NEW PIPE SPECIFICATIONS AND STANDARDS

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INTRODUCTION

Drainage has always been a primary concern for everyone involved in the design, construction, and maintenance of streets and roadways. It has often been said that the three most important issues facing our industry are drainage, drainage, and drainage. Therefore, it is imperative that pipes and other drainage structures be fabricated of the highest quality materials, installed or constructed in accordance with appropriate practices and be maintained diligently over their service lives.

Historically, INDOT has actively reviewed the performance of its drainage structures. However, the effort has not always been coordinated and the study results have not been made available to all appropriate parties. In order to correct this lack of focus, the Pipe Service Life Committee (PSLC) was formed in the early 1990s. The PSLC was given the responsibility of reviewing hydraulic design criteria, drainage structure material and construction specifications, drainage structure related standard drawings, and the performance of existing drainage structures.

The PSLC performed the above tasks and presented recommended specifications changes to the INDOT Specifications (now Standards) Committee on at least two occasions during 1994. Many of these proposals were approved by the Specifications Committee and implementation was to be scheduled when the accompanying standard drawings were developed. However, standard drawing development was postponed as metrification of all standard drawings was the top priority of the Standards Section in 1995. In the meantime, several PSLC members left the department or had been reassigned within INDOT. These two events combined to prevent the original PSLC proposals from being implemented.

In late 1995, the current PSLC membership was assembled. The current committee includes:

--Richard Smutzer, Chief, Materials & Tests Division, Chairman
--Jeff James, Technical Services Division, Secretary
--Tim Bertram, Chief, Operations Support Division, Member
--Merril Dougherty, Design Division, Member
--Ned Barr, Materials & Tests Division, Member
--Tony Uremovich, Technical Services Division, Member
--Tommy Nantung, Research Division, Member

The new membership took the previous PSLC proposals and amended them to include new technology and to conform to other...
specifications adopted in the meantime. In addition, the required metric standard drawings were developed and a design memo explaining the new specifications and standard drawings was prepared. These items have been presented to and approved by the Standards Committee late in 1996 and early in 1997. The related Instructions to Field Employees are currently being developed and will be presented to the Standards Committee upon completion.

**SPECIFICATIONS CHANGES (HANDOUT 1)**

A new pipe classification system has been adopted. The system includes five pipe types which are described below:

--Type 1 Pipe--Mainline & Public Road Approach Culverts
--Type 2 Pipe--Storm Sewer Pipes
--Type 3 Pipe--Driveway Culverts
--Type 4 Pipe--Underdrain Mains & Drain Tile
--Type 5 Pipe--Broken-back Pipe Installations

Refer to Handout 1 for the list of appropriate materials for each pipe type.

Structures which can utilize materials included in the classification system will be paid for by pipe type, not by individual material.

If any of the following structures are necessary, the pay item will include the required structure:

--Precast Reinforced Concrete Box Sections
--Precast Reinforced Concrete Three Sided Culverts
--Structural Plate Arch Structures

The Structural Plate Arch is not to be confused with the Structural Plate Pipe-Arch which is included in the pipe classification system. The arch has no bottom plates as it utilizes concrete foundations on each end of the span. The pipe-arch is a deformed pipe with structural plates at the flowline.

In addition, there are several drainage structure applications which are not included in the pipe classification system. Some of these are listed below:

--Concrete (Box, Slab-top, Arch, etc.) Culvert Extensions
--Pipe Extensions
--End Bent Drains
--Slotted Drain Pipe
--Slotted Vane Drain Pipe
--Sanitary Sewer Pipe

When any of the above applications apply to an individual structure, the pay item includes the required application. Also, pay items for concrete culvert extensions and pipe extensions include the material required for the extension.
Several changes have been made to specifications related to polyethylene (PE) and polyvinyl chloride (PVC) pipe. Both of these materials can now be utilized for mainline or public road approach culverts and they can both be used for pay item diameters up to and including 900 mm. However, PE and PVC pipes which are not fabricated of Hydrostatic Design Basis (HDB) rated resins and installed under or within 1.5 m of mainline or public road approach pavement must be backfilled with flowable mortar.

Sanitary sewer pipe materials have been deleted from the specifications. If included in the contract, allowable sanitary sewer pipe materials must be listed in a special provision.

STANDARD DRAWING REVISIONS (HANDOUT 2)

Refer to Handout 2 for the metric standard drawings which illustrate the new pipe related requirements. No revised English standard drawings have been prepared. If it is necessary to let an English contract after the effective date of these proposed changes, the designer will need to include appropriate details with English units on the plans or reference the required metric standard drawings and prepare a special provision with appropriate conversion factors in the contract.

The standard drawings related to bedding and backfill of pipe installations have been consolidated into one series. There is now one standard bedding instead of the previous three. If the geotechnical report indicates that a bedding other than the standard is required, details illustrating the bedding requirements must be shown on the plans. Also, new standard drawings have been developed which show the requirements for installations utilizing flowable mortar pipe backfill.

Height of cover tables have been added to the standard drawings. These drawings show the minimum and maximum cover heights for various thicknesses or strength classifications for Type 1, 2, 3, and 5 pipe materials. These tables can also be used to determine available pipe sizes for these materials. More discussion will follow regarding how these new standard drawings will be used.

Another set of new standard drawings is the 715-PSLC series. These sheets contain information related to new design criteria which will be discussed later in greater detail. These parameters are listed below:

--Required Service Life
--Site Designation
--Structure pH

Essentially, these parameters are a measurement of the severity of the environment at a structure site. More severe environments require greater metal pipe thicknesses and more extensive protective coatings or require flatter slopes for
reinforced concrete pipes. Less severe sites require fewer such measures.

Other new standard drawings have been developed to illustrate one of the two allowable methods of extending existing concrete culvert structures. This method involves removing portions of the existing structure, constructing a cast-in-place reinforced concrete splice, and utilizing precast reinforced concrete box sections for the extension. The previous standard drawings which illustrated extending these structures with corrugated metal pipe have been deleted as this practice has been discontinued.

Another consolidation of sheets has been accomplished by showing the pipe materials included in the pipe classification system on the new 715-PIPE series of drawings. This series eliminates the previous 715-PSDR and 715-PSSS series of sheets and their differentiation of surface drainage pipe from sewer pipe.

**DESIGN MEMO (HANDOUT 3)**

Handout 3 is the design memo that will be utilized until the appropriate chapters of the new design manual are published.

The majority of the design memo is devoted to instructing designers how to implement the changes in the drainage structure related specifications and standards. However, there are also elements of the memo which are not new. Existing elements include design storm requirements based on structure application as well as acceptable computer software packages and hand design methods for hydrological and hydraulic calculations.

An important new issue included in the memo is the introduction of a structure priority system. This system indicates the following preferences:

--Pipe Classification System Materials over Other Structures
--Circular Pipes over Deformed Pipes
--Structures with a Single Opening over Multiple Openings

In order to ensure that the above priorities are followed by the designer, a system consisting of six trials has been developed and must be used whenever a new culvert or storm sewer structure is proposed. The six trials are listed below:

--Trial 1--Single Circular Pipe Structure (Type 1, 2, 3, or 5)
--Trial 2--Single Deformed Pipe Structure (Type 1, 2, 3, or 5)
--Trial 3--Single Specialty Structure Installation
--Trial 4--Multiple Circular Pipe Structure (Above Pipe Types)
--Trial 5--Multiple Deformed Pipe Structure (Above Pipe Types)
--Trial 6--Multiple Specialty Structure Installation

Specialty structures include the previously discussed precast reinforced concrete box sections, precast reinforced concrete three sided culverts, and structural plate arch structures.
Because pipe types 1, 3, and 5 consist of some materials with smooth interiors and others with corrugated pipe interiors, two hydraulic designs will be required when performing Trials 1, 2, 4, or 5. The smooth interior design will be based on concrete pipe design criteria, while the corrugated interior design will be based on corrugated metal pipe design criteria. When performing the required dual designs, one of the following situations will occur:

--Case 1--The Two Designs Yield Equal Pipe Sizes
--Case 2--The Two Designs Yield Different Pipe Sizes
--Case 3--Only One Design Yields a Suitable Pipe Size
--Case 4--Neither Design Yields a Suitable Pipe Size

If the dual design process results in a Case 1, 2, or 3 scenario, the hydraulic design process is complete (refer to the memo for one additional step required for Case 3 situation in Trial 1 or Trial 4). If the two designs result in a Case 4 scenario, the hydraulic designer moves to the next trial in the quest of finding an acceptable structure size and type.

When the designer attempts to size a suitable single specialty structure, only one design using appropriate design parameters is required for each structure type considered.

If the designer performs the six trials and has not determined an appropriate structure size and type, the INDOT Hydraulics Unit must be contacted for additional guidance.

There will be discussion later in this presentation regarding how to show the results of the culvert and storm sewer hydraulic design process on the plans.

The design memo also instructs the designer how to determine the new service life parameters for each proposed Type 1, 2, 3, or 5 pipe structure. Service life parameters do not apply to Type 4 pipe structures, specialty structures, or extensions of existing structures, or any of the special application structures (slotted drain pipe, slotted vane drain pipe, end bent drains, etc.)

The required service life for all pipes in the contract is dependent on the functional classification of the mainline roadway. If the mainline is an interstate or arterial, the required service life for all structures is 75 years. If the mainline has a collector or local classification, the required service life is 50 years.

The site designation parameter designates every site as abrasive or non-abrasive. All mainline culvert sites are considered abrasive. Also, all public road approach and driveway culverts installed in natural channels are assigned an abrasive site designation. As a general rule, all storm sewer pipes and culverts installed on constructed ditch lines are to be given non-abrasive site designations. However, the designer may use judgment to assign an abrasive site designation to any structure which
requires additional protection.

The structure pH parameter is assigned based on data obtained from the project scoping report, geotechnical report, the pH map included in the memo, or in some cases, pH testing performed by the designer. The process is discussed in detail in the memo, but is essentially as follows. The designer is given pH data in the scoping report for the project. If the data is not available from the scoping report (or if no scoping report is available), the designer must use the design memo pH map or perform pH testing to acquire the data. The second round of data is provided to the designer via the geotechnical report. Again, if the geotechnical report does not include pH data, the designer must obtain substitute data from the pH map or by pH testing.

After two pH values have been obtained for each structure, they are compared. If they are within 0.5 of each other, the lower value will be the pH value assigned to the structure. For structures where the two pH values are not within 0.5 of each other, the designer must perform pH testing to obtain a third pH value. The lowest of the three pH values will then be assigned to the structure.

If a designer finds that it is desirable to extend an existing concrete culvert, a single hydraulic analysis is required. It must be demonstrated that the extended structure is capable of conveying the design storm(s) required for new culverts. The hydraulic analysis will be based on parameters appropriate for the selected extension method—precast reinforced concrete box section extension or cast-in-place reinforced concrete extension. If the analysis indicates that the extended structure does not meet hydraulic requirements, the designer must contact the INDOT Hydraulics Unit for additional instructions.

If the designer desires to extend an existing pipe, the extension material must match the existing pipe material, if possible. The designer will perform a hydraulic analysis of the extended pipe to verify that it meets the requirements for new pipes of the same application. Again, the hydraulic analysis will be based on parameters appropriate for the extended pipe material. If it is found that the extended pipe is not hydraulically adequate, the designer must contact the INDOT Hydraulics Unit for additional guidance.

Underdrain design procedures are also included in the design memo. As is the case with current practice, underdrains are only proposed when required by the pavement design or the geotechnical report. Likewise, geotextiles for underdrains are only proposed when required by the geotechnical report or the INDOT Geotechnical Engineer.

Two previous elements of underdrain design are now prohibited. Transverse underdrains connecting two longitudinal underdrain mains, as well as fittings which require an immediate 90 degree
turn in flow (tees and 90 degree elbows), are no longer permitted.

Most of the new underdrain features are related to outlets. Outlet spacing is not to exceed 100 m and each outlet pipe is to be terminated with one of two available outlet protectors.

The memo also stresses the importance of clearly showing the limits and magnitudes of all required special underdrain grades on the plans.

Drain tile design is also discussed in the design memo. All new tile to be installed within temporary right-of-way will be perforated Type 4 pipe.

If an existing tile will be disturbed by construction activity within permanent right-of-way, all of the tile within the right-of-way must be removed. If the replacement tile is to outlet at a ditch prior to crossing pavement, non-perforated Type 4 pipe with a 3.0 m terminal section of corrugated steel pipe equipped with a rodent screen will be utilized. If the replacement tile is to outlet in a storm sewer, Type 2 pipe will be used. If the replacement tile will outlet at a ditch after crossing pavement, Type 1 pipe equipped with a rodent screen will be utilized. If the replacement tile is to be connected to existing tile at the right-of-way line, Type 1 pipe will be installed from right-of-way line to right-of-way line. At locations where dissimilar pipe materials are to be joined, concrete collars will be required to make the connection.

At locations where a replacement drain tile outlets at a ditch, revetment riprap will be required between the tile outlet and the ditch flowline to prevent erosion.

The design memo also discusses the two new allowable methods to extend existing concrete culvert structures. The existing culvert can be extended using precast reinforced concrete box sections as described earlier in this presentation. The designer may use the new standard drawings if they are found to be appropriate for the project. If it is determined that the standard drawings do not apply to the project, the designer must detail all such requirements on the plans.

The second allowable method for extending existing concrete culverts is with a cast-in-place reinforced concrete extension. The designer will have to show all details associated with the cast-in-place extension on the plans.

The design memo also instructs the designer of the requirements related to sanitary sewer design. Because sanitary sewer pipe materials have been deleted from the Standard Specifications, the designer must work with representatives of the sewer utility to determine the required pipe materials and the scope of testing required. English sewer pipe diameters requested by the utility are to be converted by multiplying by 25 mm/in.
IMPACT ON CONTRACT DOCUMENT PREPARATION

How are these changes going to affect contract documents? There will be some changes in plan preparation, new standard drawings will be required for inclusion in contracts, and additional special provisions will be required.

The changes in Plan & Profile Sheet preparation are related to the dual hydraulic design requirement for Type 1, 3, and 5 pipes. If it is found that a proposed structure requires differing smooth and corrugated interior pipe sizes or that a proposed structure requires the installation of a pipe with a specific interior, the structure callout format will change. In the first case, the structure callout will include both required pipe sizes and the second situation requires that the structure callout contains the specific interior type. Sample callouts are shown below.

--20 m 750 mm Smooth or 900 mm Corrugated Pipe & ____ Required
--20 m 750 mm Smooth Pipe & ____ Required

In cases where different smooth and corrugated pipe sizes are required, the smooth alternate will be shown on the profile portion of the sheet.

For structures which do not have differing smooth and corrugated interior pipe sizes, there are no changes in Plan & Profile Sheet preparation.

Several changes in Structure Data Sheet preparation are also due to the dual design requirement. Structures which propose differing smooth and corrugated interior pipe sizes will require tabulation of all data associated with the smooth pipe installation on one line and all data related to the corrugated pipe installation is shown on a second line.

Structures which require a specific interior type will have the requirement noted in the "Remarks" column of the sheet.

The memo also includes copies of revised Structure Data and Underdrain Table Sheets which includes column headings for the new parameters. Electronic versions of these new sheets will be made available in the near future.

There will be changes in the Schedule of Pay Items and how the related quantity calculations will be performed. Sample pipe pay items are listed below:

--Pipe, Type 1, Circular, 900 mm
--Pipe, Type 1, Circular, 1050 mm Smooth or 1200 mm Corrugated
--Pipe, Type 1, Circular, 2400 mm Smooth

The above pay items are new, but the quantity calculation method is unchanged from previous practice. However, some existing pay items will have their quantities calculated differently. For
instance, assume a contract includes 20.0 m of Type 1 pipe which requires a 1050 mm smooth interior diameter or a 1200 mm corrugated interior diameter. For the structure in question, the Structure Data Sheet includes two backfill quantities and two quantities for concrete, A, structures (for concrete anchors). The designer is to use the quantities related to the smooth interior pipe installation in the calculations for the Schedule of Pay Items quantities.

Special provision preparation will be affected by these proposals, as well. Because sanitary sewer pipe materials have been deleted from the Standard Specifications, a special provision is required for every contract that includes sanitary sewer pipe. As a minimum, the special provision must include pipe material and testing requirements. In addition, the special provision may include any construction or material related requirements of the sewer utility.

The most significant special provision requirement is the material selection special provision. This special provision lists all appropriate materials, including material thicknesses or strength classification, protective coatings, etc., for every Type 1, 2, 3, or 5 pipe structure in the contract. These material requirements are determined by taking the designated pipe type, cover, required service life, abrasive/non-abrasive site designation, and structure pH from the Structure Data Sheet and referring to the appropriate height of cover tables and pipe service life sheets in the standard drawings. A computer program is under development to assist the designer in generating the appropriate material list. Also, a recurring special provision is being prepared to assist the designer present the list in a consistent manner.

IMPLEMENTATION

The revised specifications, standard drawings, and procedures are scheduled for implementation on all contracts let after January 1, 1998. In addition, there will be some contracts let during the summer of 1997 which incorporate some aspects of these proposals.

It is obvious that it is not possible to adequately explain the entire scope of the new specifications, standard drawings, and design procedures in an hour presentation at Road School. During the next several months, a series of smaller group presentations will be held to discuss these items in more detail. Between now and then, if you have any questions regarding these issues, feel free to contact me at 317/232-5342.