Quick Guide to review a Concrete mix design

This guide is meant to be a quick reference, however if any of the information required to be submitted (see MT-100), including the MDT-MAT-008 form, is missing or incorrect, the mix design submittal will not be accepted and will be returned to the contractor or supplier for correction and resubmittal.

Background information you will need:

Locate the appropriate standard and supplemental specifications, you can use this portion of our website:

https://www.mdt.mt.gov/business/contracting/standard_specs.shtml

Locate the MT-100 specifications on this portion of our website:

Materials Manual and Individual Test Procedure (Current/Archived) | Montana Department of Transportation (MDT) (mt.gov)

Locate Bid Letting date, you can use this portion of our website with the contract number or project name:

Awarded Projects List (mt.gov)

Locate the project specific requirements in Special Provisions based on the letting date:

Awarded Bid Packages | Montana Department of Transportation (MDT) (mt.gov)

The mix design submittal form (MDT-MAT-008) can be found at this location near the bottom of the page, this will be the most current version of the form:

https://www.mdt.mt.gov/publications/forms/const_forms.shtml

MDT-MAT-008 Form review by Tab

Within the form, you will only need to enter data into the applicable green boxes.

Transfer Form Tab

- The transfer form is only applicable to current, approved mix designs and is the only form required for a transfer request of a previously approved design.
- Ensure each section of the form is fully completed.
- Ensure the original submittals project information is identified properly. This may require contacting MDT district personnel.
- Ensure the AAHSTOWARE Mix Design ID is identified. This may require contacting MDT district personnel.
- Ensure the box is checked at the bottom of the page certifying the transfer is identical to the originally approved design with no changes to materials or proportioning.

Original Submittal Form Tab

- Ensure the Correct concrete class is shown.
- Ensure the Contractor and supplier are listed.
- Ensure the Mix Designer, ACI Tech, and PE are listed.
- Ensure the EPM/District/DMS are appropriately identified.
- Ensure the project information is entered and correct.
- Ensure the AASHTOWare Mix Design ID is identified. This may require contacting MDT district personnel.

Contractor Mix Design Tab

Reviewing from Top to Bottom:
The Ready-Mix Plant/Production plant needs to be identified.

Ensure the aggregate source is appropriately identified including the source number and name. Verify the aggregate is from an MDT approved source. The District Materials Supervisor or Area laboratory supervisor can provide the source number and name.

Verify the specific gravity and absorption values entered are accurate. (you know your sources best, approximately 2.65 Sp. Gr. and 1-2.2% abs. seems reasonable for most). These values are critical in calculation of water/cementitious ratio and volume on this tab.

Check the cementitious materials and admixtures to ensure that they are properly identified and that they are listed on the QPL. Locate the QPL on this portion of our website:
https://app.mdt.mt.gov/QPL/QPL/search

Next, ensure that the total cementitious content and W/C ratio meet the Class Specific requirements in Standard Specifications Table 551-2.

Check to ensure the gradation type (Conventional or Optimized) has been selected. See Aggregate Charts Tab section below for more details.

Check to ensure the Air Content and Target Slump meet the Class Specific Criteria in Table 551-2.

Ensure the admixture dosage rates are listed for each admixture including whether its oz/100 # CM or oz/cy.

Verify the volume is between 26.7 and 27.3. If not, this is not a balanced mix and will under yield or over yield respectively. Depending on the severity it may be worthwhile to contact the supplier and ask about this.

Ensure the mix design is stamped by the PE indicated on the Submittal Form per MT-100.

Aggregate Charts Tab

When entering gradation values into the columns, if no coarse aggregate is in the mix, you will need to enter 100% passing in each box of the Coarse Aggregate 1 column in order for the charts to generate.

If conventional aggregate was selected as the aggregate acceptance method, compare the supplied gradations for coarse and fine aggregate to our standard specifications: Table 701-2 Fine Aggregate for Concrete and Table 701-4 Coarse Aggregate for Concrete.

If optimized aggregate (combined gradation) was selected for the aggregate acceptance method, compare the Coarseness Factor Chart (top chart in right portion of Aggregate Data Tab or top of second page of gradations in a pdf) to the requirements in MT-122. The current requirements are:

For Class Pave concrete, the coarseness factor and workability factor must plot within the workability box defined as follows:

- The coarseness factor must not be greater than 68 or less than 52
- The workability factor must not be greater than 38 or less than 34 when the coarse factor is 52
- The workability factor must not be greater than 36 or less than 32 when the coarseness factor is 68.

For other classes of concrete, the Workability Factor must plot within Zone II. Aggregate blends that plot in Zone III may be considered for approval of a mix design if a ¾-inch nominal maximum or smaller size aggregate is utilized.

Make sure the blend percentage adds up to 100% (99.9% or 100.1% are ok and is likely due to rounding in Excel). The worksheet at the link below can be used for gradation analysis including the charts.
http://www.mdt.mt.gov/other/webdata/external/materials/materials_manual/MDT OPTIMIZED GRADATION CHARTS.XLSX

Trial Batch Data Tab

Determine what the contract's specified compressive strength is for the class of concrete you are reviewing a submittal for. Look through special provisions and plan sheets to determine if there are special circumstances for the concrete used on the project.

Compare the compressive strength data from the trial batch with the contract requirements for the class of concrete in question. Per MT-100 ensure a three-cylinder average is entered for each age of 3, 7, & 28 days. 56-day breaks are optional if submitted per 551.03.2(A)(8)(b).

For Class Pave, ensure the flexural strength (modulus of rupture) meets the standard requirements. See note in Table 551-2.

For other Classes of concrete, ensure that the submitted information meets the requirements in 551.03.2 specific to that class of concrete. A few classes have additional requirements. (See Class Specific Highlights on subsequent pages in addition to standard specification 551.03.2.)

Aggregate Data Tab

Ensure that results are submitted for each of the fields that are applicable and that the supplied results meet the requirements in section 701.

Class Specific highlights

Class Pave

- Class Pave requires optimized gradation with a wear factor not exceeding 30% in accordance with Standard Specification 501.02.1(B).
- Include the flexural strength (modulus of rupture) meeting the standard requirements of section 551.03.2(B).

Class Deck and Overlay SF

- Requires 3-5% silica fume along with a supplementary cementitious material (fly ash, slag, etc.) in proportions meeting the requirement of 551.03.2(A)(5)
- Requires Surface Resistivity or RCP meeting the requirements in 551.03.2 (C) [check the applicable supplemental specification]
- Requires a batching sequence (this is for ongoing research to try and help MDT/industry understand what works and what doesn't as far as when the silica fume is incorporated). Please don't let this be a deal breaker but do request the information and get it at some point.
- The target strength to be used for incentive calculations is the 28/56-day strength submitted with the mix design. If the mix design strength is greater than 5,500 psi, the target will equal 5,500 psi.

Class Drilled Shaft

- Target Slump is no lower than 8 inches. Do not place with a slump less than 7".
- The estimated time from batching the 1st load of concrete to completion of the shaft placement needs to be identified, also, results from trial batch testing need to be submitted verifying that the slump is maintained at least 2 hours after this time period. Delvo® and Stasis are some of the products we see that are used to accomplish this.

Class CLSM Excavatable or Non-excavatable

- For this class of concrete, determine if the required material for the project is excavatable or non-excavatable. Each has slightly different specifications.
- The gradation requirements are different for CLSM designs so check standard specification tables 551-3 or Table 701-2 for current requirements.
- Design and produce CLSM Excavatable in accordance with standard specification 551.03.2(F)(1)
- Design and produce CLSM Non-excavatable in accordance with standard specification 551.03.2(F)(2)
- There are products used for CLSM that are not on our QPL as they are neither admixtures nor cementitious materials. These are products called "high air generators" or "foaming agents". Some of the product

names are Sika® Lightcrete Liquid or Powder, Rheocell, Rheofill, Mastercell 25, etc. We have allowed the use of these products.

- Problems usually arise with the unit weight and air content not meeting requirement.

Class SCC

- SCC may be used for Classes General (in precast or aesthetic placements only), Structure, and Drilled Shaft concrete.
- Design and produce SCC meeting the specific class of concrete in accordance with table 551-2 (SCC General, SCC Structure, etc.)
- Provide a slump-flow within ± 2 inches (± 50 mm) of the target value. Set target within the range of 20 to 26 inches.
- Provide a maximum visual stability index (VSI) of 1.
- Provide a maximum J-ring value of 2 inches (50 mm).

Class Pre

- The strength for transfer of pre-stress and the 28-day strength requirement varies with beam length and design. Check the plans and specifications for each project.
- Use concrete with a cementitious content between 6.5 to 8.0 sacks (611 to 752 lbs.) per cubic yard per standard specification 553.03.3. and additional requirements in accordance with table 551-2.

Precast applications

- For precast items installed below grade, furnish low alkali hydraulic cements meeting M85/C150 Type V Portland Cement or M240/C595 Blended Cement with the (HS) designation for sulfate resistance from sources listed on the Qualified Products List per Standard specification 554.02.1(A).

AASHTOWARE Mix Design Entry Guide (Internal Staff)

- Create a design and give it the appropriate ID for the year, area, class, and numerical value. An example for Missoula, a new Class General design for 2024 would be named 2411GENERAL01.
- Select the mix design type, enter a brief description (Supplier name and class), select the material code/class of concrete and the supplier source. This will be a name, not a number for the aggregate source.
- Put in any necessary remarks and save.
- Attach the MDT-MAT-008 submission form with PE stamp, materials certs, and any other supporting files from the general tab dropdown carrot in the Attachments agency view.
- Open the Agency view "(1) – MDT Concrete Mix Design – Contractor Mix Design" and enter the data submitted from the 008 form in its entirety.
- Open the Agency view "(2) – MDT Concrete Mix Design – Aggregate (Comb) and enter the gradations from the 008 form.
- Disregard the Agency views labeled "AV #1 – MDT Concrete mix Design – Contractor Mix Design"

and “AV #2 – MDT Concrete Mix Design – Aggregate (Comb)” They are only there for older mix design still using them. The new updated Agency views should be used moving forward.

- If an Optimized/Combined gradation was selected, you will need to open the MDT Concrete Target Agency View and enter the “Combined Aggregate (Target) % passing” from the 008 form into the column. If a Conventional gradation was selected, this step is not necessary.
- Target Strength is only entered for Class Deck and Overlay. This will be from the 008 form 28-day trial batch data. If this value is above 5500 psi, 5500 psi will be the target strength.
- Once everything is completed and entered, the DMS will need to review and approve then send to the Concrete/Aggregate Supervisor for final approval and contract association.