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Performance Life of HMA Mixes

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16. Abstract

A number of hot mix asphalt (HMA) types, such as permeable friction course (PFC), stone mastic asphalts (SMA), performance design mixes and conventional dense graded mixes are currently used to construct or overlay roads. One of the important inputs into current pavement design programs is the performance lives of HMA mixes since they significantly impact the life cycle cost analyses of the pavement structures and the ultimate selection of the HMA type. Knowing performance lives is also key information when developing pavement maintenance programs. Currently, the estimated performance life of different HMA mixes (including the frequency of overlay) by the designers is highly subjective.

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1. Introduction

Hot mix asphalt layers are currently used for construction and overlays on roads across the United States. Frequently used mixes in Texas include performance-design mixes, permeable friction course (PFC), stone mastic asphalt (SMA), and dense graded mixes. The estimated performance and overlay life of the mixes listed above is not well documented, but is essential to transportation agencies for ongoing pavement design and maintenance programs. The quality of the mix types is crucial to the life-cycle cost analyses, and the HMA selection which is subjective depending on the engineer. The service life of the mix type is determined by factors such as construction, and maintenance practices. Currently, there are no means of rationally quantifying the impact of these factors on the performance of a mix. The Texas Department of Transportation (TXDOT) has specific archives that have information regarding Texas roads; however, the integration of such information is strenuous due to the different formats that this data is stored in. The purpose of the software developed at The University of Texas at El Paso (UTEP), is to attain an objective decision making tool that identifies the performance of various mixtures. The resulting performance values are presented statistically based on quantifiable data from existing databases, as well as forecast from historically monitored field data. The software is designed to not only be user-friendly, but also to assist in the decision-making process, in relation to the mix type selection required for a job based on the mix performance. The service life is then selected based on parameters such as pavement mix types, traffic volume, and climatic region. The software is called Performance Life of HMA Mixes in Texas (PERMIT) and its features include:

- Access to road construction, reconstruction, and maintenance data;
- Derived statistical data with computed analysis;
- Easily and securely accessible through an internet browser, http://ctis.utep.edu/6679/; and
- Visual representation of data acquisition through Google maps.

PERMIT was developed under research funded by the Texas Department of Transportation; and its objective is to analyze the mix type performance based on existing and historical data, to present reliable service life estimation for different mix types. The tool can be accessible to all transportation agencies.

2. Proposal Address

The project required

Task 5 of Project 0-6679 consists of the Evaluation of Performance of Mixes. The primary objective of this task includes populating a database of the performance; achieved through the creation of Performance Analysis and Statistics System (PASS). PASS provides a clean, user-friendly graphical interface that makes use of the same forms as TXDOT. The tool utilizes the input data from the site manager; it also achieved the required data analysis presented next. A further explanation is found in the How to Use – Access guide section of this document.

i. Quantifying the impact of RAP and RAS in term of HMA mix performance

ii. Quantifying the impact of the binder on the mix performance

Task 6 consisted in the Analyses of Results. This task required the identification of significant parameters that impact the performance of any given mix type. Therefore, a relationship was established between the significant parameters and performance. A closer look at the different parameters was performed, which allowed to identify and eliminate parameters that statistically do not impact performance of a given type of HMA.

Task 7 will entail documenting the process of selecting the representative performance life of typical mix types, and how lessons learned from the study can be applied to pavement design, and maintenance programs. The achieved goal is to expand and link TXDOT PMIS, DCIS, Letting, and SiteManager databases online. The SiteManager database includes design and construction QC/QA records for HMA projects in Texas. Achieving the previous goal benefits TXDOT with regards to pavement management decision making in the future.

3. Pavement Analysis and Statistics System

3.1. About SiteManager

SiteManager is a comprehensive construction management system that automates and streamlines the management of highway construction contracts; it also covers the complete construction management process from contract award through finalization. SiteManager is used by all levels of construction personnel from field inspectors, technicians and project managers, to clerks, auditors, lab personnel, management, producers, suppliers, contractors, and the Federal Highway Administration (FHWA). The information that is processed and stored in SiteManager includes construction administration, field record keeping, contract record maintenance, contractor payment processing, materials management, and civil rights monitoring data.

TXDOT archives all of this information into several tables, adding new information through the course of years. Due to the magnitude of these tables, it becomes taxing and tedious to perform queries to analyze the data. In addition to that, there is no graphical user interface (GUI) or a guide to help users run queries so that they can perform data analyses. If a user wants to analyze this data, the user has to be at least familiar with Access and SQL, and devote large amounts of time. PASS was developed with all of these constraints in mind.

PASS provides a clean, user-friendly graphical interface that makes use of the same forms as TXDOT uses to input data into SiteManager. Thanks to this, the intended users of the system will be already familiarized with the system before they even start to use it. The user is not required to have previous knowledge about Access, or how to perform SQL queries; all of that is taken care of by the GUI and the back-end processes of the system.

3.2. SiteManager Tables

In a yearly basis, TXDOT provides the development team the following tables from their databases. These tables are used by PASS:

- SMGR_TX_T_TST_RSLT_DTL – This table, henceforth referred as SMGR Input table, captures all user input fields from the SiteManager Excel forms. Content to this database is added through all the year by TXDOT personnel, and is updated on this system on a yearly basis.
- SMGR_TX_T_RSLT_VAL – This table, henceforth referred as SMGR Value table, captures the calculations made by the SiteManager Excel forms based on the user input fields. Content to this database is added through all the year by TXDOT personnel, and is updated on this system on a yearly basis.
- SMGR_TX_TST_RSLT_DSCR – This table, henceforth referred as Value Dictionary table, serves as a reference dictionary for the SMGR Value table; in order to make sense of the data inside that table, it is necessary to label the fields within it. No content is added to this database unless a new form or a new revision of a form is added to the system (SiteManager).
- SMGR_T_CONT_ITM – In this table, henceforth referred as CSJ and Specifications table, the fields ITEM CD, DESC1, and LN_ITM_NBR can be found and further expand the knowledge of the system's (PASS) main database.
- SMGR_T_PRODR_SUPP/SMGR_T_SMPL – These tables, henceforth referred as Producer table, expand the knowledge of the system's (PASS) main database by adding content about producer related information.
- SMGR_T_CONT_SMPL – This table, henceforth referred as CSJ to Sample ID, serves as a reference dictionary to link CSJ to Sample IDs.

In addition to these tables, another table had to be created:

- Input Dictionary – This table was created as a reference dictionary for the SMGR INPUT table. It is the equivalent of the Value Dictionary table for this table. It was created by using the Excel Sheet forms used in SiteManager and if any forms are added to the system this table has to be updated.

Content to these tables is updated and added through all the year by TXDOT personnel, and are given to the development team on a yearly basis.

3.3. Building the Database

In order to make sense of these tables, it is required to link them and merge them when possible. By merging these tables, the time it takes to run a query can be reduced; by linking them, users can actually make sense of the records and perform data analyses. It would be impossible to perform any analyses on a single table by itself. For instance, if users wanted to perform a data analysis on the SMGR Val table, users would not be able to do this because this table does not contain labeling information. But if this table is linked to the Value Dictionary table, then it becomes possible to make sense of this table and perform an analysis.

The main database that was built for this project is named "SiMa"; it is the result of merging the following tables: SMGR VAL, Value Dictionary, and CSJ to Sample ID tables. The linking and merging process is a complex, time consuming, and tedious task for a regular user to perform. If a user was to link and merge these tables each time an analysis was to be performed, it would take large amounts of time to get any results. The SMGR Val table alone contains more than 20 million records; and this number is going to increase as time goes by. For these reasons, a program was developed to take care of the merging and linking process. It is a Java based application that takes as input these tables, and processes them.

The first step taken by this program is to merge the SMGR VAL table to the Value Dictionary table. These tables have a common field that is named "FLD_DSCR_KEY" (see Figure 1). In order to reduce the time it would take to merge these tables, instead of following a linear search approach, a binary search approach is taken. The Value Dictionary table is sorted in descending order since it is the smaller of the two.

Figure 1 – Schematic of common field s used to link databases

After this process is finished a similar process is followed to merge the SMGR VAL + DSCR table to the CSJ to Sample ID table, only this time instead of using the FLD_DSCR_KEY to merge them, the Sample ID is used to accomplish this.

The result of this is the main database for PASS but it not limited to these tables. CSJ to Sample ID table serves as a bridge to other tables since it has information to link Sample IDs to CSJ as well as Line Item Numbers. What this means, is that this database, SiMa, can be linked to other databases such as the one that is used by PERMIT.

3.3.1. Supported Forms

The forms that are supported at the moment by PASS are:

- TX2MIXDE4 - HMACP Mixture Design: Combined Gradation
- TX2MXPROP – HMAC Mix Properties
- TX2QCQA04 - QC/QA Design Data
- TX104-6 – Atterberg Limits
- TX107 – Bar Linear Shrinkage
- TX110 – Particle Size Analysis
- TX113,4 - Moisture-density Relations of Base Material and Cohesion less Sand and Subgrade and Embankment soils.
- TX113 – Moisture-density Relations of Base Material and Cohesion less Sand
- TX115 – Nuclear Density and Moisture Determination: Tex-115-E
- TX116 – Resistance to Degradation by Wet Ball Mill Method
- TX117 - Triaxial Compression Tests: Tex-117-E
- TX418,48 – Portland Cement Concrete Report
- TX4Fresh – Hydraulic Cement Concrete Report
- TF4Hard – Hydraulic Cement Concrete Report for Structural Concrete
- TX4Pave04 – Hydraulic Cement Concrete Report for Concrete Pavement
- HCCMXDES2 – Hydraulic Cement Concrete Mix Design and Control (Mix Design)

The final product will support all forms that are used by SiteManager.

3.3.2. Integration with PERMIT and Other Systems

While PASS by itself is a robust and powerful tool that can provide extensive data analyses based on construction administration, field record keeping, or contract record maintenance data, among others, PASS was first developed with the purpose of expanding and building on top of the analyses that PERMIT performs. Thus, while PASS retrieves information from the SiteManager databases, it also cross references the data retrieved from PERMIT. Hence, the combination of the analyses of both PASS and PERMIT provide the information to help departments of transportation make more informed decisions on the

design process. The integration of these tools is accomplished thanks to the table CSJ to SAMPLE ID. Thus, after running a query with PASS, not only will the user be given information retrieved from the SiteManager tables but will also be given statistics retrieved from PERMIT. This means that prediction data, years in service data, as well as information about whether a road has been reconstructed or not is also presented.

The integration to PERMIT is accomplished thanks to the unique keys CSJ and Sample Id that are found in these systems (PASS and PERMIT); it is important to note that integration to other systems can be achieved if they share any of the unique keys that are found within the tables that are part of the PASS.

3.4. Graphic User Interface

When designing a graphic user interface, it is important to strive for consistency and cater to universal usability. For these reasons, the user interface for PASS makes use of a similar format as the one used by TXDOT to submit forms and data into the SiteManager databases. TXDOT personnel make use of Excel Sheet forms to capture information into their database. For each type of construction job there is one Excel sheet; this helps to break down the retrieving process into several categories. The biggest benefit of using a similar format as the one that TXDOT uses to input data is that the learning process will be really easy for TXDOT personnel.

When a user first access the online web based tool "PASS", the first element that is displayed are the different categories the system has. In Figure 2, three categories (or forms) can be seen.

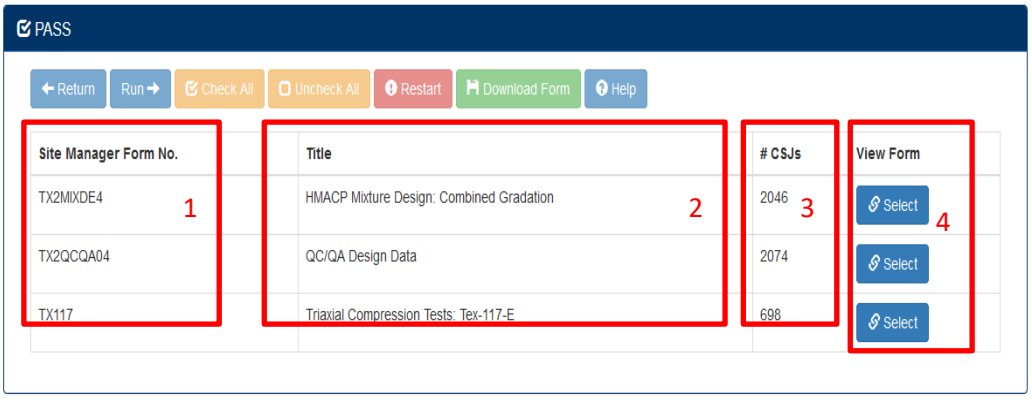

Figure 2. PASS Form Selection

Other attributes such as the Site Manager Form number (1), the title of the form (2), and unique number of CSJ records (3) for that specific category are displayed in this section. If a user wants to perform an analysis on one of these categories then the user has to select it by clicking the select button (4).

Figure 3 is a screenshot of what the graphic user interface to retrieve data of the system looks like. It looks and follows the same format as what the Excel Sheet Form for TX2MIXDE4 would like. There are several elements with different functions captured in Figure 3.

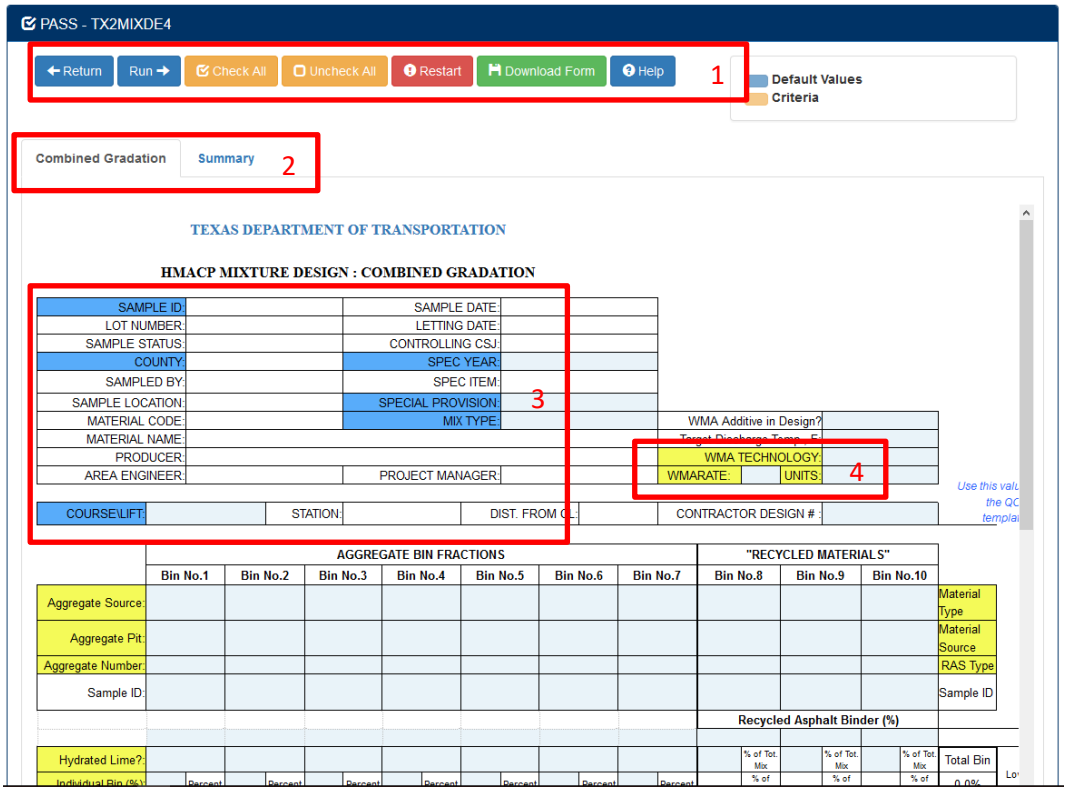

Figure 3. PASS Query Selection

Box 1. Contextual menu – It contains buttons to the following functions: Return (Go back), Run (Run query based on selected values), Check All (Selects all fields), Uncheck All (unselects all fields), Download Form (Download the original TXDOT form), and Help.

Box 2. Tabs – In some cases, the Excel sheet forms used to input data contain more than one tab per document. The tabs in the GUI represent the same thing as they do in the forms.

Box 3. Default values – The fields in blue will always be part of the queried data.

Box 4. Criteria – The fields in yellow represent the criteria users can use to build the queries.

3.5. Quality Attributes

The quality attributes of a system are the overall factors that affect run-time behavior of the system, system design, and user experience. They represent areas of concern that have the potential for application wide impact across layers and tiers. Some of these attributes are related to the overall system design, while others are specific to run time, design time, or user centric issues. The quality attributes of the system, PASS, are described below.

3.5.1. Availability

Since the system (PASS) is a web based application, the system is available as long as the center's server is up and running. In order to access the system, users have to go to the following address: http://ctis.utep.edu/PASSV7

Supported and tested web browsers are:

- Google Chrome – 48.0.2564.82
- Mozilla Firefox – 43.0.4
- Internet Explorer – 11.0.27
- Microsoft Edge – 25.10

Supported and tested display resolutions are:

- 1024 * 768
- 1366 * 768
- 1920 * 1080

While the system works in higher and lower display resolutions the ones mentioned above have been tested and convey the idea of the system.

The system will not be available only on the following cases: our server is under maintenance, the system (PASS) is under maintenance, or an electricity outage.

In addition to that, while the system can be used by multiple users at the same time, the system will slow down depending on the number of requests.

3.5.2. Maintainability

The system was built using several programs, scripts, and methods that automate the creation process as much as possible. A maintenance mode was built into the system so that data can be added over time. Similar to the PERMIT web based tool, the system is updated on a yearly basis. New data is given to the development team by TXDOT and then is added to the system.

Since the system makes use of SiteManager forms for the front-end, a semi-manually process has to be followed to add new forms to the system. In addition to that, as time passes, TXDOT releases new versions of these forms. These forms also have to be updated on the system. The table Input Dictionary has to be updated as well since this table is not provided or supported by TXDOT.

3.5.3. Modifiability

The system was built taking into consideration that in the future changes might be needed to be done as well as new features added to the system. For a programmer that is familiar with web development it would be rather easy to add new features or make any changes to the system.

3.5.4. Confidentiality

Since the system makes use of data provided by TXDOT, the security of the system is an important factor. At the moment the system can only be accessed by those who have its address. While it has not been implemented, a log in system has been created and will be added to future versions of the system. It is a system of accounts; accounts can only be requested through our website and then are submitted to be reviewed. Passwords are also salted and hashed before being stored into our database. All these measures are taken ensure to the security of the system.

3.5.5. Integrity

Since the system makes use of data provided by TXDOT, the main integrity concern is not the data presented at the end of a query but how was the database built. In section 3.3 Building the Database, the process of how the development team integrated the different tables given by TXDOT is described in more detail.

In addition to that, any calculations that the system performs were hand checked and verified by a different part of the development them to validate these results.

3.6. How to use - Access guide

There is no need to download or install any non-common, external software to a computer to be able to run PASS. In order to access PASS, users have to access the following link: http://ctis.utep.edu/PASSV7

3.6.1. With MySQL - Relational Database

Next, a demonstration of a series of queries and calculations that a user would have to perform to get the same results as PASS is shown:

1. Due to the magnitude of the database, the first step to take is to narrow down the results by looking for the specific test method form number. For instance, if one were to look for mix design data, one would have to run a query that narrows down results for the form TX2MIXDE4.

```
SELECT CSJ, SMPL_ID, DSCR_1, DSCR_2, DSCR_3, DSCR_4, DSCR_5, DSCR_6, DSCR_7, FLD_VAL
FROM   sima
WHERE  tst_meth LIKE "%tx2mixde4%";
```

This query will return all records that are related to the TX2MIXDE4 form. Fields DSCR_1 through DSCR_7 contain different fields from the excel sheet form (see Figure 4).

CSJ	SMPL_ID	DSCR_1	DSCR_2	DSCR_3	DSCR_4	DSCR_5	DSCR_6	DSCR_7	FLD_VAL
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	Lower&UpperSpecificationLi...	WithinSpec's	SieveSize:	1			Yes
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.1	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.2	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.3	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.4	Cum.%Passing	SieveSize:	3/4			99.5
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.5	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.6	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	DryRoddedUnitWeightofCoa...	Cum.%Passing					99.92
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	Lower&UpperSpecificationLi...	WithinSpec's	SieveSize:	3/4			Yes
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.1	Cum.%Passing	SieveSize:	3/8			97.8
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.2	Cum.%Passing	SieveSize:	3/8			24.6
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.3	Cum.%Passing	SieveSize:	3/8			98.9
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.4	Cum.%Passing	SieveSize:	3/8			97.4
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.5	Cum.%Passing	SieveSize:	3/8			100
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	BinNo.6	Cum.%Passing	SieveSize:	3/8			98.1
141502030	1206108DGAJEWS*145	HMACPMIXTUREDESIGN:COMBINEDGRA...	DryRoddedUnitWeightofCoa...	Cum.%Passing					79.394

Figure 4. Example of all records extracted that relate to TX2MIXDE4

2. The user then has to analyze the results and compare them side by side to the original form to further understand them, and to find the fields that are of interest to the user. Since form TX2MIXDE4 has more than one sheet, as it can be seen in Figure 5, the query has to be modified to search only for records that belong to the specific sheet.

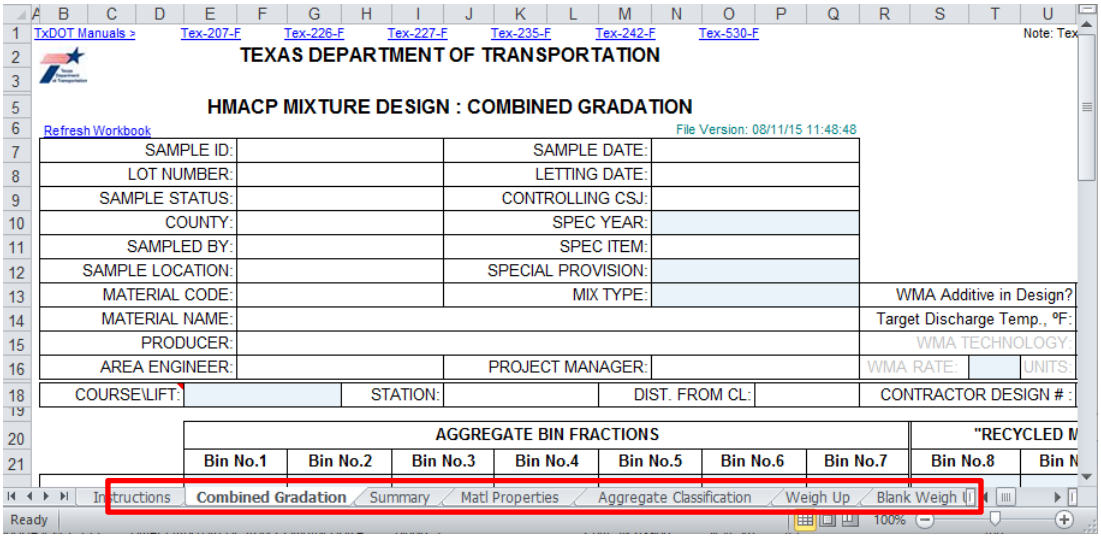

Figure 5. Example of the TxDOT mix design worksheet

Modified query:

```
SELECT CSJ, SMPL_ID, DSCR_2, DSCR_3, DSCR_4, DSCR_5, DSCR_6, DSCR_7, FLD_VAL
FROM   sima
WHERE  tst_meth LIKE "%tx2mixde4%"
       AND dscr_1 LIKE "%combinedgradation%";
```

Since we are filtering field DSCR_1 it is not necessary to select it any longer.

3. The modified query will return the following records illustrated in Figure 6:

CSJ	SMPL_ID	DSCR_2	DSCR_3	DSCR_4	DSCR_5	DSCR_6	DSCR_7	FLD_VAL
141502030	1206108DGAJEWS*145	BinNo.6	Cum.%Passing	SieveSize:	1			100
141502030	1206108DGAJEWS*145	DryRoddedUnitWeightofCoa...	Cum.%Passing					100
141502030	1206108DGAJEWS*145	Lower&UpperSpecificationLi...	WithinSpec's	SieveSize:	1			Yes
141502030	1206108DGAJEWS*145	BinNo.1	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	BinNo.2	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	BinNo.3	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	BinNo.4	Cum.%Passing	SieveSize:	3/4			99.5
141502030	1206108DGAJEWS*145	BinNo.5	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	BinNo.6	Cum.%Passing	SieveSize:	3/4			100
141502030	1206108DGAJEWS*145	DryRoddedUnitWeightofCoa...	Cum.%Passing					99.92
141502030	1206108DGAJEWS*145	Lower&UpperSpecificationLi...	WithinSpec's	SieveSize:	3/4			Yes
141502030	1206108DGAJEWS*145	BinNo.1	Cum.%Passing	SieveSize:	3/8			97.8
141502030	1206108DGAJEWS*145	BinNo.2	Cum.%Passing	SieveSize:	3/8			24.6
141502030	1206108DGAJEWS*145	BinNo.3	Cum.%Passing	SieveSize:	3/8			98.9

Figure 6. Example of records extracted from the merged database using the query developed.

After this, the user has to further analyze the results. If the user is unfamiliar with the specific name of the field, a query to search for distinct values in a specific column can be performed.

```
SELECT DISTINCT(DSCR_2)
FROM   sima
WHERE  tst_meth LIKE "%tx2mixde4%"
       AND dscr_1 LIKE "%combinedgradation%";
```

This will return a table of all the distinct values of the selected column. After this, the user can modify the query to search for specific values.

DSCR_2
AsphaltSource&Grade:
BinderPercent(%):
BinNo.1
BinNo.2
BinNo.3
BinNo.4
BinNo.5
BinNo.6
DryRoddedUnitWeightofCoa...
Lower&UpperSpecificationLi...

4. For this example, we are looking for the "Ratio of Recycled to Total Binder" but, it is not in the database so a different approach has to be taken. With the help of the original form, users can find out if the field they are looking for is calculated through a formula, and what values are required. With the original form, it was found that in order to calculate the "Ratio of Recycled to Total Binder" the fields Recycled Asphalt Binder, Binder Percent (%), and Material Type are required.

```
SELECT CSJ, SMPL_ID, DSCR_2, DSCR_3, DSCR_4, DSCR_5, DSCR_6, DSCR_7, FLD_VAL
FROM   sima
WHERE  tst_meth LIKE "%tx2mixde4%"
       AND dscr_1 LIKE "%combinedgradation%"
       AND  ( dscr_2 LIKE "%materialtype%"
                OR dscr_2 LIKE "%recycledasphaltbinder%"
                OR dscr_2 LIKE "%binderpercent(%)%");
```

5. The previous query will return the required values to calculate the "Ratio of Recycled to Total Binder".

CSJ	SMPL_ID	DSCR_2	DSCR_3	DSCR_4	DSCR_5	DSCR_6	DSCR_7	FLD_VAL
000201074	2451012THUGHES*033	BinderPercent(%):					A	5.1
000201074	2451012THUGHES*033	MaterialType	BinNo.8				B	FractionatedRAP
000201074	2451012THUGHES*033	RecycledAsphaltBinder(%)	BinNo.8				C	5.8
000201074	2451012THUGHES*033	RecycledAsphaltBinder(%)	BinNo.8	%ofTot.Mix			D	20

From the original Excel sheet form, users can find out that they need to multiply D by C and then divide it by 100. This value is the "Recycled Binder, %", this value then has to be divided by A and finally multiplied by 100. This value will be the "Ratio of Recycled to Total Binder" for the CSJ 000201074.

3.6.2. With PASS

The data mining process is minimized and simplified through the use of PASS tool. The features include:

- Access to construction, reconstruction, and maintenance data;
- Statistical data with computed analysis; and
- Easily and securely accessible through an internet browser, http://ctis.utep.edu/passv7/

The objective of PASS is to analyze pavement and reconstruction data. The query builder's function consists of user-selected form as seen in Figure 7. At the moment, only three forms are selected, but the tool has the capability to analyze any form. The user here selects the desired form.

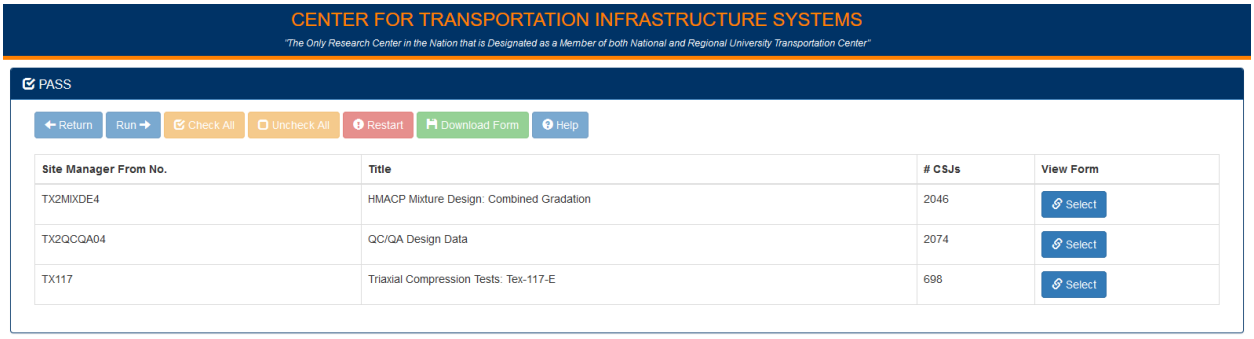

Figure 7. PASS Form Characteristics

The user then selects the requested queries. The tool has the capability to select all the parameters in the form, but for the demo, Figure 8 provides the user with previously selected parameters. The format of TXDOT forms was kept to aid the user and provide a tool where the user is already familiarized with the format.

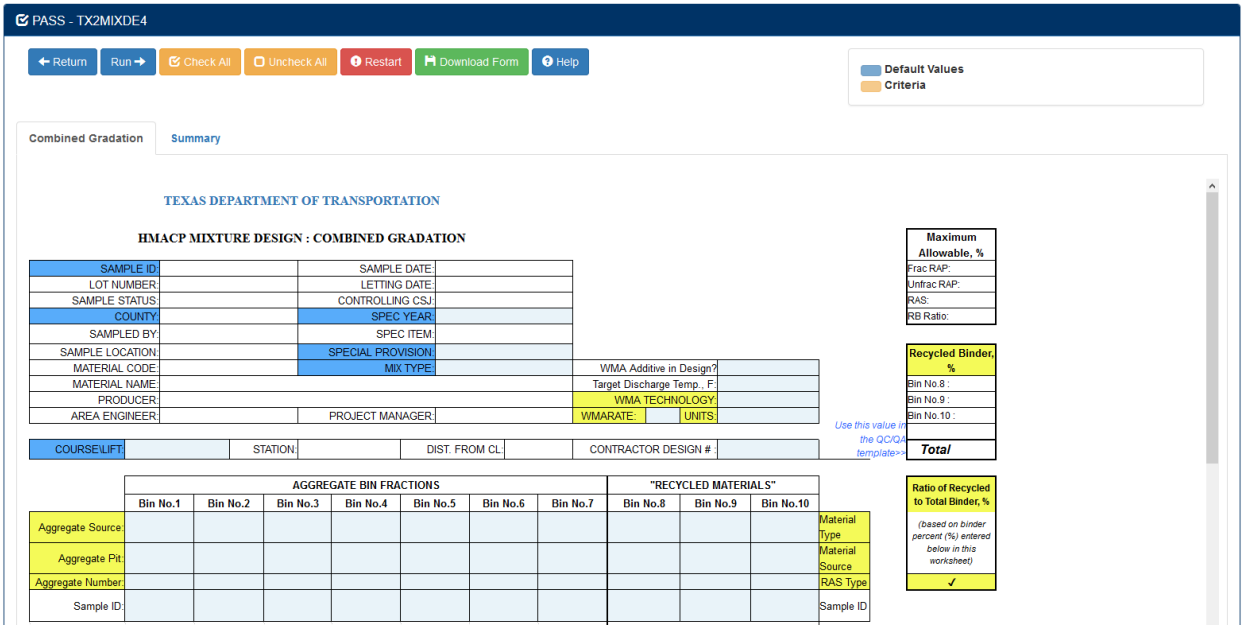

Figure 8. PASS Query Builder

Once the user has selected the required fields, one must click Run. An example of the already filtered information is seen in Figure 9. The overall results are shown in a table where calculation analyzes is performed. As seen below, the color blue section of the table is the constant parameters that will be shown to the user. The yellow section is the selected query. The tool has the capability to download the original TXDOT form and the raw data for further analysis.

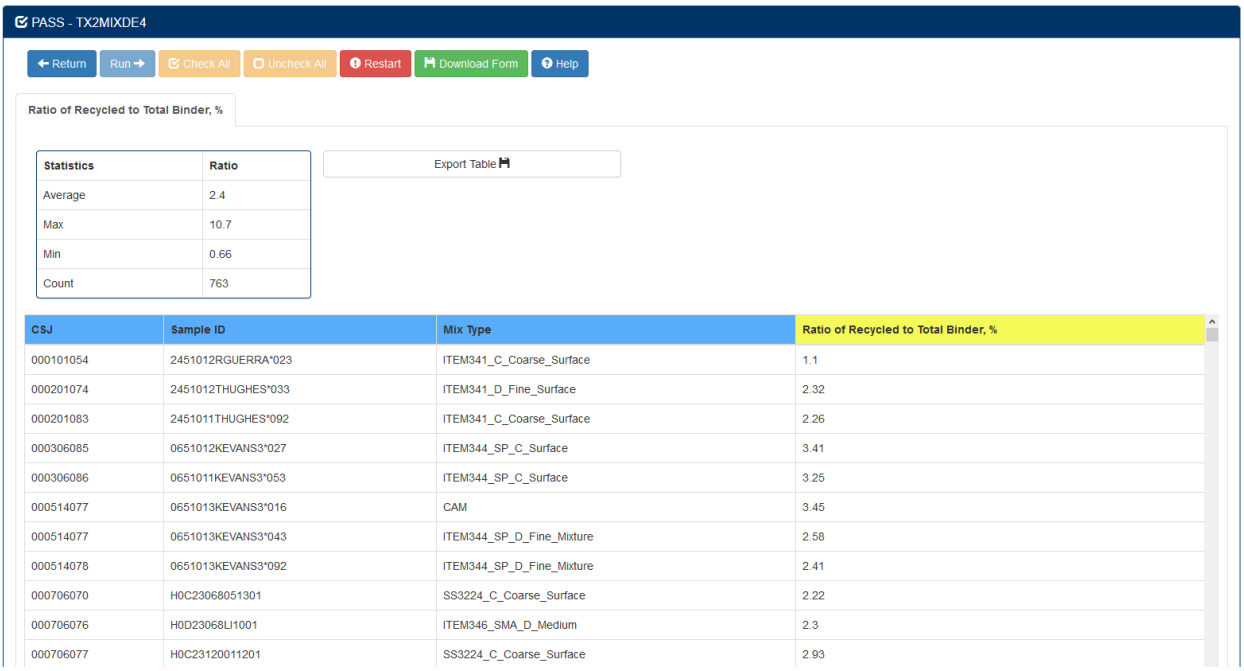

Figure 9. PASS Results

3.7. Demonstration

3.7.1. TX2MIXDE4 – WMA

The steps needed to perform an analysis on form TX2MIXDE4 is presented next. This analysis is focused on the parameters for WMA.

First step:

Access PASS (http://ctis.utep.edu/passv7) and select form TX2MIXDE4 (See Figure 10).

Figure 10. Example of GUI in selecting the specification form

Second step:

Select desired criteria. In this case, the parameters selected are for WMA. Click run when the parameter has been selected (see Figure 11). Note: a parameter is selected by clicking on the cell with the name of the desired parameter, or the cell next to it. When a checkmark shows up in the cell means that the selected parameter has been selected. To uncheck a cell, just click it again.

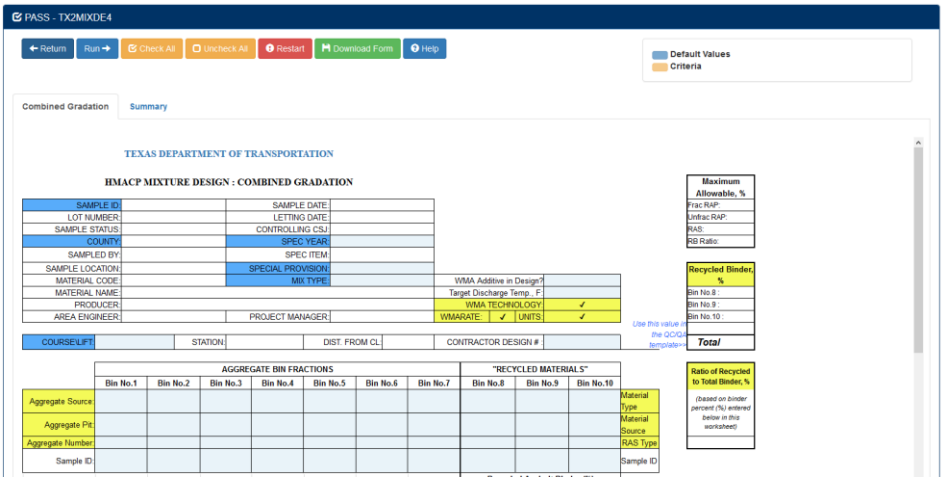

Figure 11. Example of GUI in selecting the data for extraction

Third Step:

At this point the results are displayed. In Figure 12, at the top of the page (1), statistics about the selected parameters are displayed. Below the statistics, the queried table is also displayed (2). If the users want to perform further analyses on this data it is possible to export these results by clicking the “Export Table” button (3).

4. Conclusion

This report introduced the process that was followed to create the online tool Pavement Analysis and Statistics System (PASS). Information such as the development process, how the databases provided by TXDOT were used to create a main table for the system, a description of why it was decided to use Excel Forms as a template for the graphic user interface for the system, among other design choices were also presented in this document. Information about concerns about the system was also addressed in the quality attributes section.

PASS and PERMIT serve as a bridge for users to access these databases without having to invest time on learning how to use programming languages such as MySQL. Both PASS and PERMIT provide transportation personnel the means to perform better design choices by analyzing and generating predictions based on data captured and provided to the development team by TXDOT.

Statistics	% By Weight of Asphalt
Average	0.73
Max	0.3
Min	0.3
Median	0.4
Count	52

Statistics	% By Weight of Mix
Average	0.4
Max	0.4
Min	0.4
Median	0.4
Count	2

Statistics	lb / gal of Asphalt
Average	0
Max	1000
Min	1000
Median	0
Count	0

Statistics	lb / ton of Mix
Average	4
Max	4
Min	4
Median	4
Count	1

CSJ	Sample ID	Mix Type	Year	FLD NBR	LAST MODFD UID	LAST MODFD DT	District No.	County No.	Highway No.	Years in Service	Reconstructed	Technology	Rate	Units
000803104	0205713ABOONE**122	341d	2013	1182	AUTOXM	20130806	2	184	IH 20	2.59	no	(Evotherm(MeadWestvacoAsph)	0.5	%byweightofasphalt
000806049	0205413LLEONAR*023	341d	2012	1182	AUTOXM	20120920	2	220	SH 180	2.8	no	(CecabaseRT(ArkemaInc)	0.5	%byweightofasphalt
000814112	WMD52APC701203	341d	2012	1182	AUTOXM	20120622	2	220	IH 820	4.32	no	(Advera(PQCorporation)	4	lbtonofmix
000902060	HBR18APACT1412	error	2013	1182	AUTOXM	20130925	18	57	SH 78	2.51	no	(CecabaseRT(ArkemaInc)	0.8	%byweightofasphalt
000912078	HBR18APACT1440	341b	2013	1182	AUTOXM	20131029	18	199	IH 30	2.24	no	(AstechPER(EngineeredAdditives)	0.4	%byweightofasphalt
002502194	1505813JFUENTES010	tbpfc	2013	1182	AUTOXM	20130801	15	15	IH 10	2.49	no	(Evotherm(MeadWestvacoAsph)	0.3	%byweightofasphalt
002809111	2005113BMYRICK*001	error	2013	1182	AUTOXM	20130305	20	181	IH 10	3.83	no	(Evotherm(MeadWestvacoAsph)	0.4	%byweightofasphalt

Figure 12. PASS Query Builder Results