calibration or until the meter seal is broken. Should there be a reason to suspect that the meter is no longer accurate, check it.

One method that can be used to check a water meter is to meter a volume of water from the batch plant into a 55-gallon barrel. Another method is to meter a volume of water into a water truck and weigh the truck and determine the gallons. Keep in mind that the larger the volume of water used the more accurate the check will be.

## **Bins**

The plant must have separate bins for each size aggregate. The bins are filled from the top by conveyors. Check to see that the material is not building up and spilling from one bin to another. Look inside the bins to see that there are no holes in the walls between the bins. Mixing the aggregates will result in failing test results as well as non-uniform concrete.

**Figure 4.9** Screens above aggregate bins

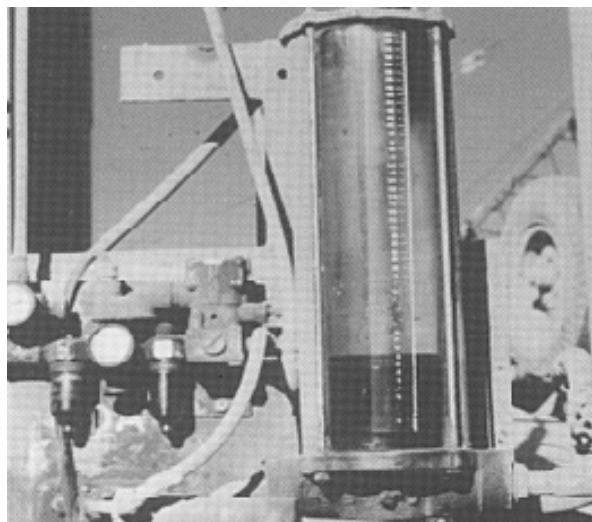


## **Admixtures**

Each admixture should be added to the batch by a mechanical metering device. The device must be able to measure within  $\pm 3$  percent of the net weight or volume per batch (**380.3 B 1** and **460.3 C**)

**1)** Check the accuracy by discharging a batch quantity into a container. Weigh (grams) the material to verify the  $\pm 3$  percent accuracy. Most admixtures are specified in ounces and weighed in grams. Divide the gram weight by 28.34 to get ounces. It is the contractor's and/or the supplier's responsibility to determine the dosage of admixture.

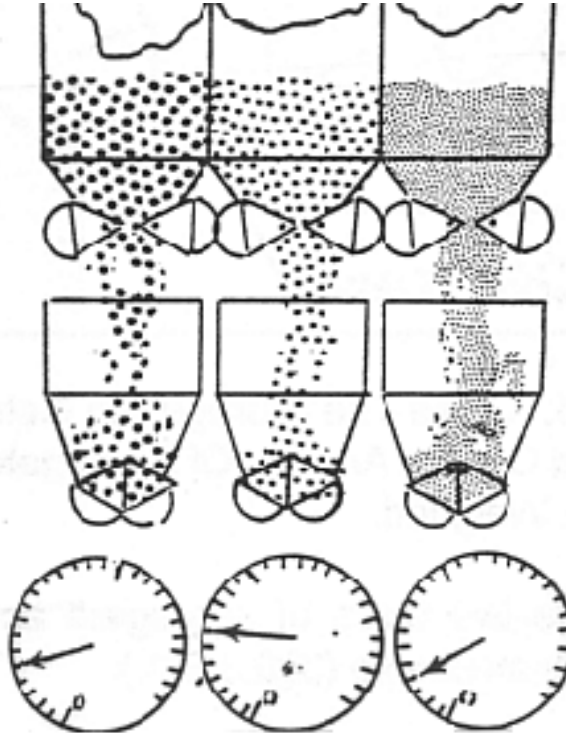
**Figure 4.10** Admixture Metering Device



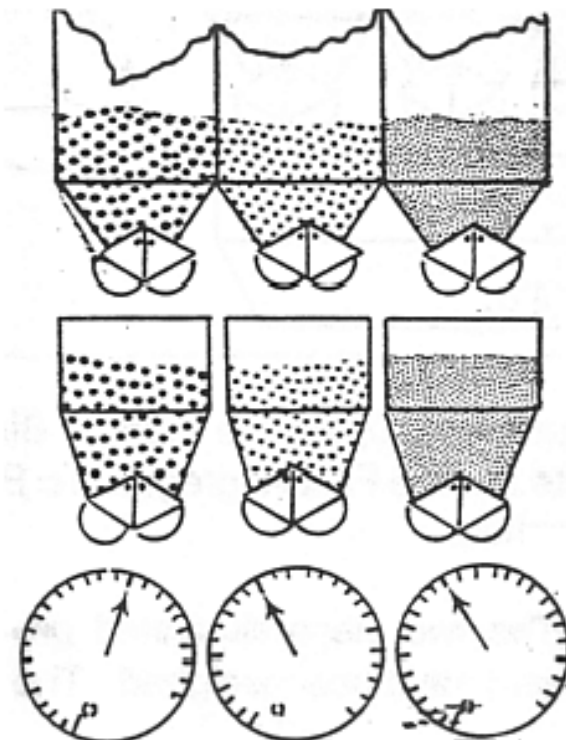
## Automatic Controls

A concrete paving batch plant must be operated with automatic controls (**380.3 B 1**). Batch plants for structural concrete are not required to have automatic controls. The illustrations below depict what the controls do when separate scales weigh aggregates and cement.

**Figure 4.11** Open the Storage Bin Gates to Start Batching



**Figure 4.12** Close Gates when the correct amount of each aggregate and cement is weighed out

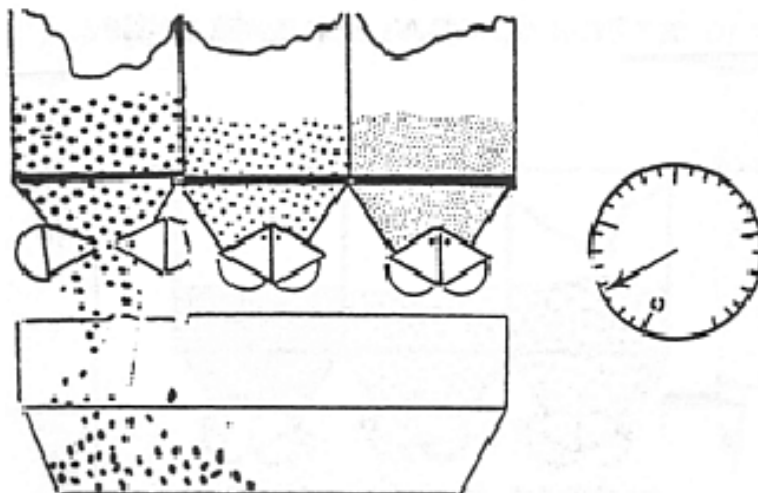


The automatic controls must also (**380.3 B 1**):

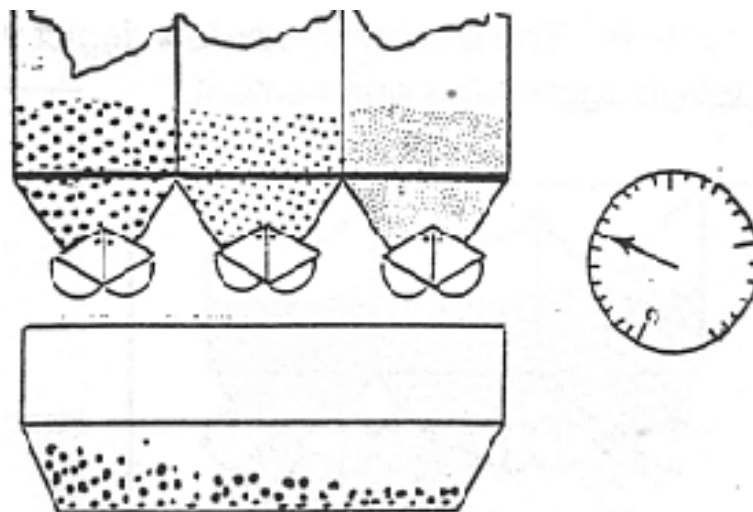
1. Keep the storage bin gates closed when the weigh hopper gates are open.
2. Must **not** open the weigh hopper gates when the aggregates weigh 1.5% more or less than they are supposed to weigh.
3. Must **not** open the weigh hopper gates when the cement weighs 1% more or less than it is supposed to weigh.

Figures 4.13 and 4.14 illustrate what automatic controls do when aggregates and cement are weighed on one scale:

**Figure 4.13** Open the storage bin gate for the first aggregate to be weighed



**Figure 4.14** Close the storage bin gate when the correct amount of aggregate has been weighed.



Check the automatic controls to be sure that they are working properly. Have the contractor put less material in the weigh hopper than is allowed by the delivery tolerance. Then have him/her try to operate the automatic controls to see if the weigh hopper gates will open (for aggregates weighed separately) or, see if the storage bin gates for the next size of aggregate will open (when everything is weighed in one hopper). Repeat this procedure after putting more material in the weigh hopper than allowed by delivery tolerance. Do the same thing with the cement weighing equipment. Do not let the plant start until these things are checked and the controls operate properly.

Should the automatic controls break down, the contractor is allowed to use the manual controls. He must have the automatic controls fixed before work begins the next day (**380.3 B 1**).

The Area Engineer can allow the contractor to produce concrete for special locations without using automatic controls. Check with the Project Engineer. There may be occasions when plans contain a note stating that automatic controls are not required.

## **Computerized Batching Plant Inspection**

When concrete is supplied from a computerized concrete batch plant, continuous plant inspection is not necessary. A normal plant (scales, meters, admixtures, stockpiles, etc.) and truck (revolution counter, manufacture plate, blade wear, etc.) inspection shall be accomplished prior to the plant furnishing material to the project. The plant production and aggregate moisture determinations need to be reviewed with the plant operator. This should be accomplished on an annual basis, if the plant normally furnishes concrete to SDDOT projects annually.

During the course of production, the plant and associated equipment shall be periodically inspected to assure that:

1. The stockpiles are properly maintained.
2. Material in bins is as indicated.
3. The proper batch weights and aggregate weight are verified and have been corrected for aggregate moisture.
4. Trucks are clean and empty prior to batching.
5. Proper mix time or revolutions is being accomplished.
6. Any new trucks are checked prior to use.
7. The rinsing of the truck mixing fins after batching is observed for excess usage of water.

At the project site, the inspector should:

1. Ensure that the appropriate information is on the ticket as specified.
2. Ensure that the weight of material is within tolerance.
3. Ensure that additional cement is added for small loads.
4. Review time requirements.
5. Check to see if trucks are taking an excessive amount of time getting to the project.
6. Check new trucks prior to use.
7. Recommend mixing the truck load an additional 20 revolutions prior to discharge to assure uniformity of the mix.
8. Ensure that the additional required 30 revolutions after the addition of any admixtures and/or water is met.
9. Ensure the maximum allowable water is not exceeded.
10. Check to ensure the aggregate moistures appears reasonable.
11. Visually monitor the mix for slump or consistency changes. If the mix appears to have changed, obtain a sample and test the fresh concrete.

12. Take appropriate action based on the concrete test results.

## **Mixing Drums**

Mixing plants (380.3 B 3) are used on concrete paving projects and are a part of the batching plant. They are large drums that mix the batched materials into concrete. Use them as recommended by the manufacturer. Each mixer is required to have a rating plate that must be checked for:

- The maximum volume of concrete that can be mixed at one time.
- The drum's mixing speed is expressed in revolutions per minute.

**Figure 4.15** Mixing Drum



**Figure 4.16** Plant Rating Plate



If the rating plate cannot be found, have the contractor supply the manufacturer's manual. Check the drum to see that it is turning at the recommended speed. To check the speed:

1. Make a mark on the drum.
2. Have the operator turn the drum at the normal mixing speed.
3. Use a stopwatch and time 10 revolutions.
4. Divide the 10 revolutions by the time in minutes to determine the revolutions per minute of the drum.

EXAMPLE: The manufacturer's plate recommends a mixing speed of 6 to 12 revolutions per minute. 10 revolutions were timed at 52 seconds.

$$\text{Convert Seconds to Minutes} = \frac{52 \text{ sec.}}{60 \text{ sec. (1 minute)}} = 0.87 \text{ minutes}$$

$$\text{Determine the Revolutions per minute} = \frac{10 \text{ rev}}{0.87 \text{ min.}} = 11.5 \text{ rev/min.}$$

Experiments have shown that the concrete is mixed better when the drum is turning at or near maximum speed. A number of factors can determine whether a concrete batch will be well mixed. Some of these are:

- charging procedure
- batch size
- method of adding water
- mixer speed
- number of revolutions
- type of materials
- mix proportions

Constant observation by the plant inspector, keeping the basic rules of good concrete in mind, will result in uniformly mixed batch of concrete.

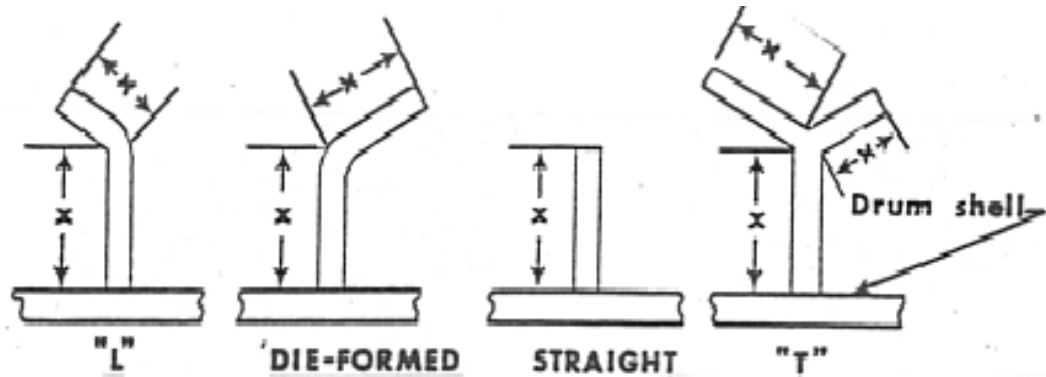
## Mixer Maintenance

A mixer must be kept clean and in good mechanical condition to do a good job of mixing. Accumulation of hardened concrete in the drum and mixing blades will reduce the efficiency of the mixture; therefore, concrete should be removed after each day's run. Badly worn mixer blades need to be replaced periodically.

Check each mixer to see that the mixing blades are in good condition by crawling inside the drum. Get the manufacturers' manual from the contractor for the correct blade dimensions. The contractor should replace the blades when they become worn down 3/4 inch or more.

The sketches below show different blades and where measurements should be taken. **(380.3 B 3)**

**Figure 4.17** Mixing Blade Configurations



Measure the blade at the point of the largest diameter of the drum. Blades worn more than allowed must be replaced before using the mixture. Quite often old dried concrete has built up around the blades. Remove this before using the mixer or proper mixing of the concrete will not be achieved.

### **Central Batch Plant**

Mix all concrete a minimum of 60 seconds (**380.3 E 1**). To make sure this happens, the mixers for both concrete paving and structural concrete must have automatic timing devices. The timer should keep the mixer from dumping the concrete before the full mixing cycle is complete.

Verify the timer. Have the operator push the "dump" button before the mixing cycle is completed. If this overrides the timer and dumps the concrete, the contractor will have to correct the situation.

The timer must be equipped with a bell, light, or some other type of device that will signal each time the time lock is released.

Use the automatic timer but switch to manual controls should it break down. The timer must be working properly before producing concrete the next day. While the plant is being manually operated, the mixing time remains at 60 seconds.

Mixing time begins when all materials, except the water, are in the mixer. It ends when the mixer starts to dump concrete. All the water must be in the drum within the first 15 seconds of the mixing cycle (**380.3 E**). When the materials are fed into the mixer, part of the water must enter the drum before the cement and aggregates do. This water will help keep the other materials from balling up and sticking to the sides of the drum. Allowing water to enter the mix first will also help spread the aggregates evenly in the mix.

### **Transit Mix Trucks**

For any mobile batch plant setup on a project site, you must obtain an air quality permit. A copy of the permit should be kept in the project file.

Most structural concrete will be delivered from a commercial Redi-Mix plant. A contractor may use a small batch plant on the project site. Most of these portable on-site plants have mixing capacity rated on the number of bags of cement they can handle. The contractor must use only full bags, not portions. Material weights must be based on the number of bags of cement being used. The batch plant measures the materials, so they can be mixed. The mixing is done while the trucks are at the plant site.

**Figure 4.18** Transit Mix Truck



**Figure 4.19** Truck Rating Plate

**11 Cubic Yard Mixer**  
**8.41 Cubic Meter Mixer**  
**Maximum Capacity**

Serial Number **36093-05839**

Drum Volume **497** Cu. Ft. **14.07** Cu. M.

Manufacturer's Rated Mix Capacity **11** Cu. Yd. **8.41** Cu. M.

\*Average Agitator Capacity **13** Cu. Yd. **9.94** Cu. M.

Mixing speed range 6 to 16 R.P.M.  
Agitating speed range 2 to 6 R.P.M.

\*The agitation capacity of inclined drum, open end mixers will vary and is governed by drum axis angle, slump, drum speed, truck chassis suspension, road grade and other variables.

**Water Tank Capacities**

Measuring Capacity **125** **15** Gallons  
**473** **57** Liters

**! WARNING**  
The manufacturer's data plate affixed to this mixer, indicating the mixer and agitator rating of the drum, specifies the performance of a drum as a mixer, and/or agitator only. The weight of different mixes may vary. **DO NOT FILL** the mixer drum with an amount of concrete

27 12:28 PM

Check the transit mix trucks before they are used. Use the trucks according to the manufacturer's recommendations. They all must have a rating plate describing:

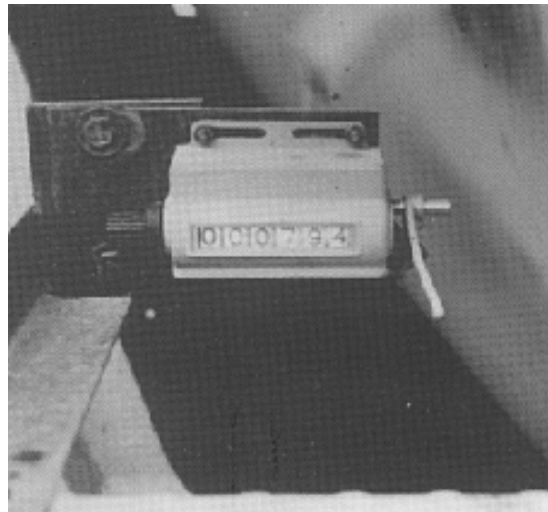
- Mixer design uses.
- The maximum amount of concrete that can be mixed in the drum.
- Speed of the drum RPM's during mixing and agitating

Check the drums to be sure that they will turn at the recommended speed. Check each mixture to be sure that the mixing blades are in good condition. The checking procedure is the same as with a mixing plant.

The truck mixers must be equipped with a revolution counter (**380.3 B 3**).

- The initial mixing time for truck mixers is 70 to 100 revolutions of the drum at mixing speed (**380.3 E 2**).
- 30 revolutions at mixing speed is required when additional water, cement, or admixture is added. (**380.3 E 2**)

**Figure 4.20** Revolution Counter



The range for agitation and mixing speed will often overlap. The contractor will normally use a drum speed within this overlap area, so all revolutions are counted. This is acceptable, but the concrete mixes better if the drum turns at near maximum speed. Ask the contractor to use a mixing speed near the top of the range.

## Concrete Pumper Trucks



**Figure 4.21** Concrete Pumper Truck

- Meet with the Contractor and supplier before using pump truck; a backup plan to complete a pour should be determined if pump truck goes down.
- Determine where and when tests will be taken.

## 5

**AGGREGATE TESTING**

The inspector or the Central Lab conducts certain tests. Some tests conducted by the Central Lab are for the inspector's information and will be used when working with concrete plants. The tests conducted by the inspector are used to determine if the materials meet specifications and/or to make adjustments for mix design. The inspector conducted tests are:

- Coarse and Fine Gradation (SD202)
- Moisture Content (SD108)
- Fineness Modulus (SD202)

**NOTE:** Check the specifications, supplemental specifications, plan notes, and special provisions for these requirements.

Slump and air tests will be conducted for your own information and to see if they meet specifications.

**Gradation and Combined Minus #200**

Test SD 202, South Dakota Materials Manual, explains the gradation test. Report the results of each test on a DOT-3, or DOT-68, Form -- Screen Analysis and P.I. Worksheet. Example forms 1, 2, and 3 show the results of gradation tests during a paving job. Example forms 5 and 6 show the results for gradation tests during a structural concrete project.

After completing the gradation test, determine what portion of the combined material is finer than the # 200 sieve (SD 206-Materials Manual). To meet the specification requirements, the combined minus # 200 must be 1.5% or less. To find the combination minus # 200:

1. Find the minus # 200 percentage for each rock and sand sample, according to the procedure outlined by the South Dakota Materials Manual under tests SD 202 and SD 206.
2. Find the percentage of the total aggregate comprised of fine aggregate, by weight, to the nearest tenth of a percent. Likewise, find the percentage that is coarse aggregate.

EXAMPLE: The following weights of materials are being put into the mix per cubic yard:

	(YD) <sup>3</sup>
Sand	1089 lbs
<u>Rock</u>	<u>1846 lbs</u>
TOTAL	2935 lbs

% Sand	1089 lbs. = 37.1%
% Rock	1846 lbs. = 62.9%

3. Change the percentage of the material in the mix to a decimal number and multiply it times the percentage of the minus # 200. Total these figures to get the combination of minus #200.

**NOTE:** Compute the minus #200 to the nearest hundredth of a percent. Report the total for the combination minus #200 to the nearest tenth of a percent.

EXAMPLE: The values of the minus #200 for the samples of paving aggregate that were taken at the same time are:

Sand	= 2.13%
1"	= 0.56%

Multiply these times the percentage of each material to get:

Sand	= .371 x 2.13% = 0.79%
1"	= .629 x 0.56% = 0.35%
Combined Minus # 200 = 1.14% or 1.1%	

Report this 1.1% combination minus #200

**NOTE:** If making a mix adjustment that will change the percentages of aggregate used from that shown in the Mix Design, use these new percentages when mathematically combining the #200 material. These new percentages should also be shown on the DOT-3 Form.

**PROBLEM:** Using the Class A mix design of Example Form 4, what is the combination minus #200 when you have the following gradation results? \_\_\_\_\_

Sand minus #200 = 1.06%
Rock minus #200 = 0.88%

## Absorbed Moisture

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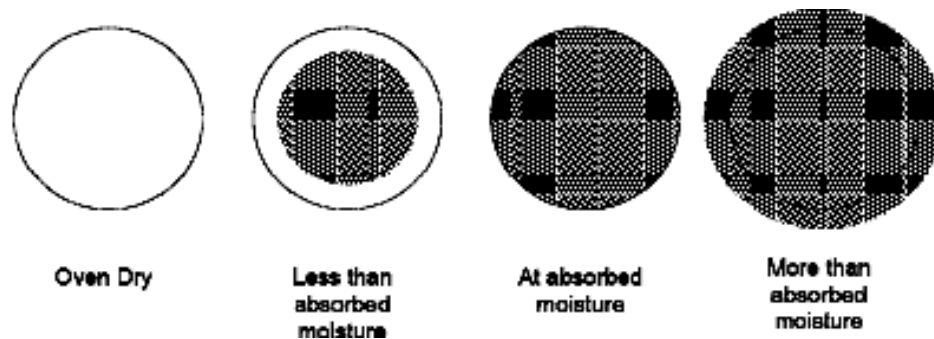
Aggregates are not completely solid - they have extremely small channels inside them. These channels soak up moisture. The amount of water needed to fill these channels is called Absorbed Moisture. The aggregates may contain more or less moisture than needed to fill these channels.

If the aggregates do not contain enough internal moisture, some of the mixing water will be absorbed. If the aggregates have more moisture than needed internally, the extra water can be used for mixing water.

The three conditions the aggregates can be in before they are put into the mix are shown in the diagram below. The example on the left needs more moisture to fill its pores. The example on the right has an excess of moisture. When aggregates like these are put in a mix, the left one will soak up some of the mixing water. The right one will give up some of its moisture, which becomes part of the mixing water. To produce uniform concrete, knowing which condition is present is important.

This is done by running a moisture test, which will indicate any free moisture or less moisture than the aggregate needs to reach the full-absorbed condition.

**Figure 5.1** Absorbed Moisture Illustration



**PROBLEM:** What is the amount of absorbed moisture in the aggregates submitted for the Class A mix in Example Form 4?

Sand \_\_\_\_\_

Rock \_\_\_\_\_

## Moisture Content

---

Run moisture tests on the aggregates to determine how much “total moisture” they contain. Free moisture is the amount of moisture in the aggregates above the amount needed for absorbed moisture. Find the total moisture content by using any of the following moisture determination methods:

- Speedy Moisture Tester
- Burning with Alcohol
- Stove Drying
- Oven Drying
- Microwave

Whichever method is used. It must be capable of checking within 0.6% of the moisture content found by drying to a constant weight in an oven at 230° ±9°F. Establish a procedure with one of the methods listed about and stay with it.

The Speedy Moisture Tester is the fastest way to find the moisture content of sand. Do not use this method for rock because the size of the sample used for the test is so small. Pick the percent of moisture "by dry weight" for the sample from the Speedy Chart for the dial reading obtained. If the Speedy Chart is not available, refer to the Materials Manual to convert from "wet weight" moisture to "dry weight" moisture.

When using any of the drying methods, find the percent of moisture content by subtracting the dry weight from the wet weight. Divide the difference by the dry weight and then multiply the results by 100.

**NOTE:** 500-gram samples are required for sand and rock moisture tests.

$$\frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100 = \% \text{ moisture}$$

EXAMPLE: Wet Weight 547.3 grams - Dry Weight 525.4 grams = 21.9 grams

$$\frac{21.9}{525.4 \text{ gr}} \times 100 = 4.16 \text{ or } 4.2\%$$

Follow the test procedure in SD108 in the Materials Manual.

After finding the total moisture content, calculate the amount of free moisture by subtracting the percent of absorbed moisture from the total moisture. Report free moisture to the nearest 0.1%.

EXAMPLE: The oven drying method gives a total moisture content of 5.6%. The absorbed moisture (Aggregate Test Results used in mix design) is 1.3%.

$$\text{Free Moisture} = 5.6\% - 1.3\% = 4.3\%$$

Check any method used against an oven-dried sample. Split a sample and run part of it by the method normally used and run the other part by the oven dry method. Keep drying the sample until it no longer loses any weight (Dry to a Constant Weight), and then figure the moisture content.

Should the difference be more than 0.6%, the method has not removed all the absorbed moisture. Increase the drying time or check the Speedy Moisture Tester.

If the aggregate looks dry when sampled, it is possible that it does not contain the full amount of absorbed moisture. In this case, consider the moisture removed to be the remaining absorbed moisture.

Report moisture test results on the DOT-35 Form - Moisture Density Worksheet (Example Form 12). Attach it to DOT-98A-Plant Inspector's Daily Report submitted daily. Report in the diary a comment and the results for any comparative tests.

## **Fineness Modulus (F.M.)**

Fineness Modulus is a factor used to indicate the surface area of aggregate. Fineness Modulus of the fine aggregate is the sum of the cumulative percentages retained on a standard set of seven sieves divided by 100. The smaller the F.M. number the finer the sand is. Likewise, the larger the F.M. number the coarser the sand is, so the F.M. tells us about the fineness or coarseness of sand.

The surface area of typical one-inch coarse aggregate is about 70 square feet for every 100 pounds. The same 100 pounds of sand will have a surface area of about 1200 square feet for a F.M. of 3.1 about 1900 square feet for a F.M. of 2.7, and 4000 square feet for a F.M. of 2.3. The reason sand has more surface area than rock is because of the particle sizes. A one square inch rock has 6 square inches of surface area. Break this same rock into 64 pieces, 1/4-inch square and there will be a surface area of 24 square inches. Keep breaking it into smaller pieces - the surface area keeps increasing. Therefore, the finer the material, the smaller the F.M. number and the larger the surface area.

Remember the cement and water forms a paste that must coat every particle of aggregate in order to produce good, strong, durable concrete. How well this happens depends upon how much surface area it has to coat.

Because the gradation of the sand can change so much, run tests to determine the F.M. Use the 3/8", #4, #8, #16, #30, #50 and #100 sieve sizes for the F.M. test. After completing the gradation test and finding the percentage of material passing each sieve size, find the F.M. of the sample. "Cumulative percent retained" on a sieve means "coarser than" so "percent passing" plus "cumulative percent retained" will always equal 100%.

To figure the F.M.:

Samples of fine aggregate for concrete require a result for Fineness Modulus (F.M.). The sieves used for determination of F.M. are identified on the DOT-3 worksheet by an (\*). Calculate the F.M. as follows:

A. Subtract the percentage passing (before rounding) the sieves designated by the (\*) from 100.0 and record the result in the column titled F.M. After this has been accomplished on each sieve designated, total the results and divide by 100.

B. Report the results to the nearest 0.01%

F.M. Example

Sieve Size	Percent Passing	100.0 Minus Percent Passing
3/8"	100	0
#4	98.1	1.9
#8	89.8	10.2
#16	70.4	29.6
#30	38.9	61.1
#50	22.6	77.4
#100	9.3	90.7
	Total	270.9

Fineness Modulus:  $\frac{270.9}{100} = 2.709$  or 2.71

**NOTE:** The Screen Analysis and P.I. Worksheet (DOT-3 Form) has a place for the calculations. Notice that each screen needed to find the F.M. is marked with a star. Always refer to the Materials Manual for current specifications.

**PROBLEM:** What is the F.M. of the sand sample shown on Example Form 5? \_\_\_\_\_

The mix design will supply the F.M. used for the sand. For the purpose of determining the degree of uniformity, a fineness modulus (FM) shall be made upon representative samples from sources proposed for use. If the fineness modulus falls outside this limit the Concrete Engineer shall be notified. A new or adjusted mix design may be provided or approved. The uniformity of grading requirements does not apply to fine aggregate for Low Slump Dense Concrete and Class M (I) concrete. **(800.2F)**

For determining the FM deviation from the mix design FM, the average of the five most recent FM tests shall be used. Until five FM tests have been made, base the deviation on the first FM test; then on the average of all previously run FM tests.

Additionally, for Portland Cement Concrete Paving conforming to **Section 380**; the FM of the fine aggregate, as established by the mix design, will be from 2.40 to 3.10 (wide band). A 0.20 variation (narrow band) from the established FM target value will be allowed providing that the narrow band FM test results are within the wide band limits of 2.40 and 3.10.

If the F.M. varies beyond the  $\pm 0.2$  limit, make adjustments to existing mix design proportions, as found in Chapter 6 Mix Design. Base the change on the average F.M. from the running average of 5 tests.

**The F.M. running average must be tracked and calculated manually. MS&T does not compare to the target F.M.**

*Reference:* "Fineness Modulus Adjustments" in Chapter 6.

## Central Lab Tests

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The Central Lab conducts tests for specific gravity, absolute volume, and absorbed moisture. These tests are conducted on materials submitted by plant inspectors.

### Specific Gravity

Specific Gravity is a ratio of the weight (force of gravity) of material to the weight (force of gravity) of an equal (specific) volume of water. In other words, it tells us how much heavier or lighter than water an object is. The specific gravity of water is 1.00. An illustration of a specific gravity calculation is shown on the next page. It compares the weights of one cubic foot of solid rock and one cubic foot of water.

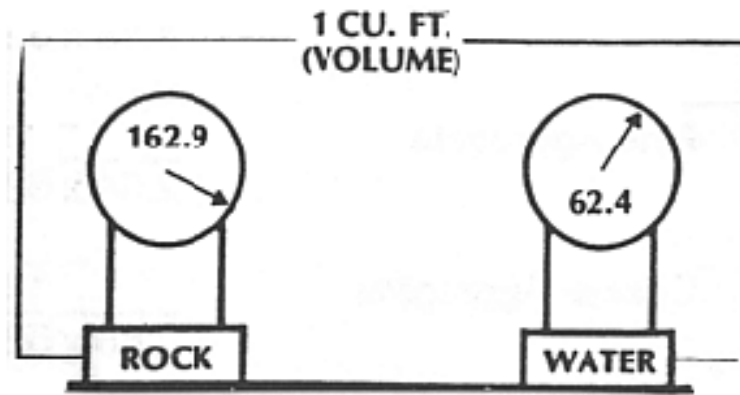
Specific Gravity =  $\frac{\text{Weight of Material per cubic foot}}{\text{Weight of Water per cubic foot}}$

Example: A one cubic foot volume of solid rock weighs 149.65 lbs. The weight of one cubic foot of water is 62.43 lbs.

Specific Gravity =  $\frac{149.65\#/cu\ ft}{62.43\#/cu\ ft} = 2.3982$  or 2.40

The specific gravity of aggregates is listed on the DOT-4 Form (Example Form 8). If cement of a type or from a source not listed is received, contact the Testing Lab for the specific gravity.

**Figure 5.2** Volume Illustration



## **Absolute Volume**

Absolute volume is the least amount of space a material would occupy if it were solid and contained no voids. The specific gravity and the weight of material must be known to find the absolute volume of a material. Find the absolute volume by dividing the product of the specific gravity, times the unit weight of water, into the weight of the material.

$$\text{Absolute volume} = \frac{\text{Weight of the Material}}{\text{Product of Specific Gravity} \times \text{unit weight of water}}$$

All concrete mixes are based on how much material it takes to make a cubic yard of concrete. Because the larger materials (coarse aggregates) leave voids that are filled with the smaller materials (sand, cement, water, and air), the absolute volume must be known.

To help understand absolute volumes, consider the following problems (Remember that water weighs 62.4 lbs./cu ft). A gallon of water weighs 8.34 lbs/gallon.

For example, a cubic yard (cu yd) of concrete contains materials with the following properties:

	<u>Weight lbs.</u>	<u>Bulk Specific Gravity</u>
Cement	460	3.15
Fly Ash	115	2.52
Fine Aggregate	1, 234	2.64
Coarse Aggregate	1,790	2.63
Water	236	1.00

The solid volume occupied by the materials in the concrete is:

Cement	$\frac{460 \text{ lbs.}}{3.15 \times 62.4 \text{ lb./cu. ft.}}$	= 2.34 cu. ft.
Fly Ash	$\frac{115 \text{ lbs.}}{2.52 \times 62.4 \text{ lb./cu. ft.}}$	= 0.73 cu. ft.
Fine Aggregate	$\frac{1,234 \text{ lbs.}}{2.64 \times 62.4 \text{ lb./cu. ft.}}$	= 7.49 cu. ft.
Coarse Aggregate	$\frac{1,790 \text{ lbs.}}{2.63 \times 62.4 \text{ lb./cu. ft.}}$	= 10.91 cu. ft.

Water	$\frac{236 \text{ lbs.}}{1.00 \times 62.4 \text{ lbs./cu. ft}}$	= 3.78 cu. ft.
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Air (6.5%)	$0.065 \times 27 \text{ cu. ft.}$	= 1.76 cu. ft.
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Total Volume of Materials = 27.01 cu. ft.

# 6

## MIX DESIGN & ADJUSTMENTS

Designing a mix is finding the correct quantities of materials for quality concrete. The Concrete Engineer NEEDS TO REVIEW all structural and paving mix designs. The mix design sheet (DOT-24) shall provide:

- Fineness Modulus of the Fine Aggregate
- Specific Gravity of the Aggregates
- Absolute Volume of Each Material per Cubic Yard of Concrete
- Weight of Each Material per Cubic Yard of Concrete
- Absorbed Moisture Value (%) of the Aggregates
- Admixtures

An example of a mix design is given in Example Form 7.

### Mix Review Process and Adjustments

Concrete Quality and Proportion: The Contractor shall design and be responsible for the performance of all concrete paving and structural mixes.

Mix design data and test results shall be recorded on a DOT-24 and submitted to the Concrete Engineer for review.

Also, the Concrete Office must review any request for adjustments to the original mix design related to the following:

- change in cement source or type
- fineness modulus
- gradation variations
- fly ash substitution
- change in admixture(s)

It is the contractor or supplier's responsibility to determine how much air entraining admixture and water to add. Do not tell him/her - just ensure that the maximum water requirements, as shown on the mix design, are not exceeded. Supplier must keep air within specification range.

## **Paving Concrete**

The contractor (**380.3 A**) sends samples of the aggregates, cement, and admixtures in the quantities specified in the - M.S.T.R. - Materials manual to the Central Testing Lab 40 days before mixing concrete. These samples must be taken from the stockpiled project materials. These stockpiles are located on the project or production site.

Plan specifications or notes direct the contractor to develop their own mix designs. Refer to the Special Provision for Contractor Furnished Mix Designs for PCC Paving.

Quantities to be submitted as specified in the M.S.T.R. Section of the Materials Manual for PCC Paving are listed below:

Fine Aggregate	750 lbs.
Coarse Aggregate(s)	1,100 lbs. (min. 350 lbs. for each size)
Cement	200 lbs.
Fly Ash	50 lbs.
Air Entraining Agent	8 oz.
Water Reducer(s)	32 oz.

Contact the Concrete Office if the same material has been used on another job and there is a current mix design.

## **Structural Concrete**

The mix design requirements can be found in **460.3 A**. The approved mix designs can be found at:

U:\ms\Materials- SDDOT Access\ConcMixDesigns\ContractorMixDesign.xlsx

## **Class M6, Controlled Density Fill, Misc. Concrete**

The Contractor is responsible for submitting to the Project Engineer all Class M6, Controlled Density Fill, and any other concrete designs to be used on the project. Designs must be reviewed for specification conformance prior to use.

Class M6 designs are submitted on a DOT-57 Supplier's Certification form (Appendix 13) and may be reviewed by the Project Engineer, Certification Engineer, or Concrete Engineer. Mix design requirements are detailed in section **462** of the Standard Specification book.

Controlled Density Fill designs are submitted on a DOT-77 Supplier's Certification form (Appendix 13) and may be reviewed by the Project Engineer, Certification Engineer, or Concrete Engineer. Specific options for proportioning are detailed in section **464** of the Standard Specifications book.

## **Water Cementitious Ratio**

Water is added to the mix for "hydration" purposes and so the fresh concrete can be worked. Most concrete needs 2.8 gallons of water per cwt. of cement for hydration. The rest of the water added is put into the mix for workability. The mix design lists the pounds of water needed per cubic yard of concrete. The water-cement ratio is defined as: (**460 C 2**)

water cementitious ratio (w/c) = 
$$\frac{\text{free water} + \text{batch water} + \text{added water}}{\text{weight of cement} + \text{fly ash}}$$

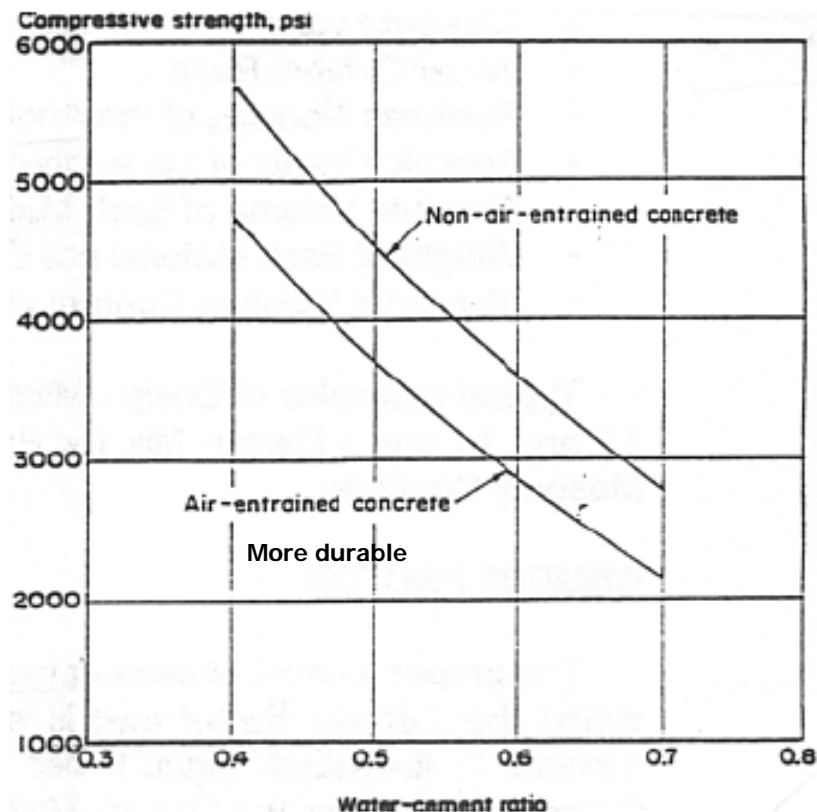
EXAMPLE: In a particular concrete mix, to produce 1 cubic yard of concrete with satisfactory workability requires 283 lbs. of water, 570 lbs. of cement, and 125 lbs of Fly Ash.

$$w/c = \frac{283 \text{ lbs}}{695} = 0.407 \text{ or } 0.41$$

Graphs for air-entrained and non-entrained concrete show the effect of the water cement ratio and air on strength (Figure 6.1). Durability increases as w/c ratio decreases. Air-entrained concrete is considerably more durable than non-air-entrained concrete.

The ratio does not tell the total water content of the mix, that can be calculated if the cement content is known. If cement remains constant, an increase in the water cement ratio indicates an increase in the water content. Similarly, a decrease in the water cement ratio indicates a decrease in the water content. The water cement ratio is significant in plastic concrete. As the water cement ratio goes up, the slump and air content increase. When the water cement ratio goes down, the slump and air content decrease.

**Figure 6.1** Compressive Strength Chart



## Moisture Adjustments

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The moisture of aggregates is usually more than is needed for absorption, thus creating free water. The mix design supplies the total amount of water needed for mixing. To get the right amount of mixing water in each batch, cut back the mix design quantity by an amount equal to the free water in the aggregate. Occasionally, check the method of drying against the oven drying method to know how much free moisture exists.

Take a moisture test of the aggregate at least every 2 hours, and let the Contractor know the results. On a paving job, take moisture tests for each sample obtained for a gradation test in accordance with the M.S.T.R section in the Materials Manual.

Some plants use moisture probes to determine the aggregate moisture but are typically only used for the sand. Moisture probes are typically mounted on the side of the bin and the probe extends into the aggregate. These probes measure the resistance to an electrical current to determine an aggregate moisture. Some of these units will show the total moisture, so discuss with the operator to determine what aggregate moisture is being provided for moisture adjustments happening in the batch computer. The following is from MSTR section and details how moisture testing may be reduced if moisture probes are being used:

Moisture testing may be reduced by the Engineer when automated concrete batching equipment with fine aggregate, or fine and coarse aggregate, moisture sensing capability is used.

When only the fine aggregate moisture sensors are used, the concrete plant shall use a coarse aggregate moisture (DOT-98A) acceptable to the Engineer. Any moisture sensor shall be accurate to 1.0% of the aggregate total moisture.

When the moisture testing is reduced, a moisture test for each size of aggregate shall be made at the start of production and every 5000 cubic yards or 5 days of production, whichever happens first.

The amount of mixing water is directly related to the slump of the concrete. Adjust the mixing water anytime the change in moisture content of the aggregates would cause a water change of 2 pounds per cubic yard of concrete.

**NOTE:** A one-gallon change in the mixing water per cubic yard of concrete will change the slump approximately one inch (excluding admixture effects).

Integral to the mixing drum of Central Plants is a “slump” indicator or amp meter that measures the power required to turn the mixer. This electronic sensor functions on drum drag. The wetter the mix (higher the slump) the lower the amperage reading. The dryer the mix (lower the slump) the higher the amperage reading.

**Figure 6.2** Amp Meter (Slump Indicator)



## Finding Free Moisture and Adjusted Weights of Mix Design

The following is an example of a paving mix design and total moisture (DOT-35 Example Form 12, 1:00pm) test results:

Material	Mix Design Weights Cu. Yd.	Total Moisture	Absorbed Moisture
Sand	1147 lbs.	4.6%	1.2%
1" Rock	1335 lbs.	0.9%	0.6%
Water	194 lbs.		

1. Find the percent of free moisture in each aggregate by subtracting the absorbed moisture from the total moisture.

$$\text{Sand} = 4.6\% - 1.2\% = 3.4\%$$

$$1" \text{ Rock} = 0.9\% - 0.6\% = 0.3\%$$

2. Find the total pounds of free water in the aggregates by multiplying the mix design cu. yd. by the percentage of free moisture and adding them together.

$$\text{Sand} = 1147 \text{ lbs.} \times 3.4\% = 39 \text{ lbs.}$$

$$1" \text{ Rock} = 1335 \text{ lbs.} \times 0.3\% = \underline{4 \text{ lbs.}}$$

43 lbs.

3. Adjust the amount of mixing water by subtracting the free water from the mix design water.

$$\text{Adjusted mixing water} = 194 \text{ lbs.} - 43 \text{ lbs.} = 151 \text{ lbs.}$$

4. Adjust the batch for the amount of aggregate in the mix. Do this by increasing each aggregate weight by the amount of free water it contains.

Material	Mix Design Weight cu. yd.	Free Water Weight	New Corrected Batch Weight
Sand	1147 lbs. +	39 lbs.	= 1186 lbs.
1" Rock	1335 lbs. +	4 lbs.	= 1339 lbs.
Water	194 lbs. -	39+4=43	= 151 lbs. (or 18.1 gal)

## Batch Weights

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Multiply the corrected batch weights/cu. yd. by the number of cubic yards to be batched at one time to determine the weights to be actually set on the scales when batching materials. Enter the data on the DOT-98A (Plant Inspectors Daily Report).

**PROBLEM:** What weights are needed for a 7-cubic yard batch if the data from Example Form 7 is used?

Assume all aggregates are at SSD.

Cement \_\_\_\_\_

Fly Ash \_\_\_\_\_

Sand \_\_\_\_\_

Rock \_\_\_\_\_

Chips \_\_\_\_\_

Water \_\_\_\_\_

## Plant Inspector's Daily Report

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Use the Plant Inspector's Daily Report (DOT-98A) to track weights and changes to the mix design. Complete this form for each day that concrete is produced. Example Form 9 is a completed DOT-98A form and will be used for the example below.

**To start filling out the Project and Design Mix portion of the form, you would:**

1. Enter the county name, project number, and the PCN number.
2. Enter the report number (consecutively, one report per day of operation) and note whether a structure or paving mix.
3. Complete the first four lines of the mix design box using the information contained in the mix design.

**To fill out the Proportioning for Moisture in Aggregate part of the report:**

The weights that will be set on the scales will be different because of the free moisture in the aggregates. Make use of the PROPORTIONING FOR MOISTURE IN AGGREGATE part of the report.

4. A moisture test was run at 10:45 AM with the following results:

<u>Material</u>	<u>Moisture</u>
Sand	5.7%
1.5" Rock	0.2%
1" Rock	0.6%
3/8" Rock (chips)	2.3%

Enter the time the tests were made in the first row. In this example (Example Form 9), go to the 3rd 'Time' column from the left. Enter the % TOTAL MOISTURE for each of the aggregates in the designated cells below the time entry row.

5. Enter the % ABSORBED MOISTURE for each aggregate. This is given on the "ABSORBED MOISTURE %" line in the box.

Sand = 1.1%

1.5" Rock = 0.2%

1" Rock = 0.2%

3/8" Chips = 0.6%

6. Subtract the % absorbed moisture from the % total moisture for each aggregate. This is the % FREE MOISTURE in the aggregate. For this example,

Sand contains 4.6% free moisture (5.7% - 1.1%).

1.5" rock contains 0.0% free moisture (0.2% - 0.2%)

1" rock contains 0.4% free moisture (0.6% - 0.2%) and,

3/8" chips contain 1.7% free moisture (2.3% - 0.6%)

7. Determine the free water in the aggregates. For each aggregate, multiply the % moisture times the batch weight of that material.

Sand 4.6% x 1,211 lbs. = 56 lbs.

1.5" Rock 0.0% x 393 lbs. = 0 lbs.

1" Rock 0.4% x 878 lbs. = 4 lbs.

3/8" Chips 1.7% x 546 lbs. = 9 lbs.

Enter these amounts on the "FREE MOISTURE, WT LBS" line for each aggregate

8. Find the weights needed for the mix design per cubic yard. Add the free moisture weights to the batch weights of each aggregate and put these figures on the "CORRECTED BATCH WEIGHT" line.

Sand 56 lbs. + 1,211 lbs. = 1,267 lbs.

1.5" Rock 0 lbs. + 393 lbs. = 393 lbs.

1" Rock 4 lbs. + 878 lbs. = 882 lbs.

3/8" Chips 9 lbs. + 546 lbs. = 555 lbs.

9. Calculate the amount of water to be added. Add the weights of the free moisture in the aggregates and enter the total on the "FREE WATER" space. In this case, the free water would be: 56 lbs. + 0 lbs. + 4 lbs. + 9 lbs. = 69 lbs. or 8.3 gallons.
10. The next row is "ADDED WATER". The weight in this space is the actual amount of water to add to the batch to maintain the slump. For this example, 172 lbs, or 20.6 gallons of water was needed.
11. The "TOTAL WATER" is calculated by adding the "FREE WATER" and "ADDED WATER". In this case, the Total Water Weight matches the Design Mix Water Amount (i.e. water is at its 'maximum' as allowed by the mix design). "TOTAL WATER" would be: 69 lbs. + 172 lbs.=241 lbs. or 28.9 gallons.

**To fill out the Scale Weights portion of the report:**

12. Determine the size batch to be used and enter this in the "batch size" column under SCALE WEIGHTS. Multiply this times the appropriate weights from above. REMEMBER, these are the actual weights the contractor will set on his plant scales. Be sure to use the "Corrected Batch Wt." for the sand and rocks. Enter the necessary weights for an 11-cubic yard batch (3rd line of calculations under SCALE WEIGHTS section). These exact weights cannot be set on the scales because they are not graduated fine enough. By setting the weight to the nearest graduation, the mix will still be obtained. New moisture tests have been run at the same time the above adjustment was made.

**DOT-98A**

REMEMBER, these moisture tests are run on a 2-hour basis and may not coincide with other adjustments. A workability adjustment does not mean that new moisture tests are needed.

Adjustments in the mix design can be made to improve workability. This is because of a change in F.M. or the water requirements to maintain slump. Any time a change in the mix design is made, show the new mix in the FIELD MIX CU. YD. area. These new weights will be needed when figuring the PROPORTIONING FOR MOISTURE IN AGGREGATES.

The Inspector's Daily Report (Example Form 9) shows that the mix was adjusted throughout the day due to changes in aggregate moistures. The moisture tests at 9:15 A.M. show that the 1" rock actually contained less total moisture than is required for absorption. The batch weight of this aggregate was reduced by the weight of water that it was missing.

Most of the plants will be measuring water in gallons rather than pounds. If using gallons, compute the free moisture in each aggregate in pounds and convert it to gallons to complete the total water being used.

If using the same field mix as on the previous day, the last field mix of the previous report should be entered as the first field mix on the current daily report.

Weather conditions may affect a concrete mix. For example, one day is hot, windy, and the humidity is low. The next day is cool, breezy, and the humidity is high. The slump can be maintained by reducing the total water content.

Whenever adjustments in the weights of the aggregates are made, always base the adjustment on the weights being used before the adjustment was made. The last adjustment will most likely be the field mix that will be used the next time concrete is produced.

Whenever making a mix adjustment, make it on "cubic yard" weights.

Attach a copy of the moisture tests (DOT-35) to the Plant Inspector Daily Report and send to the Concrete Engineer, the Area Engineer, and the Region Materials Engineer. Keep the original report for the files.

**NOTE:** Be sure that the report is signed and dated; keep a copy for use in developing the next day's report.

**Figure 6.3** DOT-98A (MS&T) Plant Inspectors Daily Report

DOT - 98A  
(09/2004)

South Dakota  
Department of Transportation  
File No.

**Plant Inspectors Daily Report**

Project IM 0291(73)4 County Union Inspector Arens, James PCN 6179  
Report # 19 Structure/Paving Mainline Design Mix Based on Saturated Surface Dry Aggregate Date 10/24/2011

Material	Cement	Fly Ash	Fine Aggregate	Coarse Aggregate	Water (lbs)	FM Fine Agg.
Source & Type	Ashgrove	Headwaters	A Higman Sand	B Concrete Materials	C Concrete Materials	Air Grace Daravair M
Specific Gravity	3.14	2.48	2.64	2.64	2.63	
Absorption			1.1	.2	.6	
Design Mix cu. yd.	460.	115.	1,211.	878.	546.	4.
*Field Mix cu. yd.						

\*Changes in design mix made in the field (workability, FM, etc)

Time	6:45 am	8:00 am	9:30 am	11:30 am	2:00 pm	4:30 pm
S Total Moisture, %	7.	6.8	6.7	6.6	6.5	5.8
A Absorbed Moisture, %	1.1	1.1	1.1	1.1	1.1	1.1
N Free Moisture, %	5.9	5.7	5.6	5.5	5.4	4.7
D Free Moisture Wt. lbs	71.	69.	68.	67.	65.	57.
Corrected Batch Wt. lbs	1,282.	1,280.	1,279.	1,278.	1,276.	1,268.
R Total Moisture, %	4	4	3.1	2.9	2.4	1.8
O Absorbed Moisture, %	2	2	2	2	2	2
K Free Moisture, %	2	2	1.1	1.0	1.0	0.6
C Free Moisture Wt. lbs	1	1	14.	13.	10.	9.
Corrected Batch Wt. lbs	384.	380.	392.	396.	394.	382.
W Total Water (lbs)	241.	241.	241.	241.	241.	241.
A Free Water (lbs)	79.	81.	85.	83.	88.	73.
T Added Water (lbs)	162	160.	156.	158.	172.	168.
E Gallons Water	19.4	19.2	18.7	18.9	20.6	20.1
R						

\* = field design used

**Scale Weights**

Batch Size	Cement	Fly Ash	Fine Aggregates	Coarse Aggregates	Water (gal.)	Air
11.00	5060	1265	14102	9680	5061	213
11.00	5060	1265	14080	9647	5160	211
11.00	5060	1265	14069	9680	5149	208
11.00	5060	1265	14058	9691	5116	208
11.00	5060	1265	14038	9658	5039	227
11.00	5060	1265	13948	9702	5105	221

\* Extra Cementitious Material Added

Remarks: Produced from 6:30 am to 6:00 pm  
Produced 275 loads @ 11 CuYds ea.

Additional Water for Workability:

# Mix Adjustments

---

## Air Content

The air content of the concrete plays a big part in workability. Do not neglect the air content when workability problems develop. Water is sometimes increased to correct a low slump when all that was needed was to increase the air content.

There are many factors that affect the air content, including aggregate gradation and mixing action.

<u>Increase of:</u>	<u>Percent Air will:</u>
Water/Cementitious Ratio	Increase
% Sand	Increase
Fines in Sand	Decrease
Cementitious Content or Fineness	Decrease
Temperature	Decrease
Mixing Time	Decrease
Wind Velocity	Decrease
Vibration	Decrease

## Admixtures

Check that the amount of admixture recommended by the supplier or manufacturer is being used in the mix. Do not allow the admixtures to contact each other before mixing, as a chemical reaction will begin. Check that the plant operator is following the manufacturer's product use recommendations. It is the concrete supplier's responsibility to provide information on admixture use.

## Fineness Modulus Adjustment

**Reference:** Testing of 'Fineness Modulus' in Chapter 5.

The proportion of sand in a mix design needs to be adjusted when the F.M. deviates from the design

F.M. by more than 0.2. This is a rule of thumb and for Contractor supplied mixes they will need to submit a solution.

The following conditions exist:

- For each increase of 0.1 in the F.M., increase the sand weight by 1/2% of the total weight of all the aggregates in the batch.
- For each decrease of 0.1 in the F.M., decrease the sand weight by 1/2% of the total weight of all the aggregates in the batch.

**NOTE:** Change the weight of the coarse aggregate at the same time that the sand weight is changed. This change will also have to compensate for any aggregate volume change, so the batch volume stays constant. This will be covered during Mix Adjustment.

Weight of Sand per Batch	= 1226 pounds
Weight of Rock per Batch	= 1856 pounds
Specific Gravity of Sand	= 2.62

Specific Gravity of Rock = 2.68

The F.M. of the sand has increased 0.3

1. Find the amount of weight that should be added to the sand weight. Multiply the total aggregate by 1.5% or 0.015.

$$\text{Extra Sand Weight} = 0.015 \times (1226 \text{ lbs.} + 1856 \text{ lbs.}) = 46.2 \text{ lbs.}$$

2. Find the volume of this extra sand by dividing the unit weight of water times the sand's specific gravity into the extra sand weight.

$$\text{Extra Volume} = \frac{46 \text{ lbs.}}{2.62 \times 62.4 \text{ lbs./cu. ft.}} = 0.28 \text{ cu. ft.}$$

3. Find how much the rock weight must be reduced to maintain a constant volume. Multiply the extra volume times the unit weight of water times the rock's specific gravity.

$$\text{Rock Weight} = 0.28 \text{ cu. ft.} \times 62.4 \text{ lbs./cu. ft.} \times 2.68 = 47 \text{ lbs.}$$

**NOTE:** This weight can also be found by using a ratio of specific gravity's (rock divided by sand) times the extra sand weight.

$$\frac{2.68}{2.62} \times 46 \text{ lbs.} = 47 \text{ lbs.}$$

4. Find the new batch weights for the sand and rock.

$$\text{Sand Weight} = 1226 \text{ lbs.} + 46 \text{ lbs.} = 1272 \text{ lbs.}$$

$$\text{Rock Weight} = 1856 \text{ lbs.} - 47 \text{ lbs.} = 1809 \text{ lbs.}$$

**NOTE:** Use the adjusted weights to figure the free moisture and corrected batch weights per cubic yard (DOT 98A form).

### **Additional Tests**

There will be requirements to make adjustments in the mix, such as when the F.M. changes in sand or when the aggregate moisture changes. To determine how the changes will affect the slump or air content, take a sample from a batch load and conduct the appropriate test(s). The South Dakota Materials Manual explains the air content under SD 403 and the slump under SD 404. Do not use these test results for acceptance tests.

**NOTE:** The results attained at the plant will usually be higher than those from the inspector at the placement site because of air loss during transit.

## **Hot Weather Concreting**

Do not place concrete when it has a temperature above 90°F. Bridge deck concrete temperature should be maintained below 80°F. The Engineer may authorize the maximum temperature be raised

to 85°F with specific circumstances, see specification book (**460.3 J**). Excessive concrete temperature can lead to the following:

- Lower ultimate strength
- Reduced Durability
- Lessened Resistance to freeze-thaw cycles
- Increased Shrinkage cracking

*Rule of Thumb:* For each rise of 10°F in the concrete temperature, add one gallon of water per cubic yard to maintain the same slump - Do not to exceed the water/cement ratio.

EXAMPLE: If using 29 gallons of water per cubic yard when concrete temperature was 65°F, use 30.5 gallons of water per cubic yard when the temperature is 80°F.

The temperature of concrete cannot be controlled as easily in hot weather as in cold weather. However, there are various methods that can be used to lower the temperature of fresh concrete. The plant operator can:

1. Use cold water even to the point of adding measured quantities of ice.
2. When practical, avoid the use of hot cement.
3. Insulate water-supply lines and tanks or at least paint exposed portions of a light color to reflect heat.
4. Cool coarse aggregate stockpiles by spraying them with water.
5. Cool mixer drums with water, paint them a white or light color, and keep them washed clean of cement and dust.
6. Shade materials and facilities with surplus camouflage nets or similar material.
7. Work at night assuming illumination is available for the paving operation.
8. Use Retarders/Hydration Stabilizers.

## **Cold Weather Concreting**

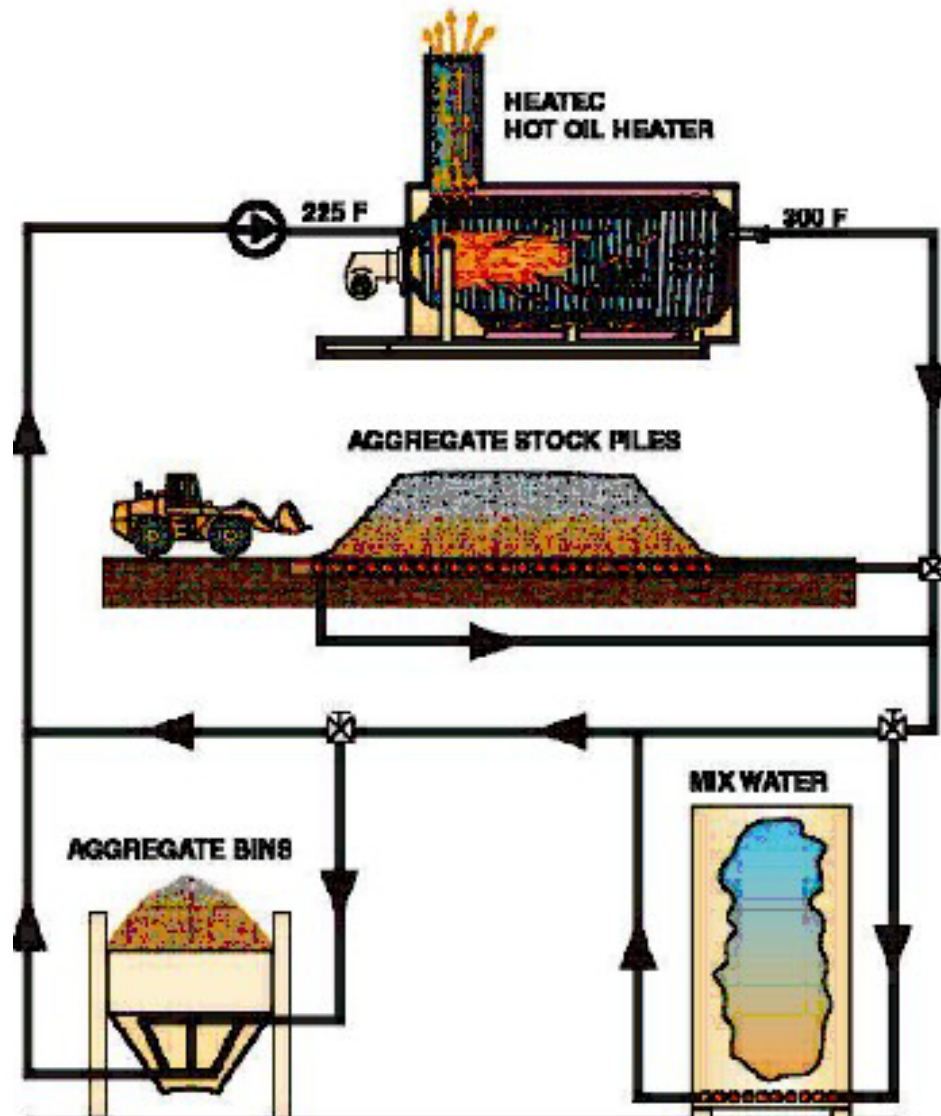
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Check the temperature of the mixed concrete when the weather is cold. The concrete must be at least 50°F and not more than 90°F. The contractor may heat the water or aggregates to keep the concrete within these limits. The water should never be heated over 160°F nor the aggregates over 100°F. If the water is heated over 100°F, mix it with the aggregates before adding cement to avoid a flash set. Keep the aggregates and water heating uniform to produce uniform concrete.

Be alert for frozen material. Conduct checks to ensure frozen lumps, ice, or snow is not allowed in the mix. When aggregates are heated, either radiant heaters built into the ready-mix plant or a "Thawzall" type hot water line system will be used on the pile. Check the material carefully to see that it is heated uniformly. If it is not, difficulty in producing uniform concrete or a flash set might occur.

Figure 6.4 Heating Aggregate Stockpiles

**ONE HEATEC HOT OIL HEATER  
CAN PROVIDE ALL THE HEAT NEEDED  
FOR MAKING CONCRETE IN COLD WEATHER**



The hydration time period can be reduced if one additional bag of cement per cubic yard of concrete is added. When this is done, make adjustments in the mix because of the extra volume.

### Extra Bag Adjustment

The extra cement also requires additional water to maintain the slump. Generally, the adding of 4 gallons of extra water per bag of cement is acceptable.

The following steps show how to adjust a mix for the addition of one bag of cement in cold weather to potentially shorten cure time of the concrete. The adjustments are made on the quantity of materials needed per cubic yard of concrete.

**NOTE:** The increase of one bag of cement will usually require an increase of approximately 30% more air entrainment per cubic yard.

**Example:**

Component	Weight	Specific Gravity
Cement	625	3.21
Sand	1269	2.63
Rock	1676	2.62
Water	267	1.00

1. Cement increased one bag = 94 lbs.

$$\begin{aligned}\text{New cement wt.} &= \text{design or field mix wt.} + \text{added cement wt.} \\ &= 625 \text{ lbs.} + 94 \text{ lbs.} = 719 \text{ lbs.}\end{aligned}$$

2. Add 4 gallons of water for the extra cement

$$\begin{aligned}\text{New water wt.} &= \text{design or field mix wt.} + \text{added water wt.} \\ &= 267 \text{ lbs.} + 33.4 \text{ lbs.} = 300 \text{ lbs.}\end{aligned}$$

3. Determine the added absolute volume due to the addition of 94 lbs. of cement and 4 gallons of water.

$$\begin{aligned}\text{Added cement vol.} &= \frac{\text{wt. of cement}}{\text{Sp. Gr. of cement} \times \text{water wt. per cu. ft.}} \\ &= \frac{94 \text{ lbs.}}{3.21 \times 62.4 \text{ lbs./cu. ft.}} = 0.47 \text{ cu. ft.}\end{aligned}$$

$$\begin{aligned}\text{Added water vol.} &= \frac{\text{No. of gallons} \times \text{water wt. per gallon}}{\text{water wt. per cu. ft.}} \\ &= \frac{4 \text{ gallons} \times 8.34 \text{ lbs./gallon}}{62.4 \text{ lbs./cu. ft.}} = 0.53 \text{ cu. ft.}\end{aligned}$$

$$\begin{aligned}\text{Total added vol.} &= \text{added cement vol.} + \text{added water vol.} \\ &= 0.47 \text{ cu. ft.} + 0.53 \text{ cu. ft.} = 1.00 \text{ cu. ft.}\end{aligned}$$

4. Reduce the absolute volume of the sand and rock to make room for the added volume of cement and water. Pro-rate the added volume based on the percentage of the sand and rock weights of the total aggregate weight. Do this so an absolute volume of 27 cu. ft./ 1 cu. yd. can be maintained.

$$\begin{aligned}\text{Total aggregate wt.} &= \text{sand wt.} + \text{rock wt.} \\ &= 1269 \text{ lbs.} + 1676 \text{ lbs.} = 2945 \text{ lbs.}\end{aligned}$$

$$\% \text{ of sand} = \frac{\text{sand wt.}}{\text{total aggregate}} = \frac{1269 \text{ lbs.}}{2945 \text{ lbs.}} = 43.1\%$$

$$\% \text{ of rock} = \frac{\text{rock wt.}}{\text{total aggregate wt.}} = \frac{1676 \text{ lbs.}}{2945 \text{ lbs.}} = 56.9\%$$

$$\begin{aligned}\text{Vol. sand to be reduced} &= \text{vol. increase} \times \% \text{ sand} \\ &\text{(cement \& water)}\end{aligned}$$

$$= 1.00 \text{ cu. ft} \times 43.1\% = 0.43 \text{ cu. ft.}$$

$$\begin{aligned}\text{Vol. rock to be reduced} &= \text{vol. increase} \times \% \text{ rock} \\ &\text{(cement \& water)}\end{aligned}$$

$$= 1.00 \text{ cu. ft} \times 56.9\% = 0.57 \text{ cu. ft.}$$

5. Determine the new weights for sand and rock.

$$\begin{aligned}\text{Reduced sand wt.} &= \text{reduced vol.} \times \text{sand Sp. Gr.} \times \text{water wt/cu. ft.} \\ &= 0.43 \text{ cu. ft} \times 2.63 \times 62.4 \text{ lbs./cu. ft} = 71 \text{ lbs.}\end{aligned}$$

$$\begin{aligned}\text{Reduced rock wt.} &= \text{reduced vol.} \times \text{rock Sp. Gr.} \times \text{water wt/cu. ft.} \\ &= 0.57 \text{ cu. ft} \times 2.62 \times 62.4 \text{ lbs./cu. ft.} = 93 \text{ lbs.}\end{aligned}$$

$$\begin{aligned}\text{New sand wt.} &= \text{design or field mix wt.} - \text{wt. of reduced vol.} \\ &= 1269 \text{ lbs.} - 71 \text{ lbs.} = 1198 \text{ lbs.}\end{aligned}$$

$$\begin{aligned}\text{New rock wt.} &= \text{design or field mix wt.} - \text{wt. of reduced vol.} \\ &= 1676 \text{ lbs.} - 93 \text{ lbs.} = 1583 \text{ lbs.}\end{aligned}$$

6. The new field batch weights with the extra bag of cement and the 4 gallons of water are:

$$\begin{aligned}\text{Cement} &= 719 \text{ lbs.} \\ \text{Water} &= 300 \text{ lbs.} \\ \text{Sand} &= 1198 \text{ lbs.} \\ \text{Rock} &= 1583 \text{ lbs.}\end{aligned}$$

## MOBILE CONCRETE MIXER

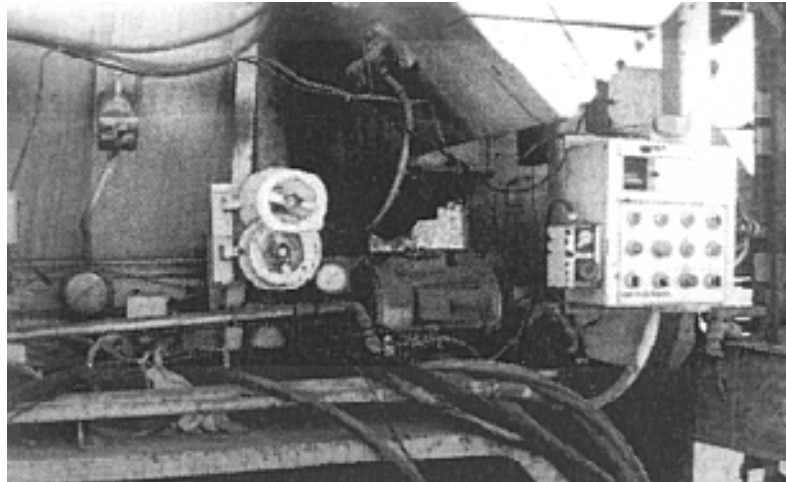
Specifications require that bridge deck overlay concrete be proportioned and mixed by a self-contained, mobile continuous mixing unit. The Mobile Concrete Mixer is usually truck mounted and carries unmixed material including water, to produce fresh concrete at the job site.

An annual calibration and inspection by the SDDOT will be required for each mixer before the start of the first project each year. The calibration establishes the meter count, i.e., the number of revolutions, and discharge time in seconds required to dispense 94 pounds of cement. Gate openings, pointer adjustments, and general operating condition of equipment will also be inspected, as per the manufacturer's recommendations.

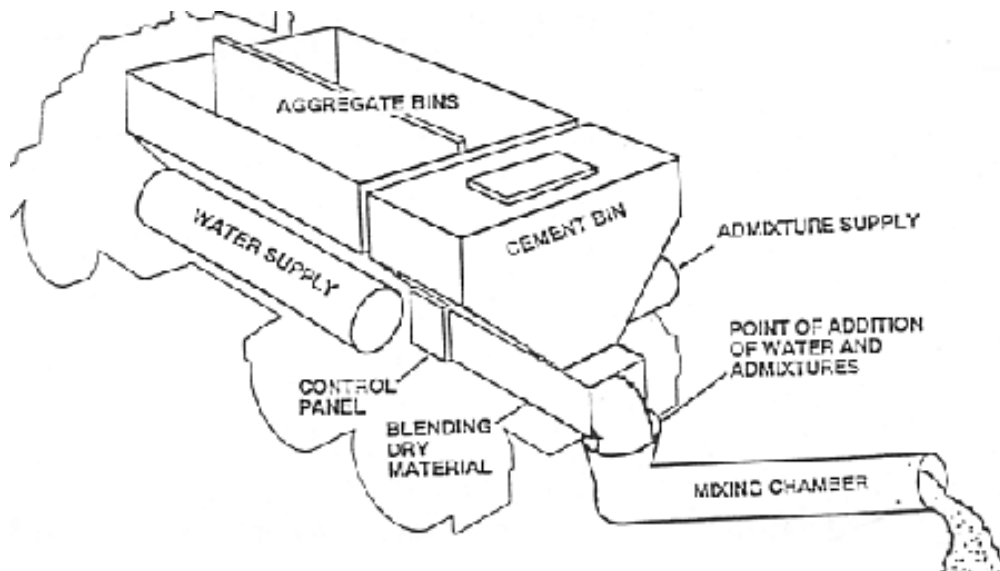
**Figure 7.1** Mobile Concrete Mixer



**Figure 7.2** Mobile Concrete Mixer



**Figure 7.3** Typical Mobile Concrete Mixer Schematic



The Contractor must have a qualified mixer operator who is completely familiar with the procedures necessary to calibrate the machine. The Contractor should supply necessary scales, containers, stop watches, operating manuals, and other materials and equipment necessary for calibration and inspection.

For actual calibration procedures, see the mixer operating manual. The calibration is recorded on DOT-293 (Figure 7.4) (Example Form 11-DOT-293). The form is signed by both the Contractor's representative and the inspector. The rock and sand gates are also calibrated in accordance with the operating manual.

Once calibrated, the mobile mixer does not need to be calibrated prior to each use. A yield test is run before each pour. The yield test is the proper way to determine whether the mobile mixer is still in proper calibration and good mechanical condition. The yield test involves discharging 1/4 cu. yd. Differences would indicate the need to re-calibrate. See the operating manual for proper yield test procedures.

Before running the yield test, you should inspect the general condition of the mixer. Make sure the bins, gates and belts are free of dried mortar, mud or other contaminants. Also ensure that filters and traps are clean.

Figure 7.4 Mobile Mixer Calibration Worksheet

DOT-293  
(1-12)

### MOBILE MIXER CALIBRATION

Contractor Overlays Inc. Mobile Mixer Serial No. 2B48  
 Inspector Rock Cartwright Operating Speed 10  
 Date 4-11-11

STEP 1.: Determine free moisture in sand and find starting point for sand and rock dial settings from operators manual or previous calibration:

Free Moisture Content of Sand (W) 3.5% (from test results)

Sand Dial Setting (Starting Point) (Y) 3.0

Rock Dial Setting (Starting Point) (Z) 4.2

STEP 2.: Set Mobile Mixer to Operating Speed.

Using the meter count designated in the Mobile Mixer Operators Manual or the Previous Years Calibrated Meter Reading as a starting point to target 70 to 90 lbs of cement. Make six test runs discharging cement. Record the "Weight of Cement", "Actual Meter Count" and "Time" for each of the six test runs in the table below.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	TOTALS
CEMENT WEIGHT	89.8	92.8	96.3	95.3	94.8	95.3	564.3 LBS (A)
METER COUNT	43	44	45	45	45	45	267 COUNTS (B)
TIME	18.3	18.9	19.7	19.5	19.2	19.4	115.0 SECONDS (C)

STEP 3.: Divide the Total Meter Count by the Total Cement Weight (Record to 4 Decimal Places):

$$\frac{(B)}{(A)} = \frac{267 \text{ Counts}}{564.3 \text{ Lbs}} = 0.4732 \text{ counts/lb(D)}$$

STEP 4.: Determine Cement Meter Reading for Discharge of 1 Cu. Yd. of Concrete by multiplying new cement meter count by the lbs of cement in the mix design.

$$(D) 0.4732 \text{ counts/lb} \times 823 \text{ lb/yd (mix design)} = 389.4 \text{ Counts/Yd}^3 (E)$$

STEP 5.: Determine weight of sand per cement meter count:

Adjust for free moisture content (from step 1) by multiplying the weight of sand required in the mix design by (1 + free moisture content):

$$\frac{(Wt.) \ 1394}{(E)} \times (1 + \frac{0.035}{(W)}) = \frac{1442.8 \text{ Lbs.}}{(F)}$$

Determine weight of sand per cement count by dividing the adjusted weight by the cement meter count for 1 Cu. Yd.:

$$\frac{(F) \ 1442.8}{(E) \ 389.4} = \frac{3.71 \text{ Lbs/Count of sand}}{(G)}$$

STEP 6.: Determine new sand setting (dial setting) by dividing a measurable weight of sand (Between 80 and 90 lbs.) by the weight of sand per cement meter count.:

$$\frac{(Wt) \ 85 \text{ lbs.}}{(G) \ 3.71 \text{ Lbs/Count}} = \frac{23 \text{ Counts}}{(H) \text{ (round to whole no.)}}$$

Set Dial for Sand to setting in (Y) of Step 1.

Discharge sand and try to stop discharging when cement meter reading is at the Count calculated above (H). Record the Sand Dial Setting, Weight of Sand Discharged, and the Actual Cement Meter Reading. Compute the Weight of Sand Discharged per Count. Continue until three successive runs are made in which the Weight of Sand Discharged per Count equals the value (G) from Step 5.:

	<u>DIAL SETTING</u>	<u>SAND WEIGHT</u>	<u>CEMENT METER COUNT</u>	<u>WEIGHT OF SAND PER COUNT</u>
Run 1	<u>3.0</u>	<u>90.3</u>	<u>21</u>	<u>4.30</u>
Run 2	<u>2.9</u>	<u>88.8</u>	<u>23</u>	<u>3.86</u>
Run 3	<u>2.9</u>	<u>92.4</u>	<u>24</u>	<u>3.85</u>
Run 4	<u>2.8</u>	<u>85.5</u>	<u>23</u>	<u>3.72</u>
Run 5	<u>2.8</u>	<u>85.3</u>	<u>23</u>	<u>3.71</u>
Run 6	<u>2.8</u>	<u>85.4</u>	<u>23</u>	<u>3.71</u>

Use Sand Dial Setting = 2.8

STEP 7.: Determine weight of rock per cement meter count by dividing the weight of rock required by the mix design by the cement meter count for 1 Cu. Yd. (adjust rock weight for free moisture if needed) :

$$\frac{(Wt.) \quad 1394}{(E) \quad 389.4} = \frac{3.58}{\text{Lbs/Count of rock (I)}}$$

STEP 8.: Determine new rock setting (dial setting) by dividing a measureable weight of rock (Between 80 and 90 lbs.) by the cement meter count for 1 Cu. Yd.:

$$\frac{(Wt.) \quad 85 \quad \text{lbs.}}{(I) \quad 3.58 \quad \text{Lbs/Count}} = \frac{24 \quad \text{Counts (J) (round to whole no.)}}{\text{Lbs/Count}}$$

Set Dial for Rock to setting in (Z) of Step 1.

Discharge rock and try to stop discharging when cement meter reading is at the Count calculated above (J). Record the Rock Dial Setting, Weight of Sand Discharged, and the Actual Cement Meter Reading. Compute the Weight of Rock Discharged per Count. Continue until three successive runs are made in which the Weight of Rock Discharged per Count equals the value (I) from Step 7.:

	<u>DIAL SETTING</u>	<u>ROCK WEIGHT</u>	<u>CEMENT METER COUNT</u>	<u>WEIGHT OF ROCK PER COUNT</u>
Run 1	<u>4.2</u>	<u>82.7</u>	<u>22</u>	<u>3.76</u>
Run 2	<u>4.1</u>	<u>83.3</u>	<u>23</u>	<u>3.62</u>
Run 3	<u>4.1</u>	<u>83.7</u>	<u>23</u>	<u>3.64</u>
Run 4	<u>4.0</u>	<u>86.2</u>	<u>24</u>	<u>3.59</u>
Run 5	<u>4.0</u>	<u>82.3</u>	<u>23</u>	<u>3.58</u>
Run 6	<u>4.0</u>	<u>85.8</u>	<u>24</u>	<u>3.58</u>

Use Rock Dial Setting = 4.0

## WATER ADJUSTMENTS (If needed)

Use the following bullets to adjust the rate of water discharged to maintain the mix design W/C ratio.

- Adjust the mix design water for free moisture in sand (and rock if needed) and convert to gallons.  $= \frac{\text{gallons}}{\text{yd}^3}$  (K)
- Divide the Total Number of Seconds by the Total Cement Weight as determined in Step 2. (Record to 4 Decimal Places):

$$(C) \frac{\text{seconds}}{\text{lb}} \div (A) \frac{\text{lb}}{\text{yd}^3} = \frac{\text{sec}}{\text{lb}} (L)$$

- Determine Time to Discharge 1 Cu. Yd. of Concrete by multiplying the seconds/lb by the lbs of cement in the mix design.

$$(L) \frac{\text{sec}}{\text{lb}} \times \frac{\text{lb}}{\text{yd}^3} (\text{mix design}) = \frac{\text{sec}}{\text{yd}^3} (M)$$

- Determine Discharge rate of water by multiplying (M) by adjusted mix water (K).

$$(M) \frac{\text{sec}}{\text{yd}^3} \div (K) \frac{\text{gallons}}{\text{yd}^3} = \frac{\text{sec}}{\text{gallon}} (N)$$

- Convert (N) to Gallons/Minute and set the mixer's Water Meter to this rate.

$$60 \frac{\text{sec}}{\text{minute}} \div (N) \frac{\text{sec}}{\text{gallon}} = \frac{\text{gallons}}{\text{minute}}$$

## YIELD TEST

Before batching concrete a Yield Test must be run:

- 1/4 Cu. Yd. Form
- Determine Cement Meter Count for 1/4 Cu. Yd.
- Set Mobile Mixer at Operating Speed
- Set Cement Meter at Zero
- Discharge Concrete until Cement Meter Reading is reached
- 1/4 Cu. Yd. Form should be full, but no overspill

## CUBIC YARDS FOR PAYMENT

To compute the Cubic Yards for Payment:

- Get a total cement meter count used for each placement
- Total cement meter count divided by cement meter reading for discharge of 1 cubic yard.

$$\text{Total Meter Count} / (E) = \text{Cubic Yards Used}$$

- Deduct any waste if needed

## 8

**DAILY INSPECTIONS**

The production of quality concrete begins at the plant where the concrete is produced. Be sure that all specifications are met, and that quality concrete is being produced. Check the SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, PLAN NOTES, and SPECIAL PROVISIONS very carefully to be sure that the Contractor is fulfilling the contract requirements.

Maintain a cooperative relationship with the contractor and his personnel. Never direct them on the operation of their equipment. If they ask for a suggestion provide a good recommendation. There may be problems, so be cooperative. If something can be done to improve the job, discuss the change with the contractor. If an unmanageable situation develops, contact the Project Engineer. Remember, everyone wants to produce quality concrete with as few problems as possible.

**Scales**

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Check scales before “starting up” and periodically thereafter. Verify that the scale will balance empty when weighing hoppers at zero load. On a beam scale, the over under indicator will show if the scale is in balance. On a dial scale, the pointer should be on zero. Have the contractor adjust the scales if they do not balance. Adjustments will not affect the accuracy of the scale. Adjustments are necessary when excess material sticks to the hopper or temperature changes affect the lever rods.

Check the scale sensitivity after the zero balance. Place a weight equal to one scale graduation on the weigh hopper. The over/under indicator should move at least 1/8 inch on a beam scale. The pointer on a dial scale should move to the next graduation mark. Remove the weight and have the Contractor fill the weigh hopper to check movement. Repeat this process for all loads that will be weighed. The contractor must repair the scale if it does not meet the sensitivity requirements. Adjustments to the working parts can be made, but a scale inspector must check the accuracy.

**NOTE:** The engineer can use other means to check small on-site plants. Check with him/her for the procedure to use in these situations.

**Cement and Fly Ash Checks**

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The quantity of cement and fly ash used versus the quantity specified will be checked periodically by running a cutoff. The Contractor shall completely empty the silo and necessary conveyances at the direction of the Engineer. Individual cutoffs shall not show an underrun exceeding 1.5%, nor shall the final cutoff show an overall underrun exceeding 1% (**380.3 D**). It is best to run the

cutoff when the silo is nearly empty because the contractor will have to empty the silo. Get copies of all the cement and fly ash weight tickets to check the amount of cement. Have the contractor empty any partially unloaded cement or fly ash and all silos. Be sure to get a total for all the cement and fly ash delivered and used since the last cement and fly ash check and cutoff.

Use DOT-13 Form - Cement Record Sheet (Appendix 13) for the cement and fly ash checks. This form is used on a daily basis. Use Page 1 of DOT-13 Form (Appendix 13) for cement and fly ash brought to the plant site. Record the:

Car or Transport Number

- Date it was unloaded
- Number of cwt. in the load
- Initials of the person who took the cement sample

Use page 2 of DOT-13 Form (Appendix 13) for the cement and fly ash used each day. To find the amount of cement and fly ash used, perform the item entries listed below:

Item #6: The date for each day that concrete was batched.

Item #7: Any cement or fly ash wasted during unloading. Estimate if necessary

**NOTE:** A little cement goes a long way. 100 pounds of spilled cement will appear much larger.

Item #8: Any cement wasted during batching or to wind loss. Estimate if necessary.

Item #9: The weight in cwt. of cement specified for each batch.

Item #10: Total number of batches actually used.

Item #11: Total number of batches wasted.

**NOTE:** The totals of items 10 & 11 should equal the number of batches produced by the plant each day.

Item #12: Total cwt.'s of cement and fly ash used (number of batches used times the weight per batch).

Item #13: Total cwt.'s of cement or fly ash wasted from items 7, 8, and 11 (number of batches wasted times the weight per batch).

Item #14: Total of the cement from items 12 and 13.

Item #15: Only fill in this column when making a cement or fly ash check. This is the total received from item 4 of Appendix 13.

Item #16: Only fill in this column when making a cement check. This is the difference between the totals of items 14 and 15. Use a plus (+) when item 15 is larger than item 14.

If the difference in item 16 is more than % of the total of item 14, start doing some checking. Perhaps there is a problem with the scale. Their accuracy could be off, or the cement or fly ash is not being batched within the % tolerance.

**NOTE:** A cutoff will not be performed if concrete is supplied by a commercial redi-mix plant also supplying concrete to non SDDOT projects at the same time.

From time to time minor adjustments in the mix design will be needed to meet job conditions. Mix adjustments that affect the cement quality need to be monitored and OK'd by the Plant Inspector before changed so the correct amount of cement batched can be used for the cutoff.

The concrete plant will have some form of dust collection system. The dust captured goes into the "bag house" or dust collector. These fines are mostly cement and fly ash dust with a little aggregate

dust as well. Bag house fines are reused by some concrete plants, if these fines are not re-used, they are often buried on-site. Bag house fines being reused must be either constantly metered or regularly dumped back into a cement or fly ash silo. If the bag house dust is being dumped regularly, this interval must be agreed to by the inspector as unregulated use of this waste product cannot be allowed.

## Hauling Units

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A small amount of concrete may stay inside the drums or boxes of the hauling units. This concrete dries over time. When a new batch is placed in the unit, it will combine with the dried concrete. Poor concrete will be produced when this happens. To eliminate this possibility, clean the concrete compartment on all haul units and flush with water. Make sure that all of the wash water is out of the unit before the next batch, or it will cause too much slump. It also creates quite a mess!

Allowing trucks to haul overloaded should not be allowed. The contractor is required to have cab cards for each of his trucks and a gross permissible is known (**9.1F**). Batching loads of concrete to cause overloads should be avoided. If this becomes a problem alerting the Motor Carrier or Highway Patrol should solve the problem.

## Batch/Haul Tickets

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There are time requirements for mixing and hauling. Tickets are issued to control these limits.

Batch Ticket  
Ticket: 333  
Customer Name: S.D.D.O.T.  
Delivery Address:  
Job Description: Paving HWY 18  
Instructions:  
Formula: #2  
Load Size: 9.00 yards  
Daily Qty: 2,997.00  
Driver:  
Truck: 0  
Product Name Target Actual Error %MC  
1" Rock 12,800 12,740 lbs -0.5% 0.9  
Sand 11,560 11,520 lbs -0.3% 2.3  
Chips 4,260 4,280 lbs 0.5% 1.4  
Cement 3,960 3,965 lbs 0.1% 0.0  
Flyash 990 995 lbs 0.5% 0.0  
Water 187 186 gallons -0.5%  
Air 184 184 fluid ozs 0.0%  
Water Reducer 296 296 fluid ozs 0.0%  
Production Total: 2,997.00 yards  
Water to Add at Site: 1 gallons

6/28/2005 4:10:40 PM  
Job Name: South Dakota DOT  
Resold Amt 0.00  
Order Qty: 0  
Temper Water Quantity: 0  
Water to Cement Ratio: 0.38  
Slump: 1.5  
Mix Time: 76  
Del Qty: 23,185 yards

There may be times when different types of concrete are batched from the same plant. The mix design number could be placed on the haul ticket in the "Material" blank to eliminate confusion.

The mixing time starts when the cement comes into contact with the water or wet aggregates. Put the mixing start time on the ticket.

Put the revolution counter reading under "Revolutions". Take the reading when the drum starts turning at mixing speed. Plant Inspectors should review the Requirements regarding computer generated batch tickets, especially as they apply to Structural Concrete and Concrete for Incidental Construction.

There are occasions when the haul from the batch plant to the job site exceeds the allowable time limit. In this case, the contractor can add the water and cement at the job site. Under these conditions, do not put the water in the batch, the start mixing time, and the revolution counter reading on the ticket. Note on the ticket the amount of free water and how much more water should be added at the job site. The Placement Inspector will make any further adjustments.

There are two things to be done when the water and cement are added on site. Use aggregate weights for the batch that will be equal to some number of full bags of cement. Also, calibrate the water tank on the truck so the Placement Inspector can get the correct amount of water.

## **Delivery Times**

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When continuously agitated in the hauling unit, concrete shall be: 1) discharged within 90 minutes, and 2) screeded within 105 minutes after the cement has been placed in contact with the aggregates. When the concrete temperature is 85° or above for paving concrete (80° for structural concrete), the time limitation shall be reduced to: 1) discharged within 45 minutes and 2) discharged and screeded within 60 minutes (**380.3 F and 460.3 G**).

When not continuously agitated in the hauling unit, concrete shall be: 1) discharged within 45 minutes and 2) discharged and screeded within 60 minutes after the cement had been placed in contact with the aggregates. When the concrete temperature is 80°F or above, the time limitation shall be reduced to: 1) discharged within 30 minutes and 2) discharged and screeded within 45 minutes. (**380.3 F and 460.3 G**).

## **Partial Batches**

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Whenever the concrete is mixed, a certain amount of cement paste is lost in coating the inside of the drum. The amount of paste needed for this coating remains the same regardless of the size of the batch being mixed. If a batch equal to the drum's rated capacity is being mixed, only a small percentage of the total cement paste is lost. If a small batch is being mixed, a larger percentage of the total cement paste will be lost. This loss could result in the production of low strength concrete.

Specification (**380.3 E**) provides guidance on how much extra cement is to be added for partial batches. When a concrete batch is transported in a truck mixer or agitator and the batch is smaller than 60% of the rated capacity of the truck mixer or agitator, the following percentage of additional cementitious material at the same proportions as listed on the mix design shall be added to the batch:

40 to 60 percent rated capacity - - - - -	5% cement
20 to 39 percent rated capacity - - - - -	10% cement
10 to 19 percent rated capacity - - - - -	15% cement
0 to 9 percent rated capacity - - - - -	20% cement

The above provisions regarding additional cementitious material shall also apply to the mixing of small batches in central plants. Additional cementitious material will not be required when the small batch is mixed in a drum that is sufficiently coated with mortar to withstand the loss of cementitious material. Sufficient mortar coating, as determined by the engineer, may include mortar coating the drum from a previously mixed batch during continuous mixing operations. Additional cementitious material will be required if more than 30 minutes has passed from the mixing of the previous batch, if the drum has been cleaned following the previous batch, or if the mortar coating the drum has been disturbed following the previous batch.

EXAMPLE: The contractor wants to mix a 2.5 cubic yard batch in a mixer that has a rated capacity of 7.5 cubic yards. The amount of cement required for a 2.5 cubic yard batch is 1410 pounds.

$$\text{Portion of rated capacity} = \frac{2.5 \text{ cu. yds.}}{7.5 \text{ cu. yds.}} = 33\% \text{ of mixer}$$

Use 10% additional cement.

$$\text{Total cement for batch} = 1410 \text{ lbs.} \times 10\% = 141.0 \text{ lbs.}$$

$$= 1410 \text{ lbs.} + 141.0 \text{ lbs}$$

$$= 1551 \text{ lbs.}$$

Adding cement for a partial batch is the one and only exception when volume adjustments are not made. There is a possibility that the added cement may require additional water. It may not be possible to determine the exact amount of extra water. If needed, it can be added at the construction site.

## **Summary**

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The inspector at the plant site must understand how important it is for all materials to be uniform and be on the alert for any sudden changes in delivery, storage, or handling of materials. A plant inspector must know all the plant operations that could cause contamination, degradation, or deterioration during storage and handling.

The inspector must not permit stockpiling of aggregates in any manner that would create excessive segregation or degradation of the materials. He must be watchful against materials becoming contaminated as they run low. A daily report is required for all materials delivered. Report any nonconformity.

The inspector's judgement and performance will frequently determine the acceptance or rejection of thousands of dollars' worth of materials, concrete, and pavement. By the meticulous, consistent use of the principles and tests, and by the exercise of good judgment, the inspector can ensure that the materials are of the specified quality.

The plant inspector must maintain a complete diary of the daily plant operations such as the example in Appendix 13.



## 9

**ANSWERS TO PROBLEMS**

- Ch. 3, pg. 30     Sample size = 22 lbs.  
                         Opening size = 1.5"
- Ch. 5, pg. 50      $1.0\% (40.3\% \times 1.06\%) + (59.7\% \times 0.88\%) = 0.43 + 0.53 = 1.0$
- Ch. 5, pg. 51     Sand = 1.1%  
                         Rock = 0.5%
- Ch. 5, pg. 53     3.09
- Ch. 6, pg. 62     Cement = 3,220 lbs.  $(460 \times 7)$   
                         Fly Ash = 805 lbs.  $(115 \times 7)$   
                         Sand = 8,540 lbs.  $(1220 \times 7)$   
                         Rock = 9,618 lbs.  $(1374 \times 7)$   
                         Chips = 3,206 lbs.  $(458 \times 7)$   
                         Water = 1,694 lbs.  $(242 \times 7)$



## 10

**VOCABULARY**

**Absolute volume** - The least amount of space a material would occupy if it were solid and contained no voids. Found by dividing the product of the specific gravity times the unit weight of water, into the weight of the material.

**Absorbed moisture** - (Absorption) The amount of water needed to fill the permeable pores inside the aggregates.

**Accelerators** - Admixtures used to speed up the strength development of concrete at an early age.

**Acceptance samples and tests** - Acceptance samples and tests include the samples and tests used for determining the acceptability of the materials and workmanship that have been or are being incorporated into the project work. They are the principle basis for determining the acceptability of project materials and construction and assure compliance with specifications.

**Added water** - Added water as referred to on DOT-98A, Plant Inspector's Daily Report, is that actual amount of water introduced into the mix at the plant in order to obtain the desired consistency. When added water and free water are summed, the result is termed total water.

**Admixture** - Liquid or solid material added to a concrete mix to improve one or more characteristics of the concrete.

**Aggregates** - The sand and gravel or crushed rock used in making concrete. Aggregates are porous solid particles.

**Agitators** - Blades used to keep the concrete mixed during delivery to a project site. They must be turning continuously and at a speed fast enough to keep the concrete from segregating.

**Air entraining admixtures** - Those admixtures used to deliberately produce very small, uniformly spaced bubbles in a concrete mix to allow greater workability and more resistance to cycles of freezing and thawing.

**Alkali** - Any soluble mineral salt or mixture of salts found in soils and capable of neutralizing acids.

**Ambient temperature** - The temperature on all sides.

**Automatic controls** - Controls on a concrete paving batch plant. They perform specific functions automatically when weighing aggregates and cement.

**Batch** - Amount of material that is to be mixed at one time.

Batch plant - An operating installation of equipment including batchers and mixers as required for batching or for batching and mixing concrete materials. It is also referred to as mixing plant when mixing equipment is included.

Batcher - A device used for measuring materials for a batch of concrete.

Batching - Weighing or volumetrically measuring materials for a batch of concrete. Bins - Containers used for storing aggregates.

Bituminous coal - Coal that yields pitch or tar when it burns; soft coal.

Bleeding - The migration of water to the top surface of freshly placed concrete caused by the settlement of solid materials-cement, sand, and stone- within the mass.

Carbon - A nonmetallic chemical element found in many inorganic and all organic compounds.

Cement check - Verification of actual cement used vs. theoretical amount of cement used.

Cement shipped to the project is compared against the theoretical amount used through the plant. Plant wastes are also accounted for.

Cement content - (Cement factor) - Quantity of cement contained in a unit volume of concrete or mortar, preferably expressed as weight.

Cement, low alkali - A Portland Cement that contains a relatively small amount of sodium or potassium or both, and in the United States, a cement containing not more than 0.6%  $\text{Na}_2\text{O}$  equivalent.

Cement, Portland - Portland Cements are hydraulic cements consisting essentially of hydraulic calcium silicates. Hydraulic cements set and harden by reacting chemically with water.

Cement, Type I - A general purpose Portland Cement suitable for all uses where the special properties of other types are not required.

Cement, Type II - A Portland Cement that is used when moderate sulfate resistance or moderate heat of hydration is desired.

Cement, Type III - A "high early strength" Portland Cement used when rapid strength is needed.

Central mixed concrete - Concrete which is completely mixed in a stationary mixer from which it is transported to the job site.

Central testing lab - Central Materials Surfacing Laboratory.

Certificate of calibration - As referred to in this manual, a certified statement by a qualified agency attesting to the accuracy of equipment they have checked and/or adjusted. The certificate should show the serial number of equipment, date of calibration, be signed by a representative of the agency and indicate the accuracy witnessed.

Certificate of compliance - Refer to the Materials Manual, Required Samples, Tests, and Certificates Section, "5.10 Certificates" for a complete definition and operational procedures.

Certified fabricators, mills, and plants - Refer to the Materials Manual, Required Samples, Tests, and Certificates Section, "5.11 Certified Fabricators, Mills, and Plants".

Coarse aggregates - Aggregates with particles predominantly larger than 0.2 inches (No. 4 sieve).

Concrete - As referred to in this manual, concrete is a construction material comprised of Portland Cement, aggregates of a specific gradation, water, and various admixtures blended together in specific proportions.

Contractor - An independent person or firm who has signed a legal agreement to perform work that meets the standards specified by that agreement.

Conveyor - A mechanical device used to transfer the materials used to make concrete. The flow is uniform.

Curing - Maintenance of humidity and temperature of freshly placed concrete during some definite period following placing, casting, or finishing to assure satisfactory hydration of the cementitious materials and proper hardening of the concrete.

Dissolved solids - The impurities dispersed in water used for mixing concrete, expressed as PPM (parts per million). When excessive, they may affect setting time, strength, and other properties of concrete.

Drum - The part of a mixer where batched materials are mixed into concrete. Expanded shale - A lightweight aggregate.

Fine aggregates - Aggregate particles smaller than No. 4 sieve, but larger than No. 200 sieve.

Fineness Modulus (FM) - FM is an index of the fineness of an aggregate. The higher the FM, the coarser the aggregate.

Flash set - When concrete sets up almost immediately after the mixing action has been completed, leaving no time to place and finish concrete. Slump is lost nearly instantaneously.

Fly ash - A mineral admixture which improves the workability of concrete mixes deficient in the finer sand particles, and usually has some water reducing qualities.

Free moisture - Amount of moisture in the aggregates above the amount needed for absorbed moisture and considered to be part of the mixing water in concrete. It is also called free water.

Gradation - The grading is the particle size distribution of an aggregate as determined by a sieve analysis and expressed as the percentage of material passing each sieve.

Graduations - As referred to in this manual, graduations are the increments marked on scales that determine the accuracy to which material can be weighed.

Haul ticket - Tickets used to control various specifications, normally the DOT-75 Form. As referred to in this manual, they may be used to control mixing time and rate, time of delivery, amount of water added, and provide a ready means of determining approximate quantities when required. Information normally shown on a ticket includes: project number, type of material, date, truck number, allowable and actual water, time mixing started and time of discharge, batch size, mixer revolutions and rate, and inspector's initials. Other information may include: location of placement, running total of quantity and special remarks by the inspector.

Hauling unit - The unit used to carry batches of concrete.

Hydration - The chemical reaction of cement and water to form a rocklike mass. Injurious - Harmful or damaging.

Inspector - The authorized representative assigned to make detailed inspections of contract performance.

Lignite coal - A soft, brownish-black coal in which the texture of the original wood can still be seen.

Structural concrete - As referred to in this manual, Portland Cement Concrete produced in conformance with mix designs for general construction use. Generally, this term is used when speaking of Class A concrete construction applications.

Mix Design - The concrete mixture "or recipe" developed using a process by which one arrives at the right combination of cement, aggregates, water, and admixture for making concrete that will conform to a given specification for workability, strength, and durability.

Mixer - A machine used for blending the constituents of concrete, mortar, grout, or other mixture.

Mixing plant - See Batch Plant

Moisture content - The amount of moisture in the aggregate consisting of absorbed moisture plus free moisture.

Moisture testing - Testing of a sample by various methods to determine the amount of moisture present.

Partial batch - A batch size smaller than 60% of the rated capacity of the mixer or agitator. Additional cement must be added to partial batches, as required by the Standard Specifications, to account for cement paste lost to coating the inside of the drum.

Paving concrete - As referred to in this manual, Portland Cement Concrete produced in conformance with mix designs for use in flat work. Generally, this term is used when speaking of specific mix designs for individual paving contracts involving slipform operations.

Pit - An area of land designated for use in the securement of construction materials. Typically, the pit area is salvaged of topsoil, mined, and reclaimed after use.

Plans - The contract drawings and notes which show the location, character, and dimensions of the prescribed work, including: layouts, profiles, cross sections, and contract documents.

Plastic concrete - That concrete which is pliable and capable of being molded or shaped like a lump of modeling clay. All grains of sand or pieces of gravel or stone are encased and held in suspension. This concrete does not crumble but flows sluggishly without segregation.

Pozzolan - A volcanic rock, powdered and used in making a hydraulic cement. Sometimes added in addition to or as a partial replacement of cement to aid in workability and resistance to sulfate attack and alkali reactivity.

Quality control - System for insuring quality of output involving inspection, analysis, and action to make required changes.

Ready mixed concrete - Concrete that is proportioned and mixed off the project site and delivered to the construction area in a plastic and unhardened state. (See Central Mixed Concrete and Transit Mixed Concrete).

Sample splitting - Breaking down a sample to make it a more acceptable size to testing.

Sampling - Collecting an amount of material for testing to make sure that it meets specifications.

Saturated surface dry - Condition of an aggregate particle or other porous solid. When the permeable voids are filled with water and no water is on the exposed surfaces. (See also Absorbed Moisture)

Scale - A device used to weigh samples

Sieve - A woven wire cloth mounted in a suitable frame or holder for use in separating material according to size.

Slipform paving - Construction method used to spread and finish concrete in one operation, eliminating the need for stationary forms. A form is pulled or raised as concrete is placed.

Slump - A measure of consistency of freshly mixed concrete.

Slump loss - The amount by which the slump of freshly mixed concrete changes during a period of time after an initial slump test was made on a sample.

Special provisions - Additions and revisions to the standard and supplemental specifications applicable to an individual project.

Specifications - A general term applied to all directions, provisions, and requirements pertaining to performance of the work.

Specific gravity - For the purposes of this manual, a ratio found by dividing the weight of a volume of water into the weight of an equal volume of solid material. This is how many times "heavier" than water the material is, in simple terms.

Speedy moisture test - A fast method of determining the amount of moisture in a sample using a gas pressure method as outlined in the Materials Manual for the test SD108.

Stockpile - As referred to in this manual, a carefully constructed pile of aggregate for project use. Special precautions are taken to avoid segregation, contamination, or other detrimental effects to the pile.

Structure concrete - Concrete used to carry structural load or to form an integral part of a structure.

Sulfates - Salts or sulfuric acids.

Supplemental specifications - Approved additions and revisions to the standard specifications.

Suspended solid - Impurities in mixing water that contribute to turbidity, expressed as PPM (parts per million). Excessive suspended solids in concrete mix water may affect setting time, strength, and other properties.

Testing - Run tests on samples to ensure that they meet specifications.

Total water - The amount of water used for mixing concrete exclusive only of that absorbed by the aggregates.

Transit mixed concrete - Materials that are mixed on the way to the job site in a truck mixer.

Transport - As referred to in this manual, the hauling unit that conveys cement or fly ash to the project. Also called a conveyance.

Water-cement ratio - The weight of water divided by the weight of cement. The ratio of total water to the total cement in the mix.

Water meters - Meters that measure mixing water. They must measure water with a tolerance of plus or minus 1%.

Water reducing admixtures - A material that reduces the quantity of mixing water required to produce concrete of a certain slump or increase slump without increasing water appreciably. In general, concrete of a specified consistency can be produced with a reduced water-cement ratio when utilizing water-reducing admixtures.

Workability - The ease of placing, consolidating, and finishing freshly mixed concrete.



## 11

## FACTORS THAT AFFECT SLUMP, WORKABILITY, AND CONSISTENCY

When concrete ingredients are blended together, the aggregates are suspended in a fluid paste. The paste serves as a lubricant to make the mixture pliable enough to be formed into the shapes or forms desired. The general term used to describe this characteristic of the plastic concrete is “workability.” Each of the elements of the fluid paste - cement, water, air, and admixture has its own influence on workability. Aggregates also affect the workability of fresh concrete. Each element and its effect are discussed below.

The first element is cement. The setting time of the cement is the amount of time from the addition of water to the mix until the concrete becomes unworkable. This setting time, in turn, is influenced by the temperature of the paste. The temperature of each ingredient when it is mixed, the increase in temperature caused by the mixing itself, the temperature of the surrounding air, and the heat of the hydration caused by the chemical action between the cement and the water all combine to determine the paste's temperature. At warmer temperatures, a concrete mix will have a lower slump than an identical mix made at a cooler temperature. Since chemical reactions go faster if the temperature is higher, the cement hydrates faster when warm than when cool. This causes the concrete to set up or harden more rapidly. This brings up a very important point about slump loss.

A concrete mix begins losing slump (it stiffens) from the moment the cement first comes in contact with the water. Unless some later change is made in the mix (for example - if water is added or an admixture is introduced), the mix has as much workability when it first comes out of the mixer as it will ever have. If the mix or ambient temperature goes up, humidity goes down (which dries the mix), or accelerating admixtures are used, slump will be lost rapidly. In practical terms, this means that the contractor's personnel will have less time to place and consolidate the concrete.

The most extreme example of rapid slump loss is concrete that undergoes “flash set.” When concrete flash sets, it sets up almost immediately after the mixing action has been completed, leaving no time to place and finish concrete. When it sets this soon, a lot of heat is given off by the hydration of the cement with the water.

In flash setting, slump is lost nearly instantaneously. Taking any of several precautions before mixing can prevent this slump loss. The most important is to keep the mix components - aggregates, cement, and water - as cool as possible. In some cases, ice is even used as a substitute for mixing water. Using retarding admixtures or some type of fly ash may also help

prevent flash set. Eliminate accelerators from the mix. The engineer should be notified if repeated cases of flash set occur.

The second element is water. It effects the workability by changing the dry cement into paste. This gives the concrete mix the mobility it needs to flow into its final position. Water in a concrete mix acts as a dispersing agent by putting more space between the aggregate particles. It also acts as a lubricant.

The more water present in the mix, the less friction and interaction there will be between the aggregate particles, resulting in an increase in the slump and the workability. Remember, more water is needed to make concrete workable than is needed just for the chemical hydration of the cement paste. *You can have all the workability you need, but the ratio between the cement and the water must be kept at the proper level. The big problem occurs when the water is added at the job site. It is difficult to add extra cement at the same time, so it is seldom, if ever, done. To avoid exceeding the proper water-cement ratio, it is best to design a workable mix that will avoid the problem.*

The third element is air. It improves the workability of the fresh concrete because air bubbles act like tiny ball bearings. The very small air bubbles spread the coarse aggregate particles apart and reduce particle interference. The air bubbles also act in a way similar to fine aggregate by adding the equivalent of aggregate surface area to the mix. This results in improving workability for the finishers because the excess water is retained in the mix that keeps bleeding to a minimum. The admixture used to entrain the air bubbles also affects the surface tension of the water, making the concrete mix more cohesive. This is especially important in slipform paving where holding a firm vertical edge is necessary.

Other admixtures besides those that entrain air also affect the slump and workability of the concrete mix by speeding up or slowing down the setting time of the fluid paste. THE KEY THING TO REMEMBER IS THAT WE NORMALLY NEED AN HOUR OR MORE TO MIX, TRANSPORT, PLACE, AND FINISH CONCRETE IN HOT WEATHER. By adding retarding admixture, we can gain some extra time to work with the concrete before it hardens. Conversely, in cold weather, the hydration process slows down and nearly stops all together at freezing temperatures. An accelerator can be added to speed up the hydration, allowing the concrete to gain early strength to resist a possible freeze.

Two other admixtures are fly ash and water-reducing admixtures. Fly ash will improve the workability of mixes deficient in the finer sand particles, and usually has some water-reducing qualities. Water-reducing admixtures reduce the amount of water required to produce concrete of a given consistency, or they allow an increase in consistency (slump) without increasing the water-cement ratio.

The fourth element is aggregates. they have an impact on workability. The particle shape and the surface texture of aggregate influence the properties of plastic concrete. Cement paste will bond better to rough and angular particles, but a gradation, particularly of the fine aggregates, can have a large influence of slump. Many fine aggregates result in more total surface area to be coated by the water in the cement-water paste. This results in less space between the particles, causing more particle friction, interaction, and a lower slump. Larger maximum size coarse aggregate results in more space between the pieces, causing less particle friction that tends to increase the slump.

The amount of fine to coarse aggregate ratio also has an effect on slump. However, if this ratio is changed, the results are not quite as obvious as with other factors affecting slump. If the percentage of fine aggregates is increased, the slump will be less, but the workability may actually be improved. This better workability develops because the fine aggregate cuts down the tendency of the coarse aggregate to interlock. However, if the percentage of fine aggregate is

increased too much, a point is reached where more cement is needed in the mix to maintain the concrete strength. This makes the mix more expensive.

The fifth element is Moisture Control- Effort must be taken to insure, as practically as possible, a uniform and stable moisture content in the aggregate as batched. The use of aggregate having varying amounts of free water is one of the most frequent causes for loss in control of concrete consistency (slump). In some cases, it may be necessary to wet the coarse aggregate in a stockpile or the delivery belts to compensate for high absorption or to provide cooling. When this is done, the coarse aggregates must be dewatered to prevent transfer of excessive free water to the bins.

Only as much water and fine aggregate should be used as is required to obtain suitable workability for proper placing and consolidation by means of vibration. The area that is filled with the right combination of solids and the less it is filled with water, the better will be the resulting concrete.



## 12

## CONCRETE PLANT CHECKLIST

This is a checklist of duties performed by a concrete plant inspector. This list does not contain all possible duties due to the differences in concrete plants, but it does contain the most important duties. The following items contain those things that must be completed prior to producing concrete:

1. The standard specifications, supplemental specifications, special provisions and plan notes that pertain to the project are on hand, are/have been reviewed and are correct for the project.
2. The aggregate stockpiles are being properly built and are/have been checked for separation, segregation, and foreign material. Tracked loaders are not being used.
3. The quality control tests for the aggregates, water, and admixtures are being performed or are on file.
4. The mix design document is on hand.
5. The plant is level on its foundation.
6. The cement and aggregate scales are/have been checked for accuracy; seals and certificates sufficient for project duration are present.
7. The water and admixture scales are/have been checked for accuracy; seals and certificates sufficient for project duration are present.
8. The plant automatic controls and timer are/have been checked and are working properly.
9. The mixer maximum volume and drum mixing speed have been checked and verified. Put results of inspection on DOT-294 form.
10. The mixer blades have been checked against the manufacturer's diagram and are within wear tolerances.
11. The revolution counters on the transit mix trucks have been checked and they work properly.
12. The site layout ensures a logical traffic pattern, safe operations, and proper drainage.

The following items must be checked shortly after the start of production and performed until project completion.

1. The required aggregate gradation tests are being conducted and DOT 3 forms are being completed.
2. Cement samples are being taken and sent to the Central Testing Laboratory.
3. Certificates of Compliance are being obtained for the cement and admixtures, if required.
4. Aggregate moisture tests are being taken and correctly documented on the DOT-35 and DOT-98A forms.
5. The batch weights are being adjusted for changes in volume, aggregate moisture content, sand F.M., workability, and water.
6. Dirt balls and other foreign materials are being removed from the aggregate.
7. The mixing time is being checked.
8. Haul tickets are being issued when needed.
9. Scales are being checked for balance and sensitivity.
10. The hauling unit's cargo boxes are being checked for contamination.
11. Cement and fly ash checks are being made.
12. The DOT-98A form is being properly filled out.
13. Additional water samples are being taken when needed.
14. The strength of the air-entraining agent is being checked so the proper amount is being used. Also, each air-entraining agent lot is being properly sampled?
15. As necessary, the temperature required to heat water, or the aggregates is being checked.
16. Safety is a daily critical inspection item.

Figure 12.1 DOT-294

DOT-294  
(01/2003)

## CONCRETE SUPPLIER CHECKLIST

Plant: IFS Date: 8/18/03  
 Location: Exit 157 129  
 Plant Personnel: James Peterson DOT: Todd Copeland - Plant 7  
James Peterson, Jr.

Plant Type: ☐ Batch Plant ☒ Central Mix Plant ☐ Both

Maximum Batch Size (C.Y.): 12  
 Plant Capacity (C.Y./Hr.): 480

Computerized Batching Equipment (Yes/No): Yes

## Materials Sources:

Coarse Aggregate: L.G. Everett - Oak Ridge  
 Fine Aggregate: L.G. Everett - Woodbury  
 Cement (Type): I-II Portland  
 Water: Longwater Hill  
 Air Entraining Admixture: WAP  
 Water Reducing Admixture: WAP  
 Fly Ash (Type): F - Coal/Coke

## Scales &amp; Weighing:

Material	Type	Dial / Digital	Capacity (Lbs.)	Smallest Gradation (Lbs.)	Scale Accuracy (<1/2% of Load)	Date Checked	Checked By
Rock	Cardinal 738	Digital	40000	40	✓	8/18/03	K-Scales
Sand	Cardinal 738	Digital	40000	40	✓	8/18/03	K-Scales
Cement	Cardinal 738	Digital	10000	5	✓	8/18/03	K-Scales

Copies of Scale Calibrations received: Yes  
 Scales enclosed and weatherproof: ✓ Yes  
 Scales have access for cleaning: ✓  
 Scales have markers for predetermined loads: ✓  
 Scales jarred by Hopper Discharge: No

Comments: \_\_\_\_\_

Figure 12.2 DOT-294 (Pg. 2)

DOT-294  
(01/2003)

## CONCRETE SUPPLIER CHECKLIST (CONT.)

	By Weight	By Volume	Calibration Chart Available	Date Calibrated	Checked By	Copies Received
Water		✓	NA	May 03	—	—

Meter Checked

Comments: Meter Checked by dumping 100 gal. + weighing  
Adjustment had to be made to get within tolerance  
54 runs @ 100 gal. made

	Metering Device	Graduated
WRA	✓	
AEA	✓	

Comments: \_\_\_\_\_  
 \_\_\_\_\_

## Aggregate Storage &amp; Handling

Separate Bins: Stackpiles  
 Concrete Floor: \_\_\_\_\_  
 Charged By: \_\_\_\_\_

Comments: Aggregate Bedding for Stackpiles except across  
and flow on dirt - Rock

## Hoppers &amp; Bins

	Vibrators	Protected from wind	Method of Charging	Automatic Moisture Sensors	Date Calibrated
Rock		✓			
Sand		✓			
Cement		✓			
Fly Ash		✓			

Comments: \_\_\_\_\_  
 \_\_\_\_\_

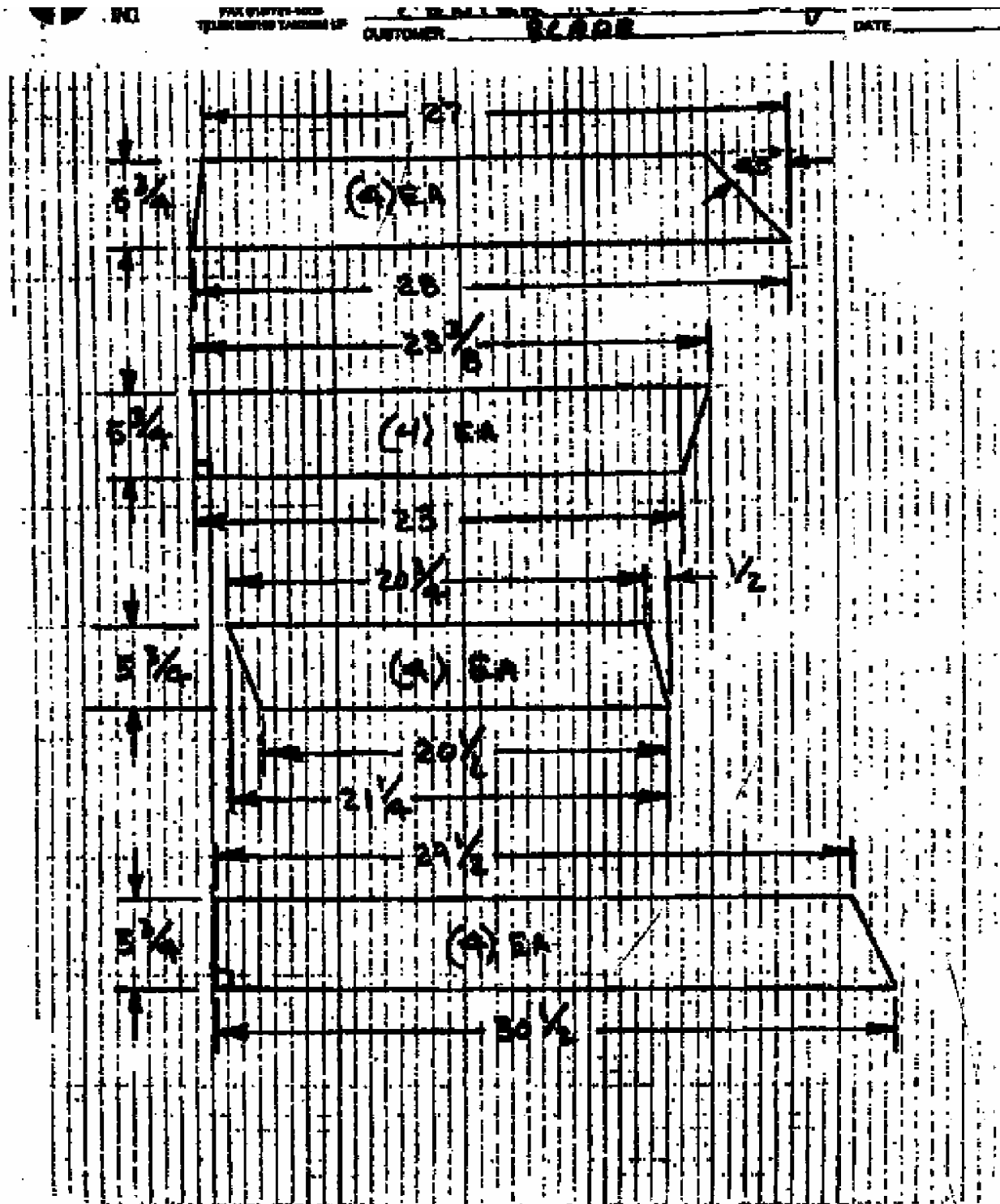
## Cold Weather Concrete

Capable of heating water: \_\_\_\_\_  
 Capable of heating Coarse Aggregate: NA  
 Capable of heating Fine Aggregate: \_\_\_\_\_

DOT-204  
(01/2003)[illegible]

**Commentaire**

Figure 12.4 Drum Charging Blades



**Figure 12.5** Drum Charging Blades (Pg. 2)

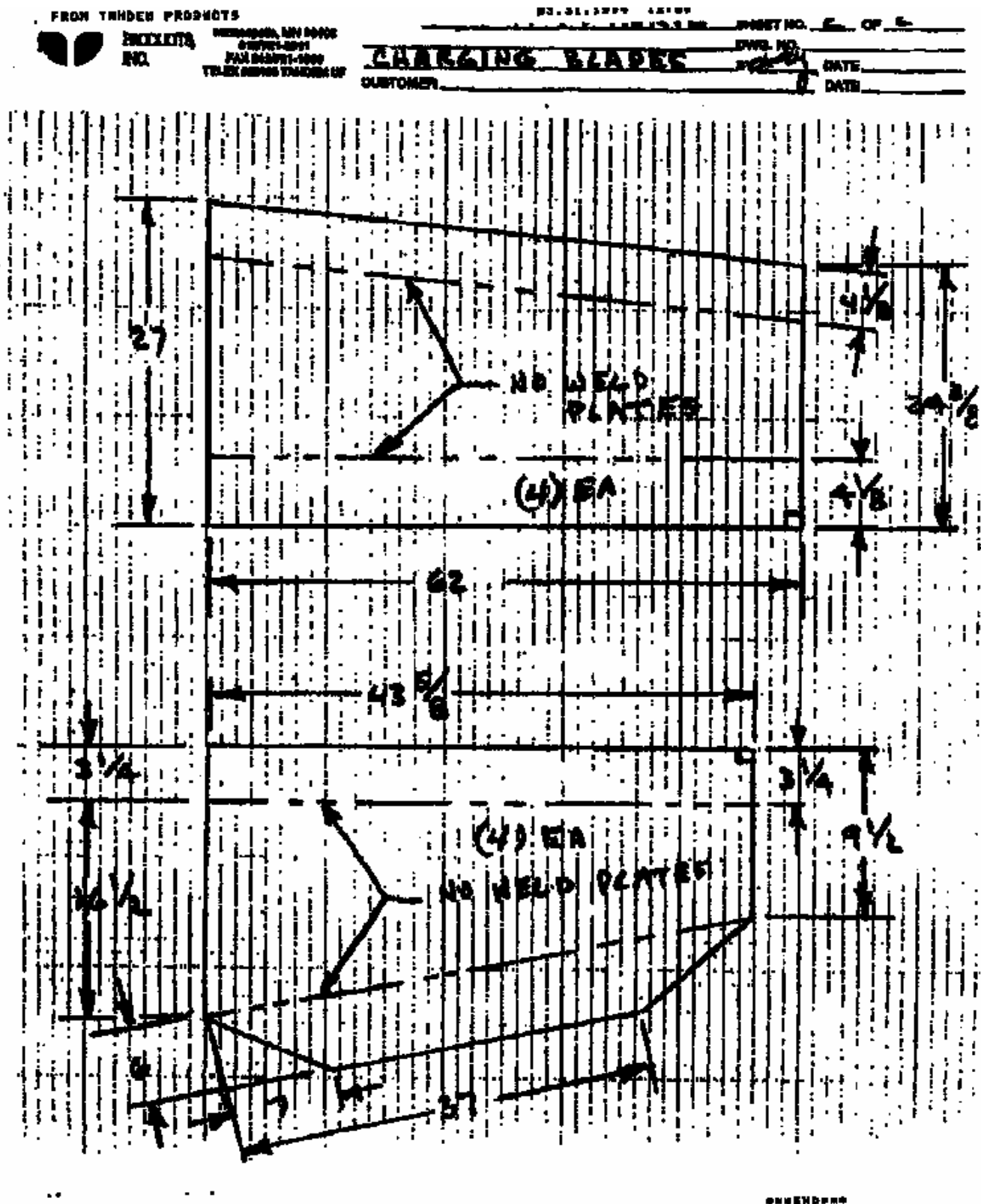


Figure 12.6 Attachment to DOT-294



**SOUTH DAKOTA DEPARTMENT OF  
COMMERCE AND REGULATION**

**COMMERCIAL INSPECTION & REGULATION**  
118 W. Capitol Avenue  
Pierre, South Dakota 57501-5070  
Weights & Measures  
605/773-3697

*Terry Schmitt*

**PLACED IN SERVICE REPORT**

Firm Name Schulte Ready Mix Date in Service 9/26/96  
Address PO Box 5 Equipment Repair      Yes      No  
City/Zip Aber SD 57315 New Installation X Yes      No  
Phone 256-3525 Rejected Equip Tag No.       
Owner/Mgr. Terry S.D. Scale #     

Kind <u>Concrete</u>	Wbridge Mod. <u>    </u>	Beam Model <u>    </u>
Class <u>III</u>	Size <u>    </u>	Serial # <u>    </u>
Make <u>Thurman</u>	Cap. <u>    </u>	Type Lever <u>    </u>
Model Ind. <u>OH-1505</u>	Serial # <u>    </u>	Load Cell Mod. <u>    </u>
Serial # <u>3185</u>	C.O.C.# <u>    </u>	Serial # <u>    </u>
C.O.C.# <u>    </u>	No. Sec <u>    </u>	C.O.C.# <u>    </u>
Cap./Div. <u>South Dakota</u>	CLC/Sec Cap <u>    </u>	AZT/Motion Set <u>    </u>

(1st Test Load)

SECTION TEST WITH      LBS. TEST WEIGHT

1 <u>    </u>	4 <u>    </u>	7 <u>    </u>
2 <u>    </u>	5 <u>    </u>	8 <u>    </u>
3 <u>    </u>	6 <u>    </u>	Bal <u>    </u>

(2nd Test Load)

SECTION TEST WITH      LBS. TEST WEIGHT

1 <u>    </u>	4 <u>    </u>	7 <u>    </u>
2 <u>    </u>	5 <u>    </u>	8 <u>    </u>
3 <u>    </u>	6 <u>    </u>	Bal <u>    </u>

(\*HB-44)N.1.3.4 Vehicle, Axle-load & Lstsk Scales - A shift test shall be conducted with at least two different test loads etc.

**STRAIN TEST**

Decreasing Increasing

Truck Wt       
Test Wts       
Error       
Balance      Bal. Chge       
SR/AZT Zero      SR Full     

CORNER TEST WITH      LBS TEST WTS.


Brief statement of repairs/Comments

*Build Test*  
*OK*

*Concrete*

**BUILDUP TEST**

95 <u>0</u>	1000 <u>0</u>	11000 <u>    </u>
100 <u>    </u>	2000 <u>0</u>	12000 <u>    </u>
200 <u>    </u>	3000 <u>0</u>	13000 <u>    </u>
300 <u>    </u>	4000 <u>0</u>	14000 <u>    </u>
400 <u>    </u>	5000 <u>0</u>	15000 <u>    </u>
500 <u>    </u>	6000 <u>0</u>	16000 <u>    </u>
600 <u>    </u>	7000 <u>0</u>	17000 <u>    </u>
700 <u>    </u>	8000 <u>0</u>	18000 <u>    </u>
800 <u>    </u>	9000 <u>0</u>	19000 <u>    </u>
900 <u>0</u>	10000 <u>0</u>	20000 <u>    </u>

Decreasing Load Test At 1/2 Test Load     

Scale Sealed? Yes

Repairman (sign) *Terry Schmitt* Agency KSSD Permit No. 90

(original to Weights & Measures 2nd sheet to owner 3rd sheet to Service Agency)

Figure 12.7 Example Attachments to DOT-294

## Replacement Drums for Most Mixer Models and More

### Don't Settle for Refurbished. Order your New McNeilus Replacement Drum Today!

McNeilus field-proven drums are made out of the finest quality materials available. Rather than using "standard" materials, McNeilus has specified higher decimal thicknesses and better quality materials to give the producer added wear and value when purchasing a McNeilus drum.

#### 3/16" Standard Drum

**Head** 1/4" .240 minimum Hi-strength 65,000 PSI  
Tensile minimum

**Shell** 3/16" .177 minimum AR200 90,000 PSI Tensile  
minimum (usually exceeds  
100,000 PSI)

200 Brinell (190-240 range) McNeilus specs  
narrow range as below 190 wears faster, above  
240 becomes more brittle, subject to cracking.

**Rear Cone** 8 gauge, Grade 50 Hi-strength

**Fins** **Rear Cone Extension** - 9 gauge AR200TN  
.142 minimum.

**Big Cone** - .210 minimum AR200TN 90,000 PSI  
Tensile minimum

This is 12% thicker than average spec for  
3/16", 17% thicker than minimum for 3/16"  
material

**Belly and Head Cone** - .240 minimum  
AR200TN 90,000 PSI Tensile minimum

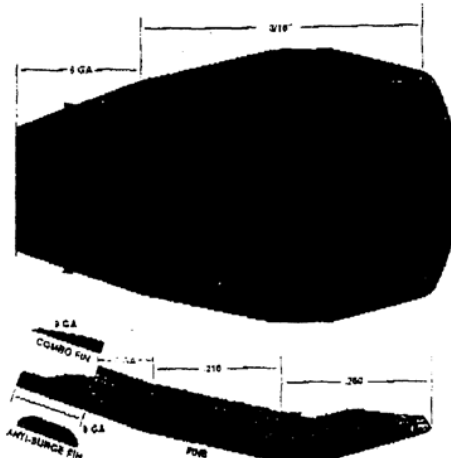
This is 28% thicker than average 3/16",  
36% thicker than minimum for 3/16"  
material

#### 1/4" Option

Shell becomes 3/16" on rear from 8 gauge, 1/4" rest from 3/16"

Fins become 1/4" in Big Cone from .210, 3/16" in high wear area in  
belly to front cone section, head section fins remain at 1/4",  
9 gauge becomes 3/16".

These specifications are for McNeilus Type III drums only.



	MOST REBUILDERS	MCNEILUS FACTORY NEW
Drum Head	Re-Used	New Head
Roller Track	Re-Used	New Roller Track
Tail Cone	Re-Used	New Tail Cone
Fin Design	Same as Old	Improved Fin Design

#### Benefits To Buying McNeilus:

1. Drum tracks are machined as one of the final steps ensuring perfectly round drums.
2. All drums are shot blasted and primed for a superior final finish coat.

**CHAIN OR DIRECT  
DRIVE MODELS**

### Replacement Drum Features Latest in Design Technology 3/16" Standard Drum, 1/4" Optional Drum

- Double reinforced 1/4" spun drum head (except Challenge)
- 3/16" or optional 1/4" Hi-Performance AR Steel drum shell for extended drum life
- Formed 3/16" AR steel mixing fins with two rows of high carbon wear rods on fin lips
- Butt welds minimize seam wear
- Includes new sprocket and trunnion bearing shaft on chain drive models
- Includes new head socket on direct drive models
- All seams welded on inside with automatic weld on outside
- Heavy duty drum track—machined after welding for perfect round
- One bolt-on inspection hatch standard—additional hatches available on request
- Shot blasted and prime painted with Sikken's® primer
- Exact fit to your mixer
- Bearing bail assemblies and components are available and in stock for quick installation on chain drive units
- Optional quick opening hatch available upon request

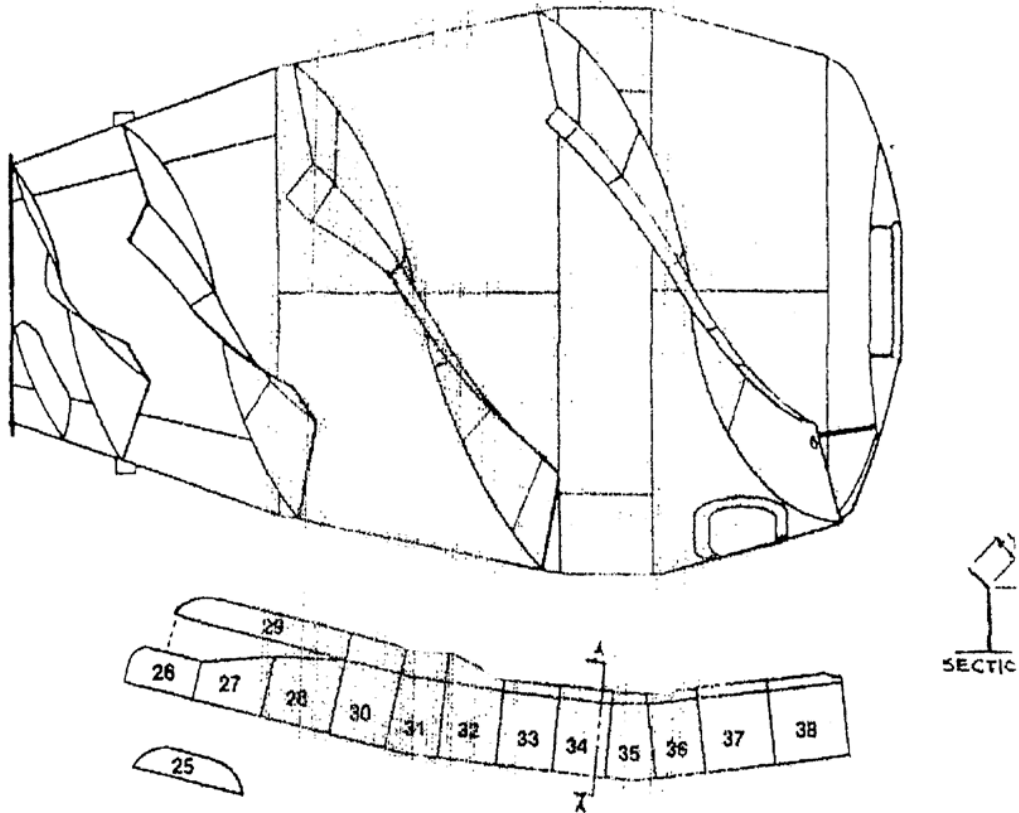
**Exact Fit, Long Life Drums for:**  
McNeilus, Challenge, Rex, Smith, Oshkosh, Viking, Advance, Riteway

© 1995 McNeilus Truck and Manufacturing Co. All Rights Reserved

Figure 12.8 Example Attachments to DOT-294

MTM Drums

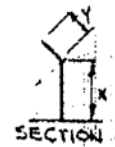
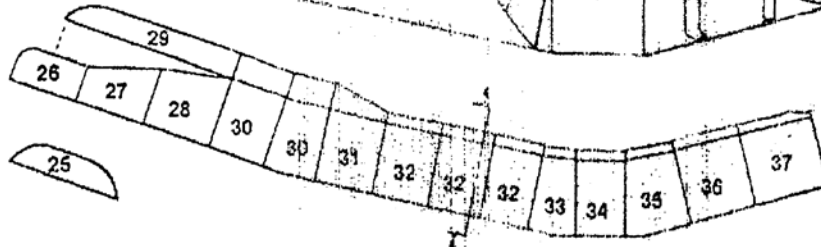
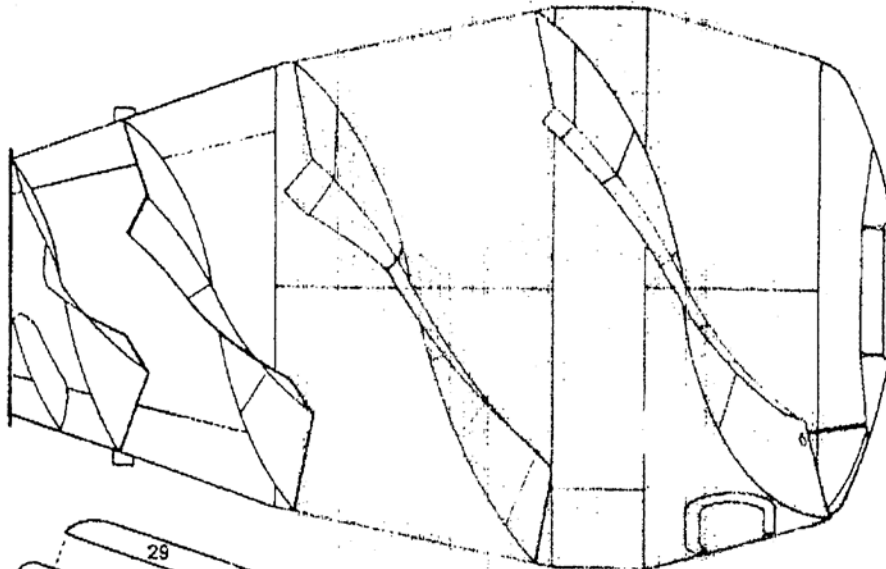
## 7-8-1/2 YARD DRUM ASSEMBLY



ITEM #	PART #	QUANTITY				BLADE HEIGHT (X)			FIN WIDTH (Y)		
		7 YD.	7 1/2 YD.	8 YD.	8 1/2 YD.	FRONT	MIDDLE	REAR	FRONT	MIDDLE	REAR
25	580-151486	2	2	2	2	8"	7 1/2"	0	0	0	0
26	580-151492	2	2	2	2	7 1/2"	8"	2 1/2"	0	0	0
27	580-151493	2	2	2	2	13"	9 3/4"	7 1/2"	0	0	0
28	580-151494	2	2	2	2	16 1/2"	15 1/2"	12 1/2"	0	0	0
29	580-151489	2	2	2	2	0	0	0	8"	7 1/2"	0
30	580-152461	4	4	4	4	18 1/2"	16 1/4"	16 1/4"	9"	9"	9"
31	580-152459	2	2	2	2	15 1/2"	15 1/2"	16 1/4"	5 3/4"	7 1/4"	9"
32	580-152462	6	6	6	6	15 1/2"	15 1/2"	15 1/4"	5 3/4"	5 3/4"	5 3/4"
33	580-152468	2	2	2	2	13 1/2"	15"	15 1/4"	5 3/4"	5"	5 3/4"
34	580-152466	0	2	0	2	13 1/2"	13 3/4"	13 1/4"	5 3/4"	5"	5 1/2"

Box 5

# MTM Drums 9-11 YARD DRUM ASSEMBLY



ITEM #	PART #	QUANTITY				SLADE HEIGHT (H)			FIN WIDTH (Y)		
		9 YD.	9 1/2 YD.	10 YD.	11 YD.	FRONT	MIDDLE	REAR	FRONT	MIDDLE	REAR
25	580-151486	2	2	2	2	0"	7 1/2"	0"	0	0	0
26	580-151492	2	2	2	2	7 1/2"	8"	2 1/4"	0	0	0
27	580-151493	2	2	2	2	13"	9 3/4"	7 1/2"	0	0	0
28	580-151494	2	2	2	2	15 1/2"	15 1/2"	12 1/2"	0	0	0
29	580-151489	2	2	2	2	0	0	0	8"	7 1/2"	0
30	580-152461	4	4	4	4	15 1/2"	16"	16 1/2"	9"	9"	9"
31	580-152459	2	2	2	2	15 1/2"	15"	16 1/2"	5 3/4"	7 1/2"	9"
32	580-152462	6	6	6	6	15 1/2"	15"	15 1/2"	5 3/4"	5 3/4"	5 3/4"
33	580-152468	2	2	2	2	18 1/2"	15"	15 1/2"	5 3/4"	5 3/4"	5 3/4"
34	580-152465	0	2	4	6	18 1/2"	13"	13 1/2"	5 3/4"	5"	5 1/2"
35	580-152503	2	2	2	2	18 1/2"	13"	13 1/2"	5 3/4"	5"	5 1/2"
36	580-152502	2	2	2	2	18 1/2"	13"	13 1/2"	5 3/4"	5"	5 1/2"
38	580-152501	2	2	2	2	18 1/2"	13 1/2"	13 1/2"	5 3/4"	5 1/4"	0

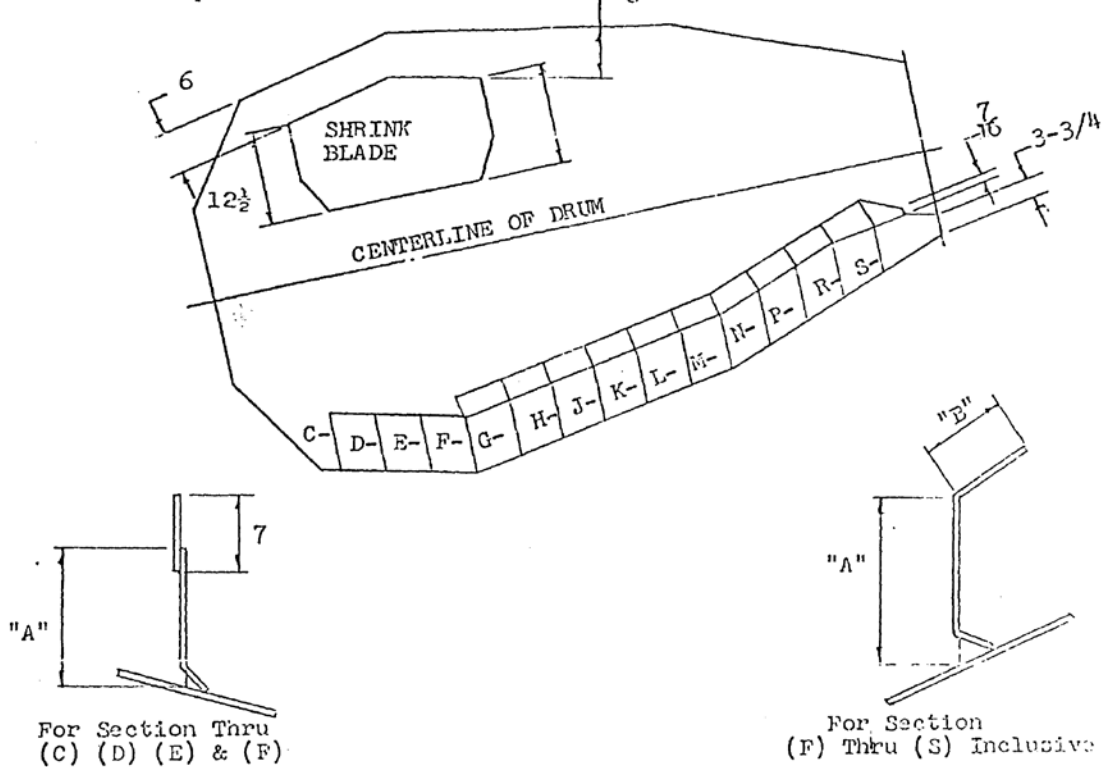
# BLADE HEIGHT DIMENSIONS

FOR 5-5½-6-6½ YD. ADJUSTA-MATE (STANDARD) TRUCK MIXERS

SERIAL NUMBERS 5 Yd. 50WR500 & Up: WP2695 thru WP3149  
 5½ Yd. 55WR500 & Up: WP2695 thru WP2869  
 6 Yd. 60WP1820 thru WP3149  
 6½ Yd. 65WP1820 thru WP3149

NOTE: Sketch shows blade spiral revolved to project in plane through centerline of drum.

All dimensions shown are design dimensions only.  
 Peripheral velocity of large diameter when mixing equals 225 feet per minute at 10 RPM of drum.



ITEM	C	D	E	F	G	H	J	K	L	M	N	P	R	S
DIMENSION "A"	12	12	12	12	12	12	12	12	12	12	12	12	9½	7½
DIMENSION "B"	-	-	-	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4

Dimensions for blades and lips are along drums.

Technical drawing of a tapered container, likely a drum or barrel, showing dimensions and labels. The drawing is oriented vertically with the top of the container at the bottom of the page.

**Dimensions:**

- Top diameter (bottom of drawing):  $20\frac{1}{4}"$
- Bottom diameter (top of drawing):  $18"$
- Height of the main body:  $20"$
- Height of the top flange (bottom of drawing):  $17\frac{1}{4}"$
- Height of the bottom flange (top of drawing):  $13\frac{1}{2}"$
- Width of the top flange (bottom of drawing):  $11\frac{1}{2}"$
- Width of the bottom flange (top of drawing):  $14"$

**Labels:**

- 4" Flanges:** Located on the left side, pointing to the top and bottom flanges.
- 8" Flanges:** Located on the right side, pointing to the top and bottom flanges.
- A5486** and **356 cu. ft.:** Located on the right side, near the top flange.
- MODEL NO. X800**: Located on the far right side.

MODEL NO. X800

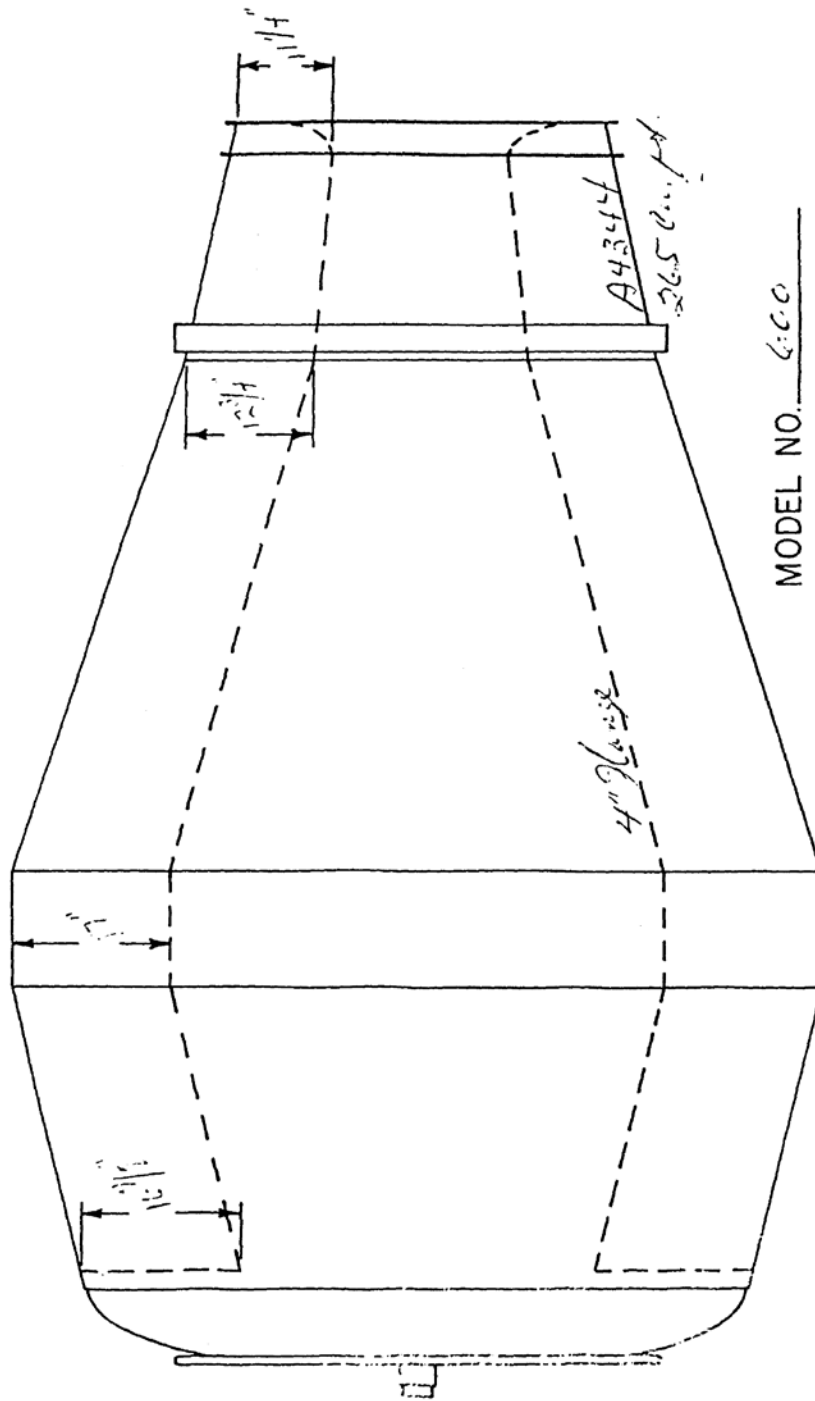
SERIAL NO. 215158-215159

**CONSTRUCTION MACHINERY COMPANY**

**WATERLOO, IOWA**

(711-712)

# TRANSCRETE BLADE SPECIFICATIONS



MODEL NO. 600

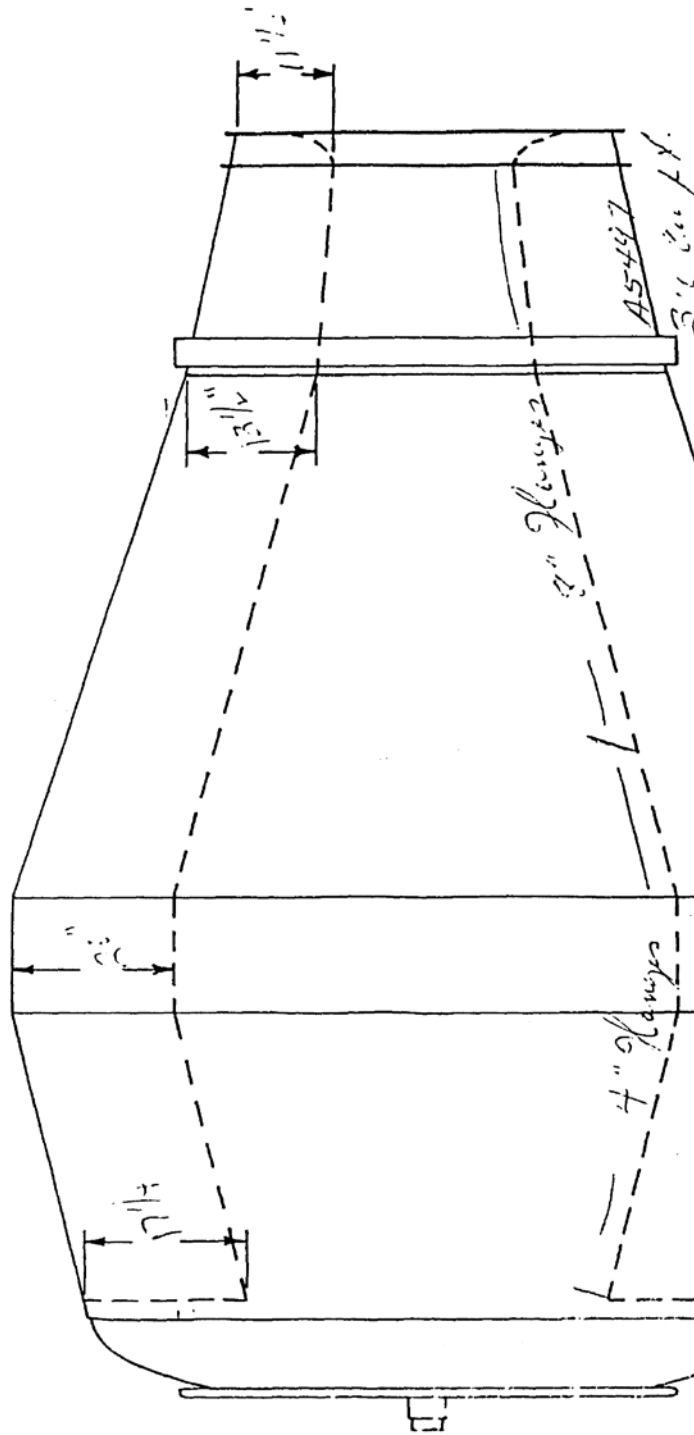
SERIAL NO. 166013

**CONSTRUCTION MACHINERY COMPANY**

WATERLOO, IOWA

(641)

# TRANSCRETE BLADE SPECIFICATIONS





## 13

## **MATERIAL CERTS AND SAMPLE, MIX DESIGN, AND DOCUMENTATION FORMS**

Admixture Certification of Conformance (Water Reducer)

Admixture Certification of Conformance (Air Entrainment)

Fly Ash Certification

Cement Certification (Type I/II)

Cement Certification (Type I/II)

DOT-1 Sample Data Sheet (Fly Ash)

DOT-1 Sample Data Sheet (Cement)

DOT-1 Sample Data Sheet (Water)

DOT-7 Report of Misc. Tests (Fly Ash)

Mix Design Approval E-mail (Class A45)

DOT-57 Supplier's Certification - M6 Concrete

DOT-77 Supplier's Certification - Controlled Density Fill

DOT-13 Daily Record of Cement Received & Unloaded (2 pages)

DOT-13 Daily Record of Cement Received & Unloaded (4 pages - old form, filled in)

Example - Plant Inspector's Daily Diary

DOT-227 Cold Weather Concrete Temperature Record (2 pages)

DOT-OS-OC-3.1 Gradation Deviation Policy

Region Article on Gradation Deviation Policy

**Figure 13.1** Admixture Certification of Conformance (Water Reducer)

GCP Applied Technologies Inc.  
62 Whittemore Avenue  
Cambridge, MA 02140-1692  
T 617-876-1400  
gcpat.com/construction

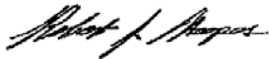
**Date: 3/21/2018**

**Andy Divine  
Divine Concrete  
P.O. Box 140  
Bonesteel, SOUTH DAKOTA 57317**

Project Name: **All**  
Product Selected: **ZYLA® 630**

This is to certify that **ZYLA 630**, a **Water Reducer**, as manufactured and supplied by GCP Applied Technologies Inc., is formulated to comply with the Specifications for Chemical Admixtures for Concrete, ASTM: **C494, Type A, D**, AASHTO: **M194, Type A, D**.

**ZYLA 630** does not contain calcium chloride or chloride containing compounds as a functional ingredient. Chloride ions may be present in trace amounts contributed from the process water used in manufacturing.



Robert J. Hoopes  
Product Development Engineer

**Figure 13.2** Admixture Certification of Conformance (Air Entrainment)



January 23, 2017

Pete Lien & Sons, Inc.  
3811 Universal Drive  
Rapid City, SD 57702

Attention: Keld Ditlev  
Project: Annual Cert.  
Project location: Varies

Certificate of Conformance  
MasterAir® VR 20 Admixture (formerly MB-VR CONCENTRATED)  
BASF Corporation Air-Entraining Admixture for Concrete

I, Richard Hubbard, Sr. Technical Marketing Specialist for BASF Corporation, Cleveland, Ohio, certify:

That MasterAir VR 20 admixture is a BASF Corporation Air-Entraining Admixture for concrete; and

That MasterAir VR 20 admixture and MB VR Concentrated admixture are the same product having identical composition, differing only in designation; and

That MasterAir VR 20 admixture is an aqueous solution of Vinsol Resin that has been neutralized with sodium hydroxide, the ratio of sodium hydroxide to Vinsol Resin is one part to six parts, with a nominal 21.5 percent by weight residue when dried at 105°C; and

That no calcium chloride or chloride based ingredient is used in the manufacture of MasterAir VR 20 admixture; and

That MasterAir VR 20 admixture, based on the chlorides originating from all the ingredients used in its manufacture, contributes less than 0.000068 percent (0.68 ppm) chloride ions by weight of the cement when used at the rate of 65 mL per 100 kg (1 fluid ounce per 100 pounds) of cement; and

That MasterAir VR 20 admixture meets the requirements of ASTM C260 and AASHTO M154, the Standard Specification for Air-Entraining Admixtures for Concrete, as well as the requirements for air-entraining admixtures as specified in Corps of Engineers' CRD-C 13.

Richard Hubbard

BASF Corporation  
Admixtures Systems  
23700 Chagrin Boulevard  
Cleveland, Ohio 44122  
Telephone (216) 839-7500

**MASTER®**  
**»BUILDERS**  
SOLUTIONS

Figure 13.3 Fly Ash Certification



Materials Testing & Research Facility  
2650 Old State Hwy 113  
Taylorsville, GA 30178  
770-684-0102

ASTM C618 / AASHTO M295 Testing of  
Coal Creek Station Fly Ash

Sample Date: 8/6 - 8/10/18  
Sample Type: composite  
Sample ID:

Report Date: 9/26/2018  
MTRF ID: 2119CC

Chemical Analysis	Results	ASTM Limit Class F/C	AASHTO Limit Class F/C
Silicon Dioxide (SiO <sub>2</sub> )	51.14 %		
Aluminum Oxide (Al <sub>2</sub> O <sub>3</sub> )	15.81 %		
Iron Oxide (Fe <sub>2</sub> O <sub>3</sub> )	5.85 %		
Sum (SiO <sub>2</sub> +Al <sub>2</sub> O <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub> )	72.80 %	70.0/50.0 min	70.0/50.0 min
Sulfur Trioxide (SO <sub>3</sub> )	0.68 %	5.0 max	5.0 max
Calcium Oxide (CaO)	13.76 %		
Magnesium Oxide (MgO)	4.30 %		
Sodium Oxide (Na <sub>2</sub> O)	3.42 %		
Potassium Oxide (K <sub>2</sub> O)	2.34 %		
Sodium Oxide Equivalent (Na <sub>2</sub> O+0.658K <sub>2</sub> O)	4.96 %		
Moisture	0.03 %	3.0 max	3.0 max
Loss on Ignition	0.17 %	6.0 max	5.0 max
Available Alkalies, as Na <sub>2</sub> O <sub>e</sub>	1.84 %	Not Required	1.5 max* <small>*when required by purchaser</small>
<b>Physical Analysis</b>			
Fineness, % retained on 45-µm sieve	21.70 %	34 max	34 max
Fineness Uniformity	0.15 %	±5 max	±5 max
Strength Activity Index - 7 or 28 day requirement			
7 day, % of control	81 %	75 min	75 min
28 day, % of control	101 %	75 min	75 min
Water Requirement, % control	94 %	105 max	105 max
Autoclave Soundness	0.01 %	0.8 max	0.8 max
Density	2.57		
Density Uniformity	1.38 %	±5 max	±5 max


Boral Resources certifies that pursuant to current ASTM C618 protocol for testing, the test data listed herein was generated by applicable ASTM methods and meets the requirements of ASTM C618.

  
Doug Rhodes, CET  
Facility Manager



**Figure 13.4** Cement Certification (Type I/II)

**GCC of America**  
Cherry Creek Plaza 1, 600 S. Cherry Street, 10th Floor, Glendale, CO 80246  
Sales (303) 739-5900 Customer Service (800) CALL GCC



### MATERIAL CERTIFICATION REPORT

**Plant:** Rapid City  
**Address:** 501 N. St Onge Street  
Rapid City, South Dakota  
**Contact:** Gail B. Amicucci  
**Phone:** (605) 721-7100

**Cement Type:** I/II, I/II(MH), Low Alkali, GU  
**Date Issued:** 04-Dec-18  
**Production Period:** 1-Nov-18  
**To:** 30-Nov-18

#### STANDARD REQUIREMENTS ASTM C150/AASHTO M85/ASTM C1157

CHEMICAL		
Item	ASTM C150 Spec. Limit	Test Result
SiO <sub>2</sub> (%)	A	20.3
Al <sub>2</sub> O <sub>3</sub> (%)	6.0 max	4.5
Fe <sub>2</sub> O <sub>3</sub> (%)	6.0 max	3.5
CaO (%)	A	63.3
MgO (%)	6.0 max	1.1
SO <sub>3</sub> (%)	3.5 max <sup>D</sup>	2.9
Loss on Ignition (%)	3.5 max	2.8
Na <sub>2</sub> O (%)	A	0.11
K <sub>2</sub> O (%)	A	0.61
Insoluble Residue (%)	1.5 max	-
CO <sub>2</sub> (%)	A	1.7
Limestone (%)	5.0 max	4.2
CaCO <sub>3</sub> in Limestone (%)	70 min	95
Potential Phase Composition <sup>C</sup>		
C <sub>2</sub> S (%)	A	52
C <sub>3</sub> S (%)	A	18
C <sub>4</sub> A (%)	8 max	6
C <sub>4</sub> AF (%)	A	11
C <sub>3</sub> S + 4.75C <sub>4</sub> A (%)	100 max	81

PHYSICAL			
Item	ASTM C150 Spec. Limit	ASTM C1157 Spec. Limit	Test Result
Air Content (volume %)	12 max	12 max	9
Blaine Fineness (cm <sup>2</sup> /g)	2600-4300	A	4190
Residue 45 µm (No. 325) Sieve (%)	A	D	3.0
Autoclave Expansion (%)	0.80 max	0.80 max	-0.05
Compressive Strength			
1 day, MPa (psi)	A	A	13.3 (1930)
3 days, MPa (psi)	12.0 (1741) min	13 (1890) min	24.1 (3490)
7 days, MPa (psi)	19.0 (2760) Min	20.0 (2900) min	34.3 <sup>E</sup> (4980)
28 days, MPa (psi) <sup>E</sup>	A	28.0 (4160) min	43.4 <sup>E</sup> (6300)
Time of Setting, Initial Vicat (minutes)	45-375	45-420	116
Heat of Hydration, 7 days, kJ/kg (cal/g)	F	A	355
Mortar Bar Expansion C-1038 (%)	B	0.020 max	-

INORGANIC PROCESSING ADDITION (if Applicable)			
Type	None	Base Phase Cement Composition	
SiO <sub>2</sub> (%)	NA	C <sub>2</sub> S (%)	55
Al <sub>2</sub> O <sub>3</sub> (%)	NA	C <sub>3</sub> S (%)	19
Fe <sub>2</sub> O <sub>3</sub> (%)	NA	C <sub>4</sub> A (%)	6
CaO (%)	NA	C <sub>4</sub> AF (%)	11
SO <sub>3</sub> (%)	NA		

#### OPTIONAL REQUIREMENTS ASTM C150/AASHTO M85/ASTM C1157

CHEMICAL		
Item	ASTM C150 Spec. Limit	Test Result
Equivalent Alkalies (%)	0.60 max	0.51

PHYSICAL			
Item	ASTM C150 Spec. Limit	ASTM C1157 Spec. Limit	Test Result
False Set (%)	50 min	50 min	80

<sup>A</sup> Not applicable

<sup>B</sup> It is permissible to exceed the specification limit provided that ASTM C1038 Mortar Bar Expansion does not exceed 0.020 % at 14 days.

<sup>C</sup> Adjusted per Annex A1.6

<sup>D</sup> No limit specified, data reported for information purpose only


<sup>E</sup> Test result of prior month

<sup>F</sup> Test result represents most recent value. Heat of hydration test has been carried out by CTL, Skokie, Illinois.


GCC of America Cement is warranted to conform at the time of shipment with current ASTM C150/AASHTO M85/ASTM C1157. No other warranty is made or implied. Having no control over the use of its cements, GCC of America does not guarantee finished work. GCC is not responsible for any additives not stated in the Certificate of Compliance. GCC of America certifies that the data described above under "Processing Addition" represents the materials in the cement manufactured during the production period indicated.

Figure 13.5 Cement Certification (Type I/II)

Version 6.42



**Holcim**



**NSF**

**Material Certification Report**

**Material:** Portland Cement

**Type:** I-II

**Test Period:** 01-Feb-2017

**To:** 28-Feb-2017

Certification			
This Holcim cement meets the specifications of ASTM C150 for Type I-II cement, and complies with AASHTO M85 specifications for Type I-II cement.			
General Information			
Supplier:	Holcim (US) Inc.	Source Location:	Ste. Genevieve Plant
Address:	2942 US Highway 61 Bloomsdale, MO 63627		2942 US Highway 61 Bloomsdale, MO 63627
Telephone:	636-524-8155	Contact:	Erin Watson
Date Issued:	15-Mar-2017		

The following information is based on average test data during the test period.  
The data is typical of cement shipped by Holcim; individual shipments may vary.

Tests Data on ASTM Standard Requirements					
Chemical			Physical		
Item	Limit <sup>A</sup>	Result	Item	Limit <sup>A</sup>	Result
SiO <sub>2</sub> (%)	-	19.8	Air Content (%)	12 max	6
Al <sub>2</sub> O <sub>3</sub> (%)	6.0 max	4.2	Blaine Fineness (m <sup>2</sup> /kg)	260 min	397
Fe <sub>2</sub> O <sub>3</sub> (%)	6.0 max	3.0			
CaO (%)	-	64.8	Autoclave Expansion (%) (C151)	0.80 max	0.05
MgO (%)	6.0 max	1.8	Compressive Strength MPa (psi):		
SO <sub>3</sub> (%)	3.0 max <sup>B</sup>	3.5	1 day	-	17.1 (2490)
Loss on Ignition (%)	3.5 max <sup>E</sup>	3.1	3 days	12.0 (1740) min	28.7 (4170)
Insoluble Residue (%)	1.5 max	0.50	7 days	19.0 (2760) min	36.4 (5280)
CO <sub>2</sub> (%)	-	1.7	28 days	-	45.1 (6540)
Limestone (%)	5.0 max	4.4	Initial Vicat (minutes)	45-375	86
CaCO <sub>3</sub> in Limestone (%)	70 min	89	Mortar Bar Expansion (%) (C1038)	-	0.016
Inorganic Processing Addition (%)	5.0 max	0.4			
Potential Phase Compositions <sup>C</sup> :					
C <sub>3</sub> S (%)	-	65			
C <sub>2</sub> S (%)	-	7			
C <sub>3</sub> A (%)	8 max	6			
C <sub>4</sub> AF (%)	-	9			
C <sub>3</sub> S + 4.75C <sub>3</sub> A (%)	-	93.4			

Tests Data on ASTM Optional Requirements					
Chemical			Physical		
Item	Limit <sup>A</sup>	Result	Item	Limit <sup>A</sup>	Result
Equivalent Alkalies (%)	0.60 max	0.51	False Set (%)	50 min	76

**Notes**

<sup>A</sup> Dashes in the limit / result columns mean Not Applicable.

<sup>B</sup> It is permissible to exceed the specification limit provided that ASTM C1038 Mortar Bar Expansion does not exceed 0.020 % at 14 days.

<sup>C</sup> Adjusted per Annex A1.6 of ASTM C150 and AASHTO M85.

<sup>D</sup> Test result represents most recent value and is provided for information only.

<sup>E</sup> Limit = 3.0 when limestone is not an ingredient in the final cement product

Equivalent Alkalies (%) Minimum = 0.42, Maximum = 0.56

This data may have been reported on previous mill certificates.

Additional Data				
Item	Limestone	Inorganic Processing Addition	Base Cement Phase Composition	Result
Type	-	IPA	C <sub>3</sub> S (%)	68
Amount (%)	4.4	0.4	C <sub>2</sub> S (%)	7
SiO <sub>2</sub> (%)	8.7	10.5	C <sub>3</sub> A (%)	6
Al <sub>2</sub> O <sub>3</sub> (%)	0.84	3.2	C <sub>4</sub> AF (%)	10
Fe <sub>2</sub> O <sub>3</sub> (%)	0.46	1.6		
CaO (%)	48.4	44.0		
SO <sub>3</sub> (%)	0.12	0.7		

By *Erin M Watson*, Quality Manager

**Figure 13.6** DOT-1 Sample Data Sheet (Fly Ash)

<b>Sample ID</b> 2285214	<b>Sample Data Sheet</b>	<b>DOT - 1</b>
<b>File No.</b>		9-14
Laboratory Test No. _____		
County <u>Jackson</u>	PCN/PROJECT <u>03W6 IM-FP 0903(104)153</u>	
SUBMITTED BY <u>Riedl, Dan</u>	PROJECT ENGINEER <u>Frazier, Richard</u>	
SEND RESULTS TO <u>Doug Sherman</u>		
CONTRACTOR <u>Reede Construction, Inc.</u>	SUB-CONTRACTOR _____	
CHARGE TO (If not above project) _____	SUPPLIER <u>Boral Resources / Coal Creek</u>	
This is a <u>Acceptance</u> sample.	MATERIAL TYPE <u>Type F</u> FLY ASH	
FIELD SAMPLE NO. <u>04</u>	DATE SAMPLED <u>11/05/2018</u>	TIME SAMPLED <u>10:30 am</u>
THIS SAMPLE REPRESENTS <u>30,000 to 40,000 Cuyds</u> (quantity & unit of measurement)		
Please identify as: Sta. _____	Dist. L/R _____	Lift _____ / _____
Certification ID: 270458		

<b>FOR CONCRETE</b> <u>Type</u> <u>Lot No.</u> <u>San</u> <input type="radio"/> cement _____ <u>Lim</u> <input type="radio"/> admixture _____ <u>Gra</u> <input type="radio"/> latex modifier _____ <u>Fil</u> <input type="radio"/> curing compound _____ <u>Cru</u> <input type="radio"/> coarse agg., size _____ <u>Coa</u> <input type="radio"/> fine agg. _____ <u>Cla</u> <input type="radio"/> cylinders _____	_____ % <b>MISCELLANEOUS</b> <u>Type</u> <u>Lot No.</u> _____ % <input type="radio"/> beads _____ _____ % <input type="radio"/> paint _____ _____ % <input type="radio"/> asphalt _____ _____ % sampling method _____ _____ % <input type="radio"/> fencing material (list under remarks) _____ % <input checked="" type="radio"/> Fly Ash <u>Type F</u>
--	--

If material is to be used for CONCRETE, check its use as follows:

☐ On Grading    ☐ On Bridge    ☒ Paving    ☐ Class    ☐ Other

If material is to be used for SURFACE COURSES, check its use as follows:

<input type="radio"/> Base Course, Type	<input type="radio"/> Treated	<input type="radio"/> Subbase, Type
<input type="radio"/> Asph. Conc., Class/Type	<input type="radio"/> Asph. Surf. Treatment, Type	<input type="radio"/> Gravel Surfacing
<input type="radio"/> Maintenance Stockpile	<input type="radio"/> Miscellaneous	<input type="radio"/> Shoulders

Use Description: PCCP Concrete

FOR SHIPPED IN MATERIAL: Producer's Name & Address Boral Resources, Underwood ND

Brand, Trade Name or Quarry \_\_\_\_\_

FOR LOCAL MATERIAL: Location of Pit or Quarry \_\_\_\_\_ 1/4 Sec. \_\_\_\_\_

\_\_\_\_\_ Twp., \_\_\_\_\_ Range, \_\_\_\_\_ County    Owner & Address \_\_\_\_\_

---

Shipping Ticket No. \_\_\_\_\_    Truck or Car No. \_\_\_\_\_    Unloaded At \_\_\_\_\_

Remarks:

**Figure 13.7** DOT-1 Sample Data Sheet (Cement)

Sample ID <b>2282973</b>	<b>Sample Data Sheet</b>	DOT - 1
File No. _____		9-14
Laboratory Test No. _____		
County <u>Pennington</u>	PCN/PROJECT <u>02R5 P 0231(12)80</u>	
SUBMITTED BY <u>Heupel, John</u>	PROJECT ENGINEER <u>Flottmeyer, Brenda</u>	
SEND RESULTS TO <u>Michael Carlson</u>		
CONTRACTOR <u>COMPLETE CONCRETE, INC. DBA COMF</u> SUB-CONTRACTOR <u>Corr Construction Services, Inc.</u>		
CHARGE TO (If not above project) _____ SUPPLIER <u>GCC of America</u>		
This is a <u>Acceptance</u> sample. MATERIAL TYPE _____ CEMENT TYPE II (IF CERT MILL)		
FIELD SAMPLE NO. <u>01</u> DATE SAMPLED <u>10/04/2018</u> TIME SAMPLED <u>07:00 am</u>		
THIS SAMPLE REPRESENTS <u>10,000 CY</u> (quantity & unit of measurement)		
Please identify as: Sta. <u>Str. No. 52-394-298</u> Dist. L/R _____ Lift _____ / _____		
Certification ID: <u>269682</u>		

<b>FOR CONCRETE</b> <u>Type</u> <u>Lot No.</u> <u>San</u> <input checked="" type="radio"/> cement I/II _____ <u>Lim</u> <input type="radio"/> admixture _____ <u>Gra</u> <input type="radio"/> latex modifier _____ <u>Fil</u> <input type="radio"/> curing compound _____ <u>Cru</u> <input type="radio"/> coarse agg., size _____ <u>Coa</u> <input type="radio"/> fine agg. _____ <u>Cla</u> <input type="radio"/> cylinders _____	_____ % <b>MISCELLANEOUS</b> <u>Type</u> <u>Lot No.</u> _____ % <input type="radio"/> beads _____ _____ % <input type="radio"/> paint _____ _____ % <input type="radio"/> asphalt _____ _____ % <input type="radio"/> sampling method _____ _____ % <input type="radio"/> fencing material (list under remarks) _____ % <input type="radio"/> _____
--	---

If material is to be used for CONCRETE, check its use as follows:

☐ On Grading    ☒ On Bridge    ☐ Paving    ☐ Class    ☐ Other

If material is to be used for SURFACE COURSES, check its use as follows:

<input type="radio"/> Base Course, Type	<input type="radio"/> Treated	<input type="radio"/> Subbase, Type
<input type="radio"/> Asph. Conc., Class/Type	<input type="radio"/> Asph. Surf. Treatment, Type	<input type="radio"/> Gravel Surfacing
<input type="radio"/> Maintenance Stockpile	<input type="radio"/> Miscellaneous	<input type="radio"/> Shoulders

Use Description: Extension/Retaining jWall and Side Walk

FOR SHIPPED IN MATERIAL: Producer's Name & Address GCC Dakota Cement, Rapid City, SD

Brand, Trade Name or Quarry Portland Cement - Rapid City Plant Only

FOR LOCAL MATERIAL: Location of Pit or Quarry \_\_\_\_\_ 1/4 Sec. \_\_\_\_\_

\_\_\_\_\_ Twp., \_\_\_\_\_ Range, \_\_\_\_\_ County    Owner & Address \_\_\_\_\_

---

Shipping Ticket No. \_\_\_\_\_ Truck or Car No. \_\_\_\_\_ Unloaded At \_\_\_\_\_

Remarks:

Figure 13.8 DOT-1 Sample Data Sheet (Water)

**Sample ID** 2174315 **Sample Data Sheet** **DOT - 1**  
**File No.** **8/28/13**  
**Laboratory Test No.** BU11295 **09/2004**  
**County** McCook, Union, Yankton **PCN/PROJECT** I2V1 029 S-291  
**SUBMITTED BY** Rothschadl, Greg **PROJECT ENGINEER** Rothschadl, Greg  
**SEND RESULTS TO** Rod Gall  
**CONTRACTOR** DAKOTA CONTRACTING CORPORATION **SUB-CONTRACTOR** \_\_\_\_\_  
**CHARGE TO** (If not above project) \_\_\_\_\_ **SUPPLIER** Concrete Materials - Yankton  
This is a Acceptance sample. **MATERIAL TYPE** WATER  
**FIELD SAMPLE NO.** 01 **DATE SAMPLED** 08/26/2013 **TIME SAMPLED** 08:30 am  
**THIS SAMPLE REPRESENTS** Project quantity from this plant. (quantity & unit of measurement)  
Please identify as: **Sta.** \_\_\_\_\_ **Dist. L/R** \_\_\_\_\_ **Lift** \_\_\_\_\_ / \_\_\_\_\_  
**Certification ID:** \_\_\_\_\_

<b>FOR CONCRETE</b>	<b>Type</b>	<b>Lot No.</b>	<b>Sand</b>	<b>%</b>	<b>MISCELLANEOUS</b>	<b>Type</b>	<b>Lot No.</b>
<input type="radio"/> cement	_____	_____	Lime	_____ %	<input type="radio"/> beads	_____	_____
<input type="radio"/> admixture	_____	_____	Gravel	_____ %	<input type="radio"/> paint	_____	_____
<input type="radio"/> latex modifier	_____	_____	Filler	_____ %	<input type="radio"/> asphalt	_____	_____
<input type="radio"/> curing compound	_____	_____	Crushed Rock	_____ %	<input type="radio"/> sampling method	_____	_____
<input type="radio"/> coarse agg., size	_____	_____	Coated Aggregate	_____ %	<input type="radio"/> fencing material (list under remarks)	_____	_____
<input type="radio"/> fine agg.	_____	_____	Clay	_____ %	<input checked="" type="radio"/> well water	<u>@ plant site</u>	_____
<input type="radio"/> cylinders	_____	_____					

If material is to be used for CONCRETE, check its use as follows:  
☐ On Grading ☐ On Bridge ☐ Paving ☐ Class ☒ Other

If material is to be used for SURFACE COURSES, check its use as follows:  
☐ Base Course, Type ☐ Treated ☐ Subbase, Type  
☐ Asph. Conc., Class/Type ☐ Asph. Surf. Treatment, Type ☐ Gravel Surfacing  
☐ Maintenance Stockpile ☐ Miscellaneous ☐ Shoulders

**Use Description:** \_\_\_\_\_

**FOR SHIPPED IN MATERIAL:** **Producer's Name & Address** Concrete Materials; Yankton, SD  
**Brand, Trade Name or Quarry** \_\_\_\_\_

**FOR LOCAL MATERIAL:** **Location of Pit or Quarry** \_\_\_\_\_ **1/4 Sec.** \_\_\_\_\_  
**Twp., Range, County** \_\_\_\_\_ **Owner & Address** \_\_\_\_\_

**Shipping Ticket No.** \_\_\_\_\_ **Truck or Car No.** \_\_\_\_\_ **Unloaded At** \_\_\_\_\_

**Remarks:** pH = 6.73 ppm = 1450

Figure 13.9 DOT-7 Report of Misc. Tests (Fly Ash)

Contract: 3780  
 PCN: 6658 (Main)  
 Project(s): MI 0607(03)319 (Main)  
 County: Davison  
 Location: I90 - EBL & WBL, Frm Mount Vernon to the James River  
 Type of Work: Remove and Replace PCCP, Bridge Deck Overlay, Epoxy Chip Seal, Asphalt Concrete Resurfacing, and Guardrail  
 Contractor: Knife River Midwest, LLC  
 Engineer: Rick Brancher  
 Date Let: 09/21/2011  
 DOT-7 Type: 41  
 Length: 28.666 miles  
 Area: Mitchell Area

## Report of Misc. Tests

SUBMITTED BY:	Mueschen, Nathan	Mueschen, Nathan
REPORT TO:		
PRODUCER:	Hoodwaters Martin Lake, Texas	Hoodwaters Martin Lake, Texas
SAMPLE ID	2176709	2177017
SAMPLE OF	FLY ASH	FLY ASH
DATE SAMPLED	08/05/2013	08/09/2013
DATE RECEIVED	08/11/2013	08/11/2013
SOURCE		
QUANTITY	110000-120000cy	120000-130000 cy
IDENTITY	12	13
LAB NUMBER	BU16266	BU16267
LOSS ON IGNITION, %	0.08	0.07
MOISTURE CONTENT, %	0.02	0.01
RETAINED ON #200 SIEVE, %	22.29	19.22
POZZOLANIC ACTIVITY INDEX WITH PORTLAND CEMENT	0	0
@ 7 DAYS, % OF CONTROL		
SPECIFIC GRAVITY	2.594	2.598
SOUNDNESS EXPANSION OR CONTRACTION, %	-0.05	-0.05
DEVIATIONS	NONE	NONE
BU16266		
BU16267		

All samples Tested in Accordance to ASTM Procedures

**Figure 13.10** Mix Design Approval E-mail (Class A45)

**Smith, Jason (DOT)**

---

**From:** Smith, Jason (DOT)  
**Sent:** Tuesday, September 4, 2018 3:12 PM  
**To:** Brown, Jordan  
**Cc:** Steen, Jeff; Letcher, Brad; Stearns, Nathan; Eisenbeisz, Hadly; Schaefer, Jerry (DOT); Hudecek, Kelly; Brown, Benjamin; Hodges, Darin; Smith, Jason (DOT)  
**Subject:** Beadle Co. #BRO 8003(24) PCN 01Y1- Contractor A45 Mix Design  
**Attachments:** Beadle 01Y1- A45 20FA,HydSt DOT24.pdf

The attached contractor Class A45 concrete submittal by GCC Ready Mix has been reviewed and meets the mix design requirements of section 460. The mix numbered C02-96-45-76-F1-2 has been added to the project structural design spreadsheet located on the U: drive U:\ms\Materials- SDDOT Access\ConcMixDesigns\ContractorMixDesign.xlsx

Inclusion of the GCP hydration stabilizer "Recover" in the design does not constitute acceptance of a change to the Delivery Requirements specified in the 2015 Standard Specification book, section 460.3. G.

Please contact me with any questions.

*Jason J. Smith, P.E.*

Concrete Mix Design Engineer  
S.D. Dept. of Transportation  
Materials & Surfacing  
104 S. Garfield Ave. Bldg B- Rm 148  
Pierre, SD 57501  
Phone: (605) 773-4464 (Ofc)  
(605) 280-4983 (C)  
(605) 773-2732 (Fax)

Cc: File

Figure 13.11 DOT-57 Supplier's Certification - M6 Concrete

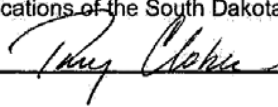
SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION		DOT-57 (9-10)			
FILE NO. _____					
<b>SUPPLIER'S CERTIFICATION - CLASS M6 CONCRETE</b>					
PROJECT	018-492 US Hwy 18	COUNTY	Fall River	PCN	i5a0
SUPPLIER	Simon Readymix				
PLANT ADDRESS	1700 School Street, Hot Springs, SD			DATE	6.28.18
<u>MIX DATA</u>					
_____ 1650 _____ lbs. Coarse Aggregate per Cubic Yard					
_____ 1325 _____ lbs. Fine Aggregate per Cubic Yard					
_____ 480 _____ lbs. Cement, Type _____ I/II _____ per Cubic Yard					
_____ 120 _____ lbs. Fly Ash, Type _____ F _____ per Cubic Yard					
_____ 32 _____ lbs. ( ) gals. ( x					
_____ 0.5-1.5 _____ oz/cwt Air Entrainment					
_____ 1.0-5.0 _____ oz/cwt Water Reducer or Other					
Source of Coarse Aggregate	Simon Materials - Hot Springs Quarry, Fall River County				
Source of Fine Aggregate	Pete Lien & Sons - Oral Pit, Fall River County				
Source of Cement	GCC Dacotah - Rapid City Terminal				
Source of Fly Ash	Boral Resources - Coal Creek, ND				
Source & Name of Admixtures	WR Grace - Daravair M & WRDA-82				
I hereby certify the mix and all component materials supplied for Class M - 6 Concrete for use on the above project meet the requirements of the specifications of the South Dakota Department of Transportation.					
Supplier or Authorized Representative	 Signature				
Title	Material Sales				
Date	6.28.18				

Figure 13.12 DOT-77 Supplier's Certification - Controlled Density Fill

DOT-77  
(09/2004)

SOUTH DAKOTA  
DEPARTMENT OF TRANSPORTATION

FILE NO. \_\_\_\_\_

**SUPPLIER'S CERTIFICATION FOR CONTROLLED DENSITY FILL**

PROJECT NH 0018(179)402 COUNTY Hutchinson & Turner PCN 036L

SUPPLIER Concrete Materials

ADDRESS 1404 N. Louise Ave, Sioux Falls, SD 43124 SD Hwy 44, Chancellor SD *of per additional submitted*

**MIX DATA**

100 Lbs. Cement, Type I/II, per cubic yard

2600 Lbs. Fine Aggregate per cubic yard

300 Lbs. Fly Ash, Type F, per cubic yard

60 gallons of Water per cubic yard

Source of Cement GCC, Pueblo, CO

Source of Fine Aggregate Corson Sand Plant, Corson, SD

Source of Fly Ash Boral Coal Creek; Headwaters Resources

I hereby certify the mix and all component materials supplied for Controlled Density Fill for use on the project indicated above meet the requirements of the South Dakota Department of Transportation. Materials and mixing are in conformance with Section 462 of the Standard Specifications, Plan Notes, and/or Special Provisions. (The Supplier is advised to confirm specific requirements regarding fine aggregate gradation, compressive strength, etc., by referring to contract documents.)

Authorized Representative Jim Simunek

Title Ready Mix Sales Representative

Date 24APR18



Page 2 DOT-13

## INSTRUCTIONS

- INSTRUCTIONS**
- Includes cement left in cars and waste not accounted for in batching operations.
  - Wind and spillage losses compensated for in scale settings. Describe 7 & 8 in diary.
  - Theoretical weight of cement desired. Shall not include cement in 8.
  - Product 9 x 10.
  - Sum 7 + 8 + (9 x 11).
  - Accumulative sum 12 + 13 to date
  - Column 15 should verify by duplication column 4.
- Entries should carry across both sheets from 1 through 16 so a check or trail balance may be made at any time.

cc: AREA (Proj. File)  
REGION MATERIALS

Figure 13.15 DOT-13 Daily Record of Cement Received & Unloaded (old form, filled in, 4 pgs)

DOT-13  
(1-84)

**CEMENT RECORD SHEET**

File No. \_\_\_\_\_

DAILY RECORD OF CEMENT RECEIVED AND UNLOADED

PROJECT NH0018(129) 123 4989 COUNTY Todd & Tapp SHEET NO. 1

CEMENT TYPE IC SOURCE GCC DAKOTAH

1	2	3	4	5	1	2	3	4	5
CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	SAMPLED BY	CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	SAMPLED BY
570571	6-9-06	468.8			138091	6-14-06	870.4	37,686.4	
570571	6-9-06	468.8			138092	6-14-06	780.0		
137985	6-10-06	823.4			138093	6-14-06	820.0		
137986	6-11-06	723.6			138094	6-14-06	792.8	37,684.2	
137987	6-11-06	780.0			138095	6-15-06	710.2		
137988	6-11-06	890.2			138096	6-15-06	766.2		
137989	6-12-06	760.4			138097	6-15-06	891.0		
137990	6-12-06	821.2			138098	6-15-06	771.4		
137991	6-12-06	800.4			138099	6-15-06	780.8		
138057	6-12-06	708.2			138100	6-15-06	831.4		
138058	6-12-06	791.9			138101	6-15-06	821.6		
138059	6-12-06	780.0			138102	6-15-06	1001.4		
138060	6-12-06	821.6			138103	6-15-06	821.8		
138061	6-12-06	710.6			138104	6-15-06	821.6		
138062	6-12-06	780.2	11,303.2	Sample 801	138105	6-15-06	771.4	48,085.0	
570571	6-12-06	820.0			138106	6-15-06	820.0		
138064	6-12-06	709.0			138107	6-15-06	764.0		
138065	6-12-06	780.2			138108	6-15-06	820.0		
138066	6-12-06	760.0			138109	6-15-06	716.8		
570571	6-12-06	890.2			138110	6-15-06	820.6		
138067	6-12-06	720.6			138111	6-15-06	763.2		
138068	6-12-06	785.8			138112	6-15-06	1000.2		
138069	6-12-06	770.6			138113	6-15-06	890.0		
138070	6-12-06	763.00			138114	6-15-06	970.0		
138071	6-12-06	785.8			138115	6-15-06	780.0	56,088.8	
138072	6-12-06	840.4			138116	6-16-06	780.0	57,238.8	
138073	6-12-06	810.0			138117	6-19-06	780.4		
138074	6-12-06	704.6			138118	6-19-06	820.0		
570571	6-12-06	820.0			138119	6-19-06	766.4		
138075	6-12-06	924.9	24,152.2		138120	6-19-06	820.0		
138076	6-12-06	820.2			138121	6-19-06	781.2		
138077	6-12-06	820.2			138122	6-19-06	770.2		
138078	6-12-06	820.0			138123	6-19-06	820.4		
138079	6-12-06	820.0			138124	6-19-06	813.6		
138080	6-12-06	1000.0			138125		780.6		
138081	6-12-06	781.2			138126		780.8		
138082	6-12-06	895.6			138127		790.0		
138083	6-12-06	820.8			138128		770.0		
138084	6-12-06	785.4	30,821.2		138129		820.2		
138085	6-12-06	900.0			138130		760.0		
138086	6-12-06	793.8			138131		791.2	69,122.0	
138087	6-12-06	831.0							
138088	6-12-06	760.4							
138089	6-12-06	769.0							
138090	6-12-06	1006.6	35866.0						

N E X T

Figure 13.16 DOT-13 Daily Record of Cement Received & Unloaded (old form, filled in)

6	7	8	9	10	11	12	13	14	15	16
DATE	WASTE PRIOR TO BATCHING CWT.	BATCHING WIND LOSS CWT.	WEIGHT PER BATCH CWT.	NUMBER OF BATCHES USED	NUMBER OF BATCHES WASTED	CEMENT USED TODAY CWT.	CEMENT WASTED TODAY CWT.	ACCOUNTABLE CEMENT TO DATE CWT.	CEMENT SHIPPED TO DATE CWT.	DIFFERENTIAL + OR - CWT.
6-12-06	73.95	6.44	4.4	3003	3	13213.2	73.95	13304.75	30001.2	
6-13-06	0	4.4	4.4	2851	24	13544.4	132.0	35981.15	30001.2	
6-14-06	0	6.4	4.4	3717	14	16332.8	108.0	42311.95	30001.2	
6-15-06	0	6.4	4.4	3488	4	16847.2	24.0	57759.15	49122.8	
6-16-06	0	6.4	4.4	3451	5	15184.4	28.4	72943.55		
6-17-06	0	6.4	4.4	3616	2	15910.4	13.2	88853.95	90176.0	+12.245
6-18-06	0	6.4	4.4	3861	9	16988.0	44.0	105841.95	108908.0	
6-19-06	0	6.4	4.4	3013	11	13257.2	54.8	119099.15	123140	
6-20-06	0	6.4	4.4	3375	10	14866.8	50.4	134129.95		
6-21-06	0	6.4	4.4	3180	6	13992	32.8	148167.95	148741.6	
6-22-06	0	6.4	4.4	3356	10	14766.4	64.0	162934.35	17281.2	
6-23-06	0	6.4	4.4	3788	1	16667.2	10.8	179601.55		
6-24-06	0	6.4	4.4	125	0	550.0	0	180151.55		
6-25-06	0	6.4	4.4	127	0	173.1	0	180324.65		
6-26-06	0	6.4	4.4	1924	4	1465.6	17.6	180540.25		
6-27-06	0	6.4	4.4	37	8	196.1	42.4	180736.65		
6-28-06	0	6.4	4.4	37	18		95.4	180832.05	190782.96	
6-29-06	0	6.4	4.4	18918.55	18918.55	18918.55				

INSTRUCTIONS  
 1. Include cement lost in tests and other lost materials in batching operations.  
 2. Used and spilled cement incorporated for in waste materials. Report by 5:00 in diary.  
 3. Theoretical weight of cement desired, shall not include cement in 2.  
 4. Actual weight of cement used.  
 5. Actual weight of cement lost.  
 6. Actual weight of cement lost in tests.  
 7. Actual weight of cement lost in other operations.  
 8. Actual weight of cement lost in other operations.  
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 100. Actual weight of cement lost in other operations.

cc: AREA (Proj. File)  
 REGION MATERIALS

Figure 13.17 DOT-13 Daily Record of Cement Received &amp; Unloaded (old form, filled in)

DOT-13  
(1-84)

**CEMENT RECORD SHEET**

File No. \_\_\_\_\_

DAILY RECORD OF CEMENT RECEIVED AND UNLOADED

PROJECT NH0018(29)023 4289 COUNTY Todd + Tripp SHEET NO. 2

CEMENT TYPE V SOURCE GCC Dakota

1	2	3	4	5	1	2	3	4	5
CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	69122.80 SAMPLED BY	CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	SAMPLED BY
5705779	6-18-06		880.4		140335	6-27		765.6	
139162	6-19-06		758.2		140336	6-27		820.4	
139166	6-19		820.0		140337	6-28		820.6	108125.2
139167	6-19		790.0		5705785	6-25		782.8	108908.0
139288	6-19		730.6		5705801	6-29		503.2	
139296	6-19		912.0		140383	6-28		820.8	
139312	6-19		746.0		140339	6-28		800.2	
139314	6-19		910.0		140340	6-28		820.2	
139315	6-19		812.8		140350	6-29		605.4	
139317	6-19		1001.2		140351	6-29		725.4	
139345	6-19		737.2		140341	6-28		820.8	
139346	6-19		763.2		140342	6-28		763.6	
139348	6-19		800.0		140343	6-28		830.6	
139356	6-19		807.0		140344	6-28		820.0	
139364	6-19		770.4		140345	6-28		779.4	
139367	6-19		550.2		140346	6-28		521.0	
139374	6-19		880.4		140348	6-28		516.8	118235.4
139383	6-19		720.0		140347	6-28		820.0	
139407	6-19		884.4		140352	6-29		715.4	
139421	6-19		518.2	14931.8	140353	6-29		711.8	
139422	6-19		812.8		140354	6-29		742.6	
139423	6-19		787.6		140355	6-29		820.0	
139424	6-19		755.6		140356	6-29		745.2	
139425	6-19		780.0		140357	6-29		812.8	
139426	6-19		1000.0		140359	6-29		766.4	
139427	6-19		640.6		140360	6-29		519.6	
139428	6-19		524.4		140361	6-29		565.2	
139429	6-20		730.0		140362	6-29		765.60	
139380	6-19		821.4		140364	6-29		800.2	
139420	6-19		902.6		140365	6-29		781.0	
139429	6-19		820.2		140366	6-29		600.0	
139433	6-20		790.0		140367	6-29		890.0	
139434	6-19		700.0		140368	6-29		820.0	
139435	6-19		506.6		140369	6-29		800.0	
139436	6-19		508.2		140372	6-29		518.0	
139437	6-19		790.2		140373	6-29		850.2	
139438	6-19		1000.2		140379	6-29		800.8	133148.2
139440	6-19		750.0		5705800	6-29		820.0	
139467	6-20		718.0	98584.40	5705803	6-30		519.2	
139439	6-19		791.0	99345.4	5705805	6-30		900.0	
139441	6-24		783.2		140358	6-29		773.6	
139479	6-19		777.8		140363	6-29		749.8	
140196	6-26		825.6		140371	6-29		580.4	
140330	6-26		781.0		140376	6-30		830.0	
140331	6-27		813.0		140377	6-30		800.2	
140332	6-27		820.0		140378	6-30		772.8	
140333	6-27		750.6		141022	6-30		901.2	
140334	6-27		820.0	105718.6	141026	6-30		813.4	

Figure 13.18 DOT-13 Daily Record of Cement Received & Unloaded (old form, filled in)

DOT-13  
(1-84)

**CEMENT RECORD SHEET**

DAILY RECORD OF CEMENT RECEIVED AND UNLOADED

File No. \_\_\_\_\_

PROJECT NH0018(29) 223 429 COUNTY Todd SHEET NO. 3

CEMENT TYPE II SOURCE FCC Dakota RC

1	2	3	4	5	1	2	3	4	5
CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	SAMPLED BY	CAR OR TANKER NO.	DATE UNLOADED	CWT. IN CAR OR TANKER	CWT. TO DATE	SAMPLED BY
141027	6-30		771.0		141627	7-7		607.0	
141034	6-30		763.4		141629	7-6		617.4	
141037	6-30		820.6		141630	7-6		766.2	
141063	6-30		782.0		141631	7-6		711.0	
141065	6-30		800.6		141632	7-6		790.2	
141067	6-30		821.4		141633	7-6		820.0	
141068	6-30		821.0		141634	7-6		579.4	
141070	6-30		791.8		141635	7-6		781.4	
141082	6-30		820.0	148746	141636	7-6		820.0	
570583	7-1		770.0		141637	7-6		781.2	
141152	6-30		777.0		141638	7-6		800.6	
141161	6-30		763.4		141639	7-6		805.4	
141162	6-30		820.4		141640	7-6		573.2	
141163	6-30		781.6		141651	7-6		801.8	
141164	6-30		800.6		141713	7-6		765.0	190452.2
141167	7-1		718.2		141641	7-6		320.76	190783.96
141172	7-1		820.4						
141175	7-1		821.0						
141176	7-1		780.6						
141178	7-1		820.8						
141179	7-1		770.4						
141180	7-1		781.2						
141181	7-2		764.6						
141184	7-2		800.0						
141185	7-2		763.6						
141186	7-2		803.2						
141187	7-2		781.4						
141233	7-3		776.0	163706					
141236	7-3		800.6						
141237	7-3		823.0						
141238	7-3		820.6						
141239	7-4		820.0						
141240	7-4		765.4						
141241	7-4		781.2						
141242	7-4		900.2						
141243	7-5		820.0						
141244	7-5		781.4						
141245	7-5		820.2						
141246	7-5		770.4						
141247	7-5		820.0						
141488	7-5		724.6						
141528	7-5		800.6						
141529	7-5		764.0						
141531	7-5		781.2						
141535	7-5		781.8	177281.2					
570583	7-5		821.0						
141605	7-5		820.4						
141605	7-5		820.0						

Figure 13.19 Example - Plant Inspector's Daily Diary

### EXAMPLE PLANT INSPECTOR'S DAILY DIARY

This example shows the various entries that might be written in the Plant Inspector's daily diary. This is an example of the information which should be recorded in the diary. The plant inspector should always confer with the Project Engineer about what he/she wants captured in the diary.

#### LEAVE WHITE PAGE IN BOOK

P0025(00)114-3432                      8-10-95  
 Kingsbury Co.                      Thursday  
 UPPER PLAINS Contracting, INC.  
 Kingsbury Concrete - Concrete Supplier  
 Curb to 10' of 60" H. of 97"  
 Arrived @ project - 5:30 A.M.  
 1st truck left project @ 6:30, fresh  
 concrete tests run - everything to specs.  
 Trucks hauling 3 cu. yd. loads.  
 6 Trucks hauling #5 - B.S. 2.1.9-10  
 Design mix is A-40 concrete.  
 Started the day with 5.590 Air  
 using haul tickets for each load  
 1:15 - we had problems with Fly Ash  
 discharging at the plant. Ticket  
 305589 - Truck #8 we quit using  
 Fly Ash and changed to all cement.  
 Taking moisture tests on sand &  
 rock and making adjustments  
 every 2 hours see Plant Report #1  
 (DOT 98A)  
 Made adjustments to Air through  
 out the day - see Plant Report  
 Took gradation on sand & rock &  
 recorded on DOT 3.  
 Sources:  
 Sand - Eversit, Rock - Spencer, Cement - RD  
 Fly Ash - National - Air - Grace, water -  
 Desmet City.  
 124 - Batches today x 8 cu. yd. = 992 yd<sup>3</sup>  
 Est. 4.00 yd<sup>3</sup>                      10  
 Total for day                      982  
 8:20 P.M. Last load batched  
 9:30 P.M. - left project  
 John S. Anderson  
 Insp.

Figure 13.20 DOT-227 Cold Weather Concrete Temperature Record

DOT-227  
(3/01)

**SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION  
COLD WEATHER CONCRETE TEMPERATURE RECORD**

Project No. \_\_\_\_\_ PCN \_\_\_\_\_ County \_\_\_\_\_ Date of Pour \_\_\_\_\_

Contractor \_\_\_\_\_ Sta. \_\_\_\_\_ Report No. \_\_\_\_\_

Structure \_\_\_\_\_

Unit \_\_\_\_\_ Inspector \_\_\_\_\_

Days	Date	Atmospheric Temperature								Strength		
		High	Low							PSI	Gain %	ACC%
0				See reverse side for fresh concrete temperature record								
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												

(See reverse side for fresh concrete temperature record)

Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Explain all deviations from specifications.

\_\_\_\_\_  
Area Engineer

Figure 13.21 DOT-227 Cold Weather Concrete Temperature Record (Page 2)

DOT-227  
(3/01)

REMARKS: Sketch need not be to scale. Show locations of all thermometers, in relation to centerline of roadway, centerline of structure unit and north arrow.

PENCIL SKETCH

Record of concrete temperature at time of placement

Time	Temperature		Remarks
	Atmospheric	Fresh Concrete	

**Figure 13.22** Figure 13.23DOT-OS-OC-3.1 Gradation Deviation Policy

<b>South Dakota Department of Transportation</b> <b>Policy</b> <b>Distribution: DOT</b>	
<b>Title</b>	<b>Aggregate Gradation Deviation for Portland Cement Concrete Pavement</b>
<b>Policy No.</b>	<b>DOT—OS—OC—3.1</b>
<b>Persons Affected</b>	DOT
<b>Policy Owner</b>	Operations Support
<b>Effective Date</b>	1/21/2009
<b>Supersedes</b>	DOT-OS-OC-3.0
<b>Next Review Date</b>	1/21/2010
<b>Purpose</b>	Control of aggregate gradation plays an important role in portland cement concrete durability. The South Dakota Department of Transportation's <a href="#">Standard Specifications for Roads and Bridges</a> requires each size of coarse and fine aggregate to conform to specific gradation requirements. The SDDOT policy detailed below establishes guidelines to follow when deviations from these aggregate gradation standards occur.
<b>Policy</b>	SDDOT employees will follow these procedures when aggregate samples deviate from Department standards for portland cement concrete pavement.
<b>Procedures</b>	
<b>I. When an aggregate sample deviates from gradation requirements or FM wideband requirements</b>	
<b>Responsibility</b>	<b>Action</b>
Area Engineer	<ol style="list-style-type: none"> <li>When an aggregate sample fails to meet the gradation requirements, may allow the Contractor to continue producing concrete if all the following actions are taken: <ul style="list-style-type: none"> <li>Notify the Contractor that a material deviation has been recorded.</li> <li>Document the deviation on a <a href="#">DOT-18, "Report of Specification Deviation."</a> This deviation is subject to price adjustment.</li> <li>Document corrective measures in the project diary.</li> </ul> </li> <li>After the corrective measures, immediately take a new sample and test it.</li> </ol>

**Figure 13.23** DOT-OS-OC-3.1 Gradation Deviation Policy (Page 2)

3. If two of the last five or fewer samples fail to meet the established gradation, the following actions shall be taken:
  - Notify the Contractor that a material deviation has been recorded.
  - Document the deviation on a [DOT-18](#) , “Report of Specification Deviation.” This deviation is subject to price adjustment.
  - Suspend production of mix.
4. Allow production to resume only after corrective measures have been taken and a sample meeting specifications is obtained.
5. Document the corrective measures in the project diary.
6. Take the next acceptance sample shortly after production resumes.
7. Get approval of Concrete Engineer before allowing changes in mix design.

## II. When an aggregate sample deviates from combined minus 200 specifications

<u>Responsibility</u>	<u>Action</u>
Area Engineer	<ol style="list-style-type: none"> <li>1. When an aggregate sample fails to meet the requirements of combined minus 200, may allow the Contractor to continue producing concrete if all the following actions are taken:                             <ul style="list-style-type: none"> <li>• Notify the Contractor that a material deviation has been recorded.</li> <li>• Document the deviation on a <a href="#">DOT-18</a> , “Report of Specification Deviation.” This deviation is subject to price adjustment.</li> <li>• Document corrective measures in the project diary.</li> </ul> </li> <li>2. After the corrective measures, immediately take a new sample and test it.</li> <li>3. If two of the last five or fewer samples fail to meet the minus 200 specifications, the following actions shall be taken:                             <ul style="list-style-type: none"> <li>• Notify the Contractor that a material deviation has been recorded.</li> <li>• Document the deviation on a <a href="#">DOT-18</a> , “Report of Specification Deviation.” This deviation is subject to price adjustment.</li> <li>• Suspend production of mix.</li> </ul> </li> </ol>

**Figure 13.24** DOT-OS-OC-3.1 Gradation Deviation Policy (Page 3)

South Dakota Department of Transportation Policy	DOT—OS—OC—3.1 Aggregate Gradation Deviation for Portland Cement Concrete
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4. Allow production to resume only after corrective measures have been taken and a sample meeting specifications is obtained, or the mix design is modified and the specification changed as follows:
  - The Engineer may allow an increase in the minus 200 specification from 1.5 percent to 1.7 percent by adding 25 pounds/cubic yard of portland cement to the mix design, on the condition that this increase does not result in an increase of deleterious material.
  - The Engineer may allow the additional cement to be removed and the minus 200 specification reset to 1.5 percent after five consecutive test results below 1.5 percent are obtained.
5. Corrective actions shall be documented in the project diary.
6. Take the next acceptance sample shortly after production resumes if corrective measures were taken.
7. Get approval of Concrete Engineer before allowing changes in mix design.

### Related Documents

[DOT-18](#)

[Standard Specifications for Roads and Bridges, 2004 ed.](#)

### Revision Log

DOT-OS-OC-3.1: Added: First heading under “Procedures” amended to include FM wideband requirements.

DOT-OS-OC-3.0: New policy.

### Signatures

<hr/>	<hr/>
Darin Bergquist, Secretary of Transportation	Date
<hr/>	<hr/>
Greg Fuller, Director, Operations	Date
<hr/>	<hr/>
Jason Humphrey, Construction and Maintenance Engineer	Date

Figure 13.25 Gradation Deviation Policy clarification (Page 1)

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## ***REGION MATERIALS NEWS***

*Volume XV, Issue II*

*August 2014*

*Rapid City, South Dakota*

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### **Aggregate Gradation Deviation for PCC Pavement**

Control of aggregate gradation plays an important role in portland cement concrete durability. The South Dakota Department of Transportation's *Standard Specifications for Roads and Bridges* requires each size of coarse and fine aggregate to conform to specific gradation requirements. Policy No. DOT-OS-OC-3.1 "Aggregate Gradation Deviation for Portland Cement Concrete Pavement" establishes guidelines to follow when deviations from these aggregate gradation standards occur.

The Materials Manual R.S.T.C. Section 5. discusses Operational Procedures for Acceptance sampling and testing in specific Corrective Action Samples and Tests.

The procedure regarding gradation deviations and corresponding numbering can be confusing. The following is an *attempt* to clarify: The procedure is on the right with corresponding comments with numbering example on the left.

#### **Region Materials News**

All past Newsletters are located at

[U:regionRC/Materials/Region Materials News](U:regionRC/Materials/Region%20Materials%20News).

The "Table of Contents" shows what is included in each issue. If you have any questions or comments regarding any back issues, please let me know.

*Matt Stone*

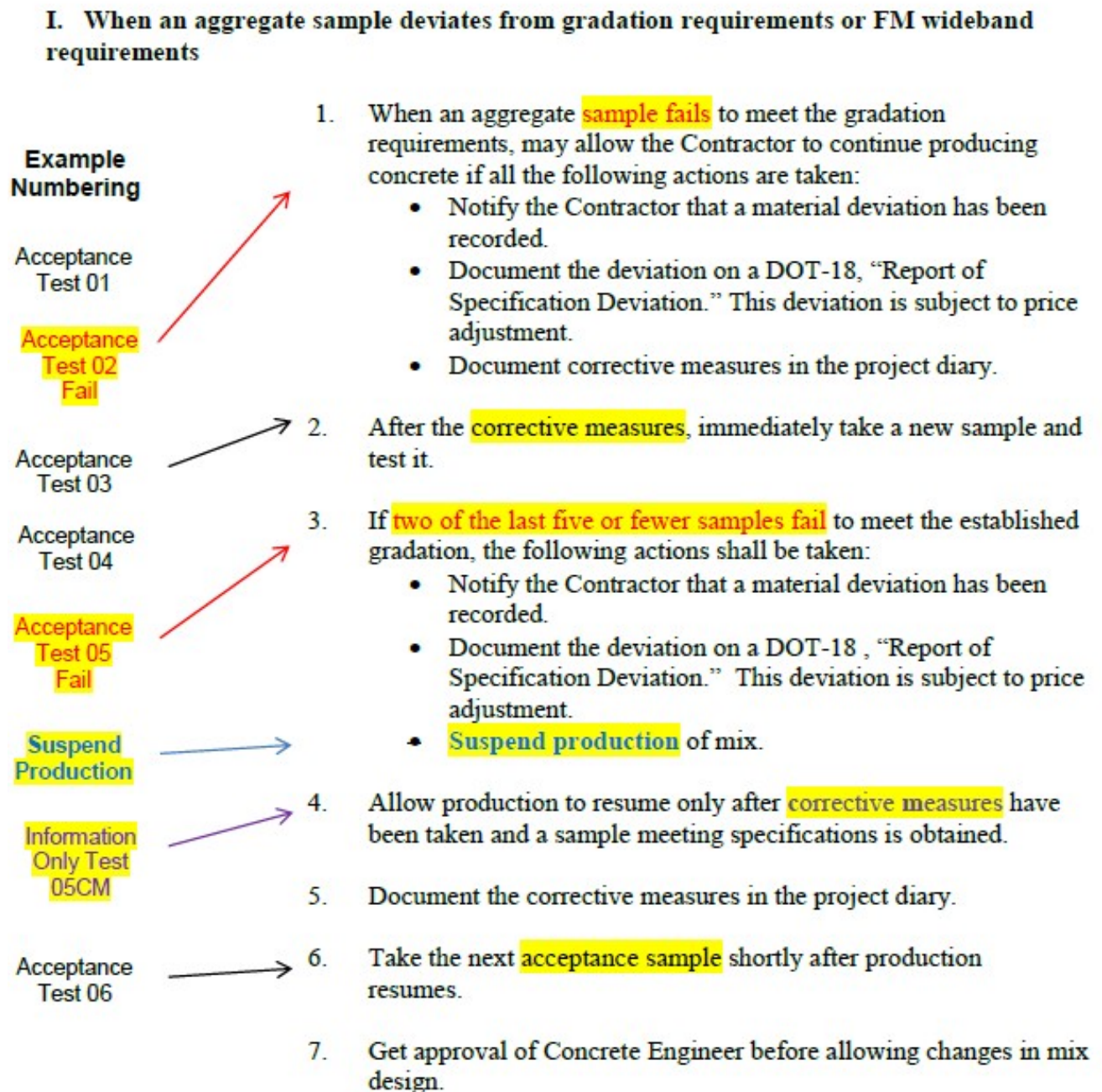
*Rapid City Region Materials Engineer*

*605.394.1630*

*605.209.6764 (cell)*

[matt.stone@state.sd.us](mailto:matt.stone@state.sd.us)

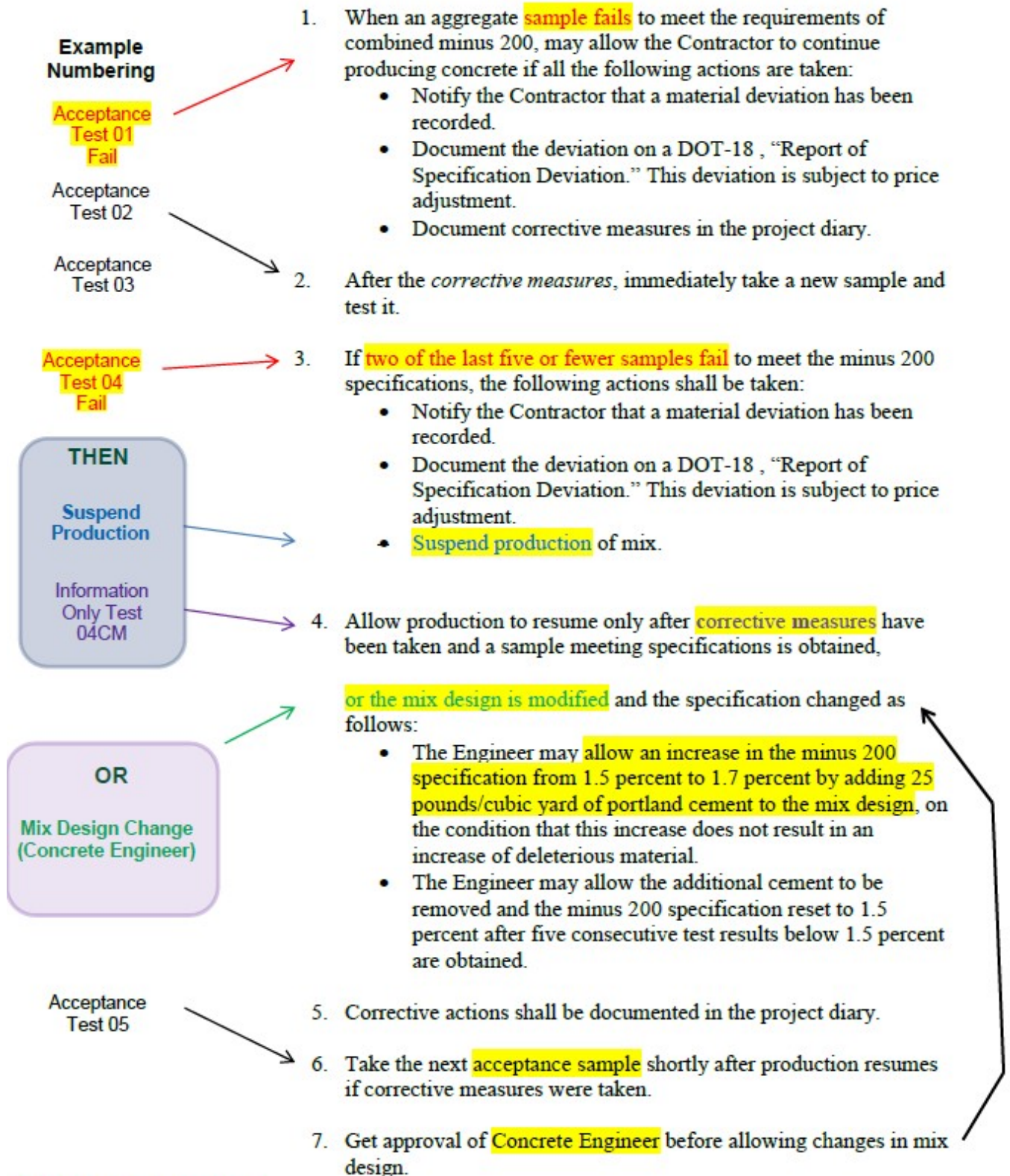
Figure 13.26 Gradation Deviation Policy clarification (Page 2)



**Note:** Corrective Action "X" Tests are only used when the material can be corrected **and** the test does not represent any material such as an embankment density or base course gradation. In the case of production being suspended for Corrective Measures, the "Purpose" of tests should be Information Only, since the test does not represent any material **but** it does not correct the previous test.

Figure 13.27 Gradation Deviation Policy clarification (Page 3)

## II. When an aggregate sample deviates from combined minus 200 specifications



*Note: CCO is not required regarding Specification change.*