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A Plan for the implementation of Mechanistic-Empirical Pavement Design Guide in Turkey

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ABSTRACT

Since 1958, most of the world's countries including Turkey depend on the Empirical Pavement Design Method established by AASHO (which is now known as AASHTO). The limitation of the data used for preparing AASHTO 1993 and Non-Mechanical Based procedure are the main reasons for the needs of new design procedure. The new AASHTO design procedure MEPDG has been established in 2002 and adopted by most of the states in the USA which is based on Mechanistic-Empirical (M-E) principles. The aim of this paper is to prepare a plan for the implementation of MEPDG in TURKEY starting with Third Region. The plan consists of two stages. Stage one is concerned with data collection and preparing of input files. This stage is subdivided into three tasks namley, Climate File, Material File and Traffic File. Stage two is associated with the use of the files prepared in Stage one to conduct studies using MEPDG software. These studies are recommended by AASHTO to evaluate the applicability of the procedure and the recommended enhancements. The studies of this stage are: (a) Sensitivity Analysis of MEPDG to Design Inputs; (b) Comparison of specific Third Region Designs with MEPDG designs; and (c) Calibration of Performance Models for Third Region in Turkey. The outcomes of this paper can be used as guidance for further studies on the implementation of MEPDG in other Regions in Turkey. Also the results of these researches can be assembled to implement the procedure for whole Turkey.

Keywords: AASHTO MEPDG, Mechanistic-Empirical, pavement design, Turkey

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INTRODUCTION

Since 1958, most of the world countries including Turkey depend on the Empirical Pavement Design Method established by AASHO (which now known as AASHTO). During this period, the method passed through stages of enhancements in 1972, 1986, and the final set of the procedure which is still used until now is the version of 1993. In 1996, the National Cooperative Highway Research Program (NCHRP) sponsored a Project 1-37A to develop a new design guide for pavement structures. This procedure is called Mechanistic-Empirical Pavement Design Guide (MEPDG). The design guide recommended by the project team in 2004 is based on mechanistic-empirical (M-E) principles (Baus & Stires, 2010; Carvalho & Schwartz, 2006; Coree, Ceylan, & Harrington, 2005; Highway & Officials, 1993; Mallela, Quintus, & Smith, 2004).

AASHTO 1993 Design Method

The procedure is dependent on Empirical models (Equations) that relate smoothness of the pavement which can be represented by Pavement Serviceability Index PSI with Material properties, Environment, Traffic (ESAL) and other factors.

One of the limitations of AASHTO 1993 (A93) is that the data that had been used for the verification of Empirical models had been collected from limited sections in two states in the USA with low traffic loadings (less than 2 millions) and moderate environmental condition (Climate).(Carvalho & Schwartz, 2006; Highway & Officials, 1993).

MEPDG Method

The method depends on determination of responses (Strains, Deflections and Stresses) induced by passing tire load on pavement section. The Multi-Layer system or Finite Element approaches are used for the calculations of the responses. This part of the processes represents the Mechanistic part of the procedure. The Empirical part consists of the calculation of Distresses/Roughness of the pavement section due to the applied load repetitions using Transfer functions that correlate responses with Distresses/Roughness. The method can be summarized in the chart shown in Figure 1 (Baus & Stires, 2010; Carvalho & Schwartz, 2006; Papagiannakis, Bracher, Li, & Jackson, 2006).

AASHTOWare (DARWin) Software

The Mechanistic-Empirical calculations in the MEPDG cannot be performed by hand or simple spreadsheets. DARWin is a Windows-based software developed as a part of AASHTO program (AASHTOWare). This software is used for the implementation of the M-E PDG methodology. A screenshot of the software's *Main screen* is shown in Figure 2 (AASHTO, 2017; Kaya, 2015).

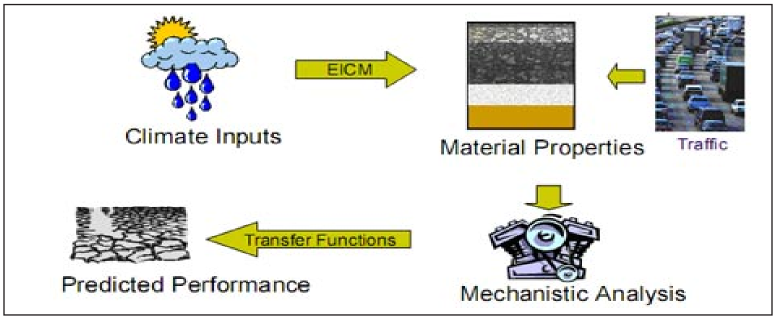

Figure 1. The Stages of MEPDG Procedure

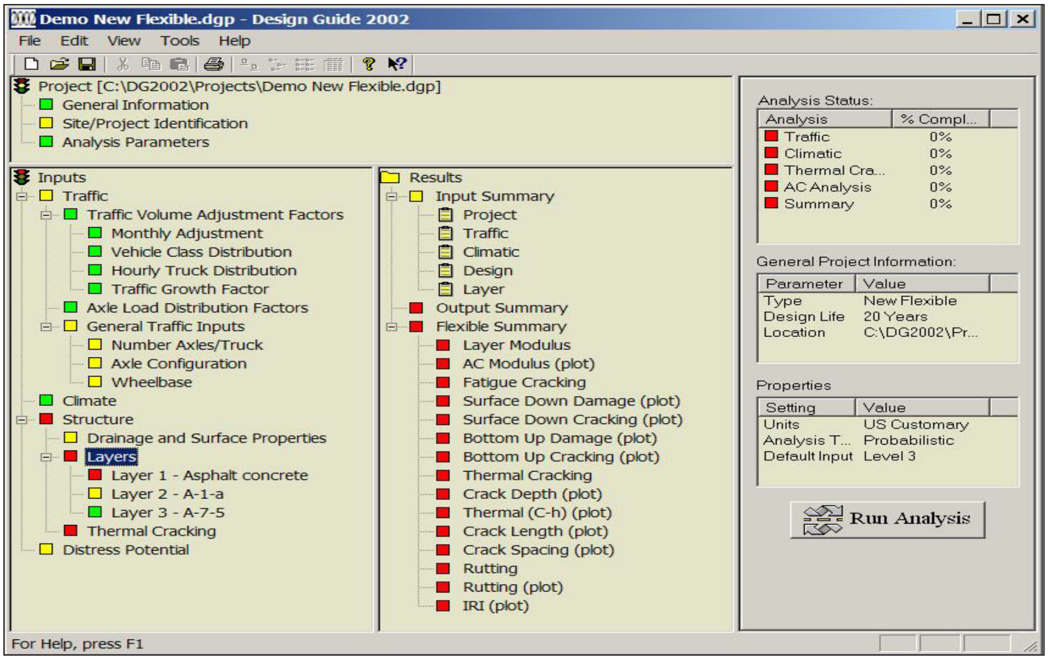

Figure 2. AASHTOWare (DARWin) Software Screenshot

Study Area – Third Region

Turkey, a bridge between two continents, is located between Europe and Asia as shown in Figure 3. In Turkey, there are 18 Regions of Transportation. One of them is the Third Region R3 as shown in Figure 4. R3 is one of the important regions. The percentage of traffic loading is between (8-10) %. The area of R3 is about 8.8 % of the total area of Turkey (http://www.kgm.gov.tr/Sayfalar/KGM/SiteTr/Root/default.aspx).

As a starting point, R3 is selected to start the implementation of MEPDG project in Turkey. The R3 is a large area consisting of four states (Konya, Aksaray, Afyonkarahisar, and Karaman). The roads net consists of about 10% of Turkish highway roads net.

Figure 3. Geographical location of Turkey (Google Map)

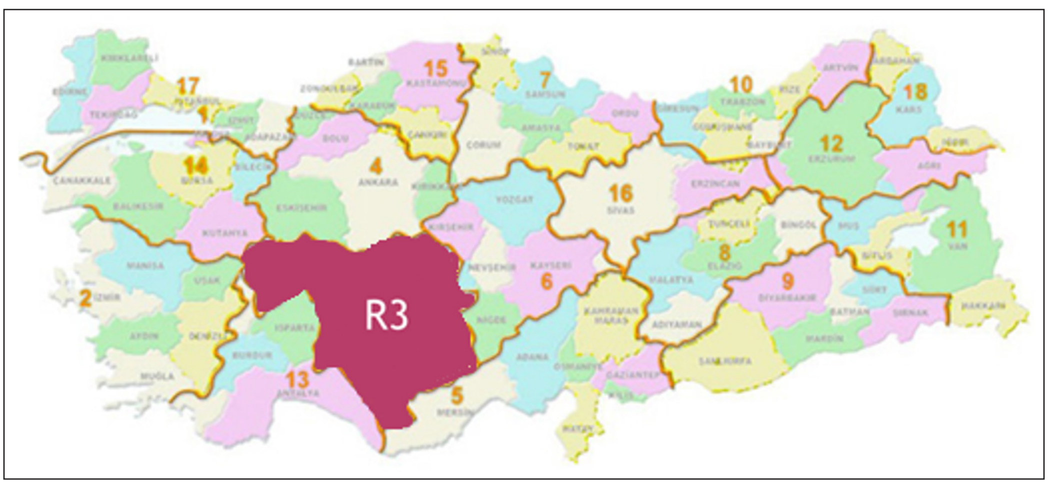

Figure 4. Third region in Turkey

Geographical and Environmental Specifications

This region is in the middle of Turkey. The Geographical and Environmental specifications of region can be discussed in subsequent items.

Temperature. The temperature variation between maximum and minimum can be shown in Figures 5 and 6 (KAYA, 2011).

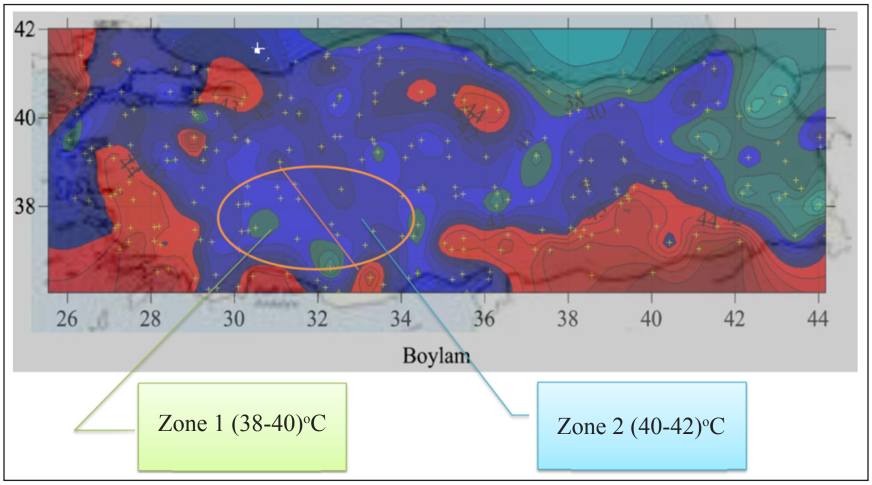

Figure 5. High temperature variation in R3 in Turkey

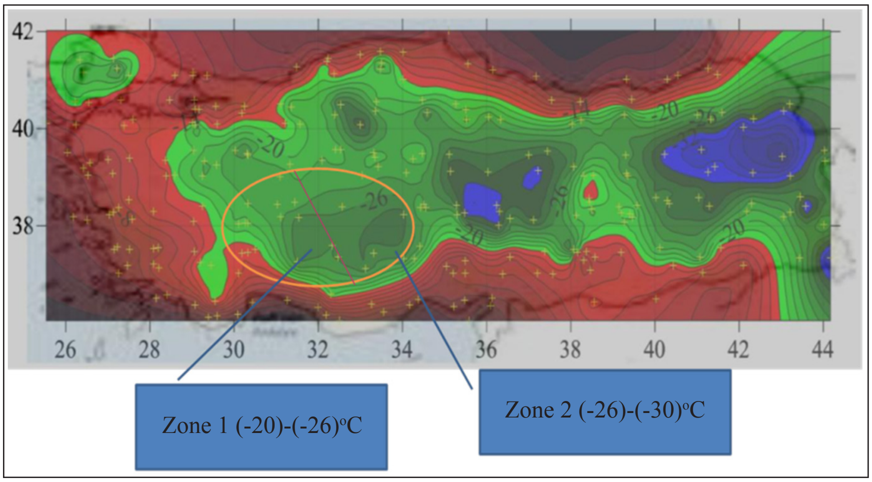

Figure 6. Low temperature variation in R3 in Turkey

As it is seen in the figures above, the weather in R3 is cold in winters when the temperature may go 30ºC below zero. For that reason, the fatigue cracks are the main distress in this region.

Precipitation. The precipitation rates in R3 can be shown in Figure 7. The precipitation rates range between 300-400 mm to be the lowest rate in Turkey. The precipitation rate of R3 is lower than other regions in Turkey. This is an indicator of deep water table and low sensitivity soils to the variations in precipitation rates.

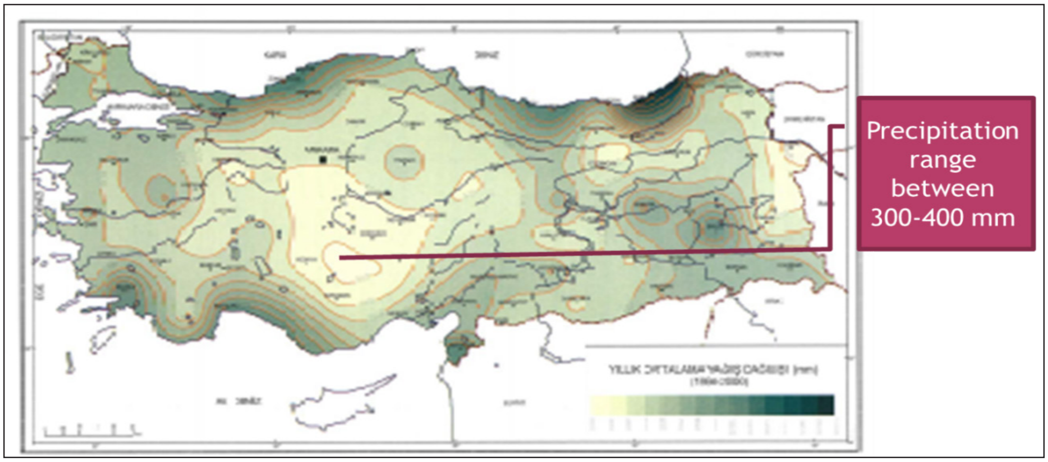

Figure 7. Precipitation variation within R3 in Turkey

Summary

1. The R3 can be environmentally classified into two regions, West and East.
2. The maximum temperature is between 38-42^{o}C, while the minimum temperature is between (-20)-(-30)^{o}C. Accordingly, asphalt type PG (56-16) is the most suitable for the R3.
3. The precipitation range of the region is the lowest in Turkey with a range of (300-400) mm.
4. The R3 is between the Latitude (30-34) and the Longitude (37-39), while the elevation is between (1000-1200) m.

Implementation Of MEPDG

The implementation of MEPDG in R3 as a first step toward the full implementation of MEPDG in Turkey must be carefully studied and divided into Stages. Each stage consists of many tasks that should be implemented simultaneously and gradually.

Each task represents a Research or a Project that either implemented by the University or by a Contractor in collaboration with Turkish Highway Administration. The Stages and their tasks can be presented in subsequent sections.(Coree et al., 2005; Flintsch, Loulizi, Diefenderfer, Diefenderfer, & Galal, 2008; Pierce, Jackson, & Mahoney, 1993). The stages and steps of the implementation are illustrated in a flow chart in Figure 8.

Stage 1

This stage is very important and the accuracy of the next stages is highly dependent on this stage. The aim of this stage is to collect the data required by MEPDG that represents the Climate, Material and Traffic of local conditions of Turkey. This data is used in

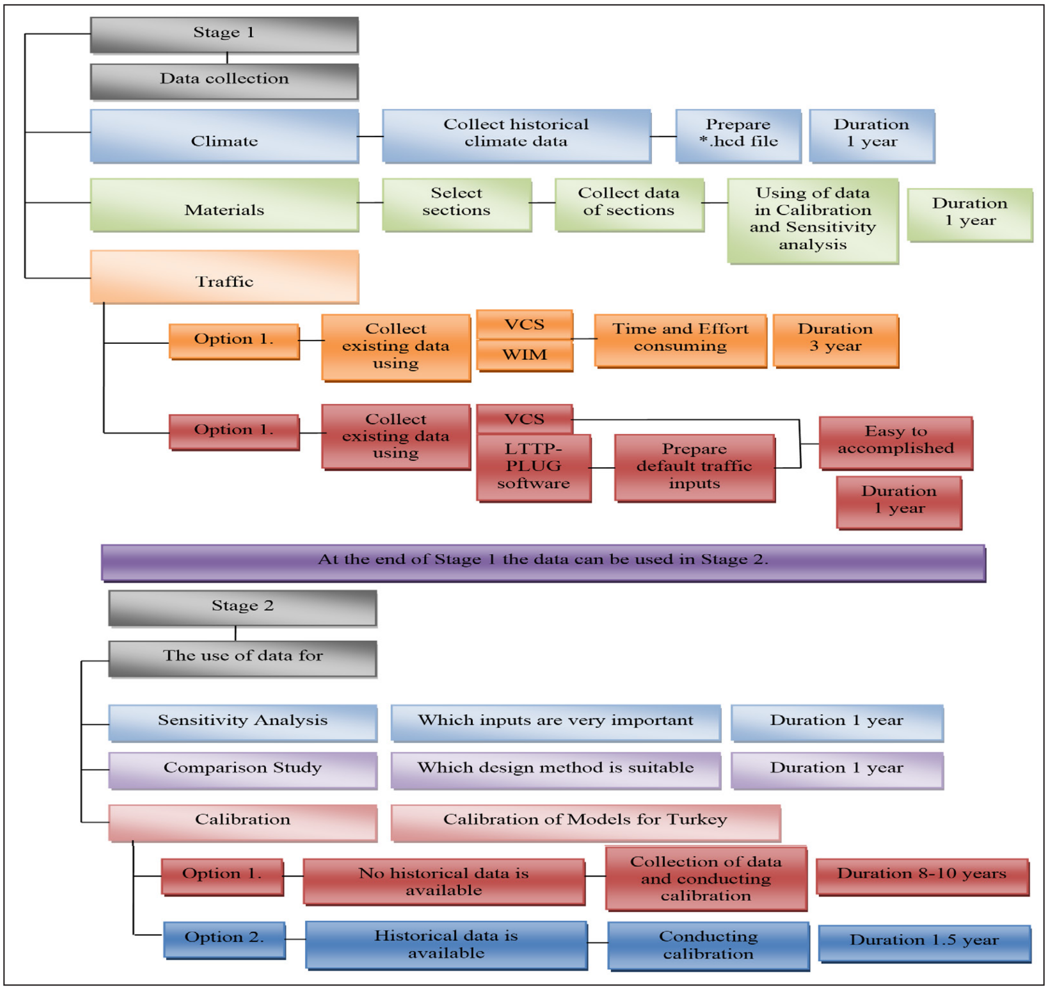

Figure 8. Implementation plan Flow Chart

subsequent steps for the implementation of MEPDG in Turkey such as Sensitivity Analysis, Comparison and Calibration. This stage consists of the following Tasks.

Task 1 (Climate File). One of the main inputs of MEPDG is the climate inputs. The Enhanced Integrated Climate Models (EICM) uses these inputs to calculate the changes in materials properties (e.g HMA modulus, Unbound material Mr) during the seasons and day. This task consists of the following steps: (Ahmed, Marukic, Zaghloul, & Vitillo, 2005; Flintsch et al., 2008; Johanneck & Khazanovich, 2010; Q. Li, Wang, & Hall, 2010; Zapata, 2009; Zapata & Houston, 2008).

Step 1: Collect climate data from weather stations around the R3 for the last five years. The data consists of Hourly (Temperature (F),Wind speed (mph)(W), % Sun shine

(SS), Precipitation (P) and Relative humidity (RH)). Below is an example about the form of data that should be entered into the MEPDG software.
1997060100,57.9,9,0,0.2,97
YYYYMMDDHH,F,W,SS,P,RH

Step 2: Completion of Un-Exist data by interpolation or averaging. Generate the complete Data file in the format of ASCII text.

Step 3: Conversion of the ASCII text file to (*.hcd) format that would be accepted by MEPDG software.

Step 4: The new added stations should be added to the Station.dat file so that the MEPDG software can read it.

Data Resource 1. The data can be obtained from the Meteorology Administration. In R3 there are 18 stations. This number of station is very good, and the virtual stations can be made easily by MEPDG software which can represent a climate condition for each site. Figure 9 shows the map of climatic stations of R3.

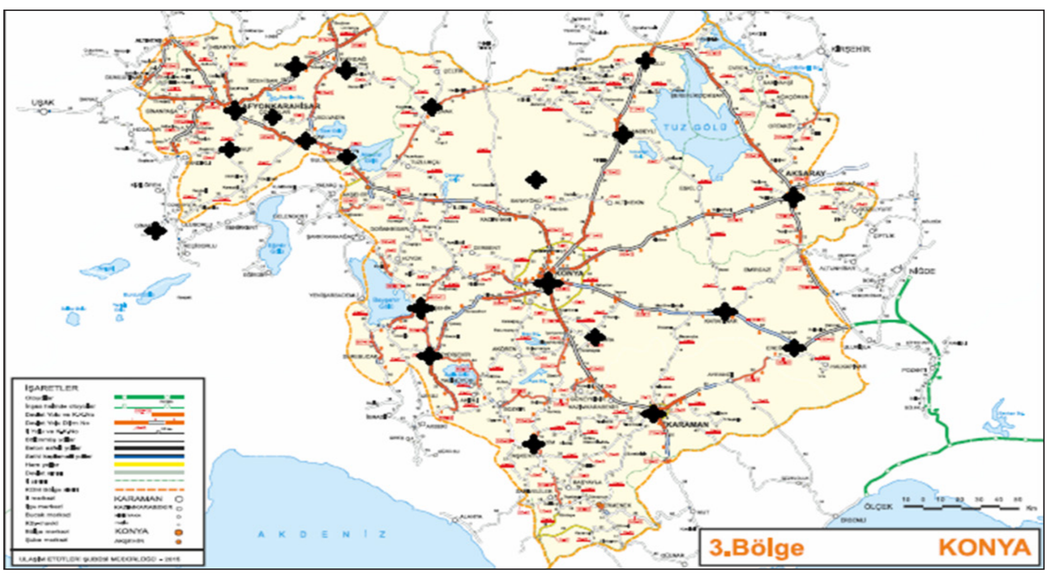

Figure 9. The weather station distribution in R3 in Turkey

Water Table 2. The climate file also consists of Water Table data. It is recommended to collect data about the water table in the R3 that can be used instead of Default values of MEPDG (Hall & Beam, 2005).

The required Water Table data is either:

1. Annual: This means that one value can represent the water table level of the site for one year (Average). Or

2. Seasonal: That means the water table is different through the seasons of the year so different values of the WT must be collected to be used by the MEPDG.

The data can be collected from: (a) laboratories; (b) universities; (c) highway administration; or any other resource of data.

Task Duration 3. This task needs about 8 months and can be established in 2018-2019.

Task Responsibility 4. It is appropriate to be carried out by University.

Task 2 (Materials File). This file is important and expensive especially if Level one is to be used. Many Departments of Transportation DOTs in the USA started the implementation of MEPDG using a mixture of Levels (2+3). Accordingly, as a first step, the Material files will be prepared according to mixture of Levels (2+3).This task consists of the following steps:(Bari, 2005; Chehab & Daniel, 2006; Flintsch et al., 2008; Hall & Beam, 2005; Mallela et al., 2004; Ovik, Birgisson, & Newcomb, 2000; Uzan, 1998).

Step 1: Select sections from the R3 to prepare the Sampling Template. These sections should be selected according to:

1. Type of Pavement (New, Overlay), or according to layer thickness (less or more than 10 cm, for example).
2. Type of roads (Interstate, Provincial).
3. Geographical Location (West, East).
4. Type of Unbound material used (HMA over Base, HMA over Base and Subbase… etc).
5. Traffic loads (High, Medium or Low).

The preparation of Sampling Template will be very useful in the Calibration process that will be conducted in the final Tasks.

It is preferable to take the following notes in consideration:

1. The number of sections can be 26 or more or according to minimum number of sections required for calibration.
2. The selected sections shall be of available data.
3. The selected sections must have different distress conditions, and it is preferable that the distress in each section is not less than 50%.

The Sampling Template can be in the form of examples shown in Tables 1 and 2.

Step 1: After the Sampling Template has been made and the sections have been selected, the data about the materials used in each section should be collected and arranged in the form required by MEPDG.

The data sources are: (a) Pavement Management System PMS; (b) Data stored in laboratories; (c) Region Three Highway Administration; (d) Any other data resource. Since the Mixture of levels (2+3) has been chosen as an implementation level, the required data is shown in Table 3. The other required properties can be used as Defaults of the MEPDG.

Table 1
The sampling template (Example1)

Thickness (cm)	**Granular base thickness (cm)**	**Subgrade type**	
		Coarse-grained soils (AASHTO Class A-1 through A-3)	**Fined-grained soils (AASHTO) Class A-4 through A-7)**
Less than 10	Less than 20		
	More than 20		
More than 10	Less than 20		
	More than 20		

Table 2
The sampling template (Example2)

Pavement type		**Structure type**	
		HMA over Base	**HMA over (Base + Subbase)**
New	Modified	3*	
	Pure		
Overlay	Modified		
	Pure		

Note: *This number indicates that there are three new sections of Modified asphalt and the pavement consists of HMA over Base.

Table 3
The sampling template of materials' properties (Example)

Material type		Required data	Level
Unbound layers (Base, Subbase) and Subgrade	Strength properties	CBR Or aggregate gradation	Level 3
	ICM properties	Aggregate gradation Atterberg limits	Level (2 + 3)
Asphalt Pavement	HMA mixture	HMA gradation %AV %P_{eff} Mix density	Level (2 + 3)
	Asphalt binder	Penetration or viscosity	Level 3

Recommendation 1. Ahmet SAĞLIK and A.Gurkan GUNGOR, conducted a study titled," RESILIENT MODULUS OF UNBOUND AND BITUMINOUS BOUND ROAD MATERIALS"(SAĞLIK and GUNGOR).The aim of their study was to measure the Resilient Modulus M_R of unbound materials and the Dynamic Modulus of HMA mixture E. They collected and tested samples of unbound materials from all the 17 regions in Turkey. The results of the study were important. They found an Empirical relationship for the determination of resilient modulus of unbound materials as shown in Eq.1 (SAĞLIK and GUNGOR).

$$M_R=175(DAC+k)0^{0.436}.CBR^{0.4}.\left[\frac{1}{1+\log(No200)}\right]^{0.35(LL.PI+1)^{0.06}}.\left[\frac{\gamma\, max}{No4}\right]^{0.09\log(\omega\, opt)} \quad (1)$$

where:

DAC: Total thickness of HMA, cm.

CBR: Soaked California Besring Ratio, %.

$\omega\ opt$: Optimum moisture content, %.

γ max : Maximum Dry unit weight, g/cm^3.

LL: Liquid limit, %.

PI: Plasticity index, %.

No200: Percent passing No.200 sieve.

No4: Percent passing No.4 sieve.

K: Depth correction factor. For Base and Subbase k=0, while for Subgrade K=17

According to the same study, it was concluded that simplified Witczak's dynamic modulus equation for 4 Hz frequency may safely be used for the estimation of Dynamic modulus of Asphalt Concrete as shown in Eq.2.

$$\text{Log } E^*=3.75+0.029No200-0.00177No200^2-0.0028No4-0.058V_b-0.8\left[\frac{Vb}{Vb+Vh}\right]+$$
$$\underline{3.87-}\ 1+e^{-2.56+0.89\log(pen)-0.0015\,[\log(pen)]^{2}}\ \underline{055No3/4} \quad (2)$$

where:

E*: Dynamic modulus, cm.

Va: Air voids, %.

V_b: Binder Content, %.

Pen: Biner penetration, 0.1 mm.

No200: Percent passing No.200 sieve.

No4: Percent passing No.4 sieve.

No3/8: Percent passing No.3/8 sieve.

No3/4: Percent passing No.3/4 sieve.

Conclusions 2. Based on the information presented earlier, there are two options:

1. The use of the results of the study by SAĞLIK and GUNGOR, so the recommended equations will be used for the determination of Mr and *E*. Or,
2. Conducting new study according to Steps 1 and 2 discussed previously to collect data and preparation of Material file (Catalogue). Accordingly the following shall be done:

Task Duration 3. This task needs about 24 months and can be established in 2018-2020.

Task Responsibility 4. It is appropriate to be carried out by joint effort between the University and Highway Administration.

Task 3 (Traffic File). The core task is how to collect traffic data and preparation of traffic file (Catalogue) for R3.The traffic data according to MEPDG is the unique of the procedure. To understand the traffic data required by the MEPDG, the following items shall be studied :(Carvalho & Schwartz, 2006; Haider, Buch, Chatti, & Brown, 2011; Harvey, Chong, & Roesler, 2000; Lu & Harvey, 2006; Lu, Zhang, & Harvey, 2009; Romanoschi, Momin, Bethu, & Bendana, 2011; Sayyady, Stone, Taylor, Jadoun, & Kim, 2010; Timm, Bower, & Turochy, 2006; Wang, Hancher, & Mahboub, 2007).

Automatic Vehicle Classification AVC Survey 1. This type of survey is used to identify:

1. Vehicle Class Distribution VCD for each type of vehicle within the traffic (e.g, Passenger cars, Trucks, Busses, etc) through the months of year.
2. Monthly Distribution Factor MDF and the distribution of each class within the year can be calculated using the results of this survey.
3. Average Annual Daily Truck Traffic AADTT.

According to FHWA classification system, there are 13 classes of vehicles as shown in Figure 10.

In Turkey there are 500 stations of VCS. The Turkish Transportation Authority has another vehicle classification system as shown in Figure 11.

The 18 Turkish classes have been grouped into five classes to simulate the FHWA classes as shown in Table 4.

It can be concluded from Table 4 that:

1. Among the 10 classes (Class4-13) according to FHWA that are used by the MEPDG, there are only 4 classes of Turkish classification system included.
2. C1 class according Turkish classification system which is opposite to Classes 1-3 according to FHWA classification system is not used by the MEPDG.

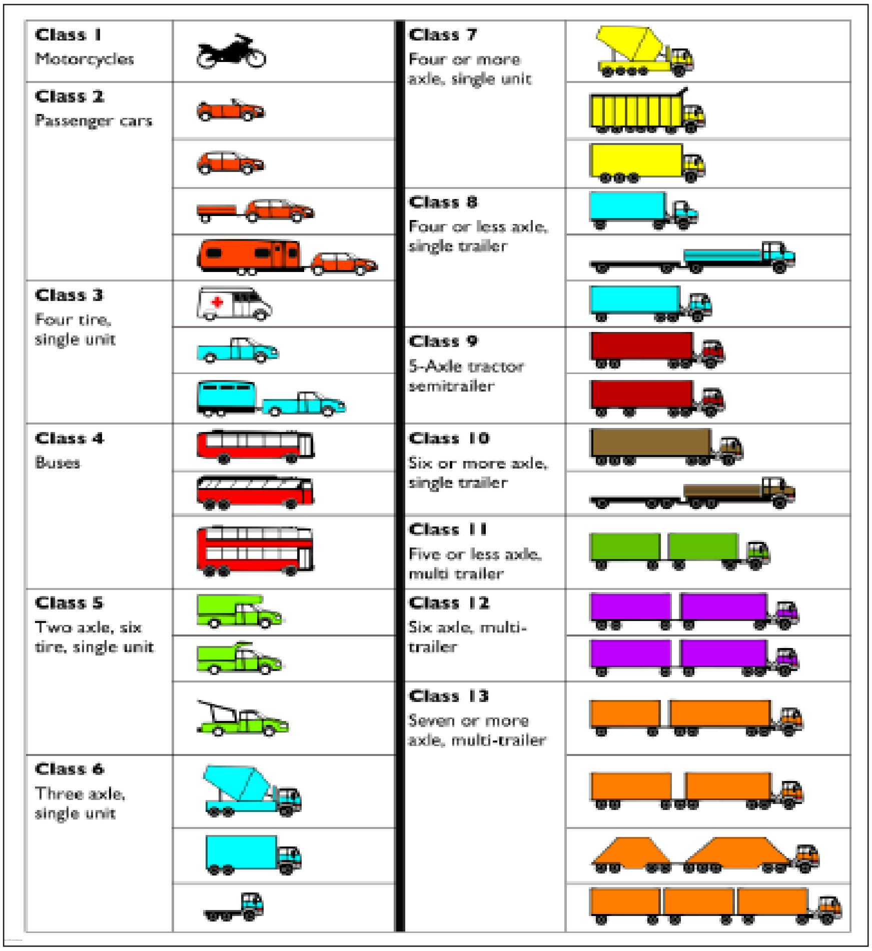

Figure 10. FHWA vehicle classification system

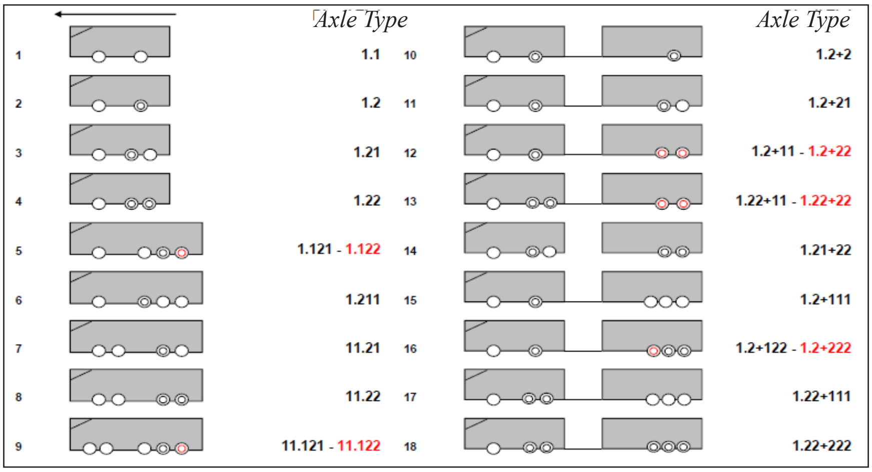

Figure 11. Turkish vehicle classification system

Table 4
Turkish as Compared to FHWA Classification System

Vehicle class as for Turkey	**Vehicles included**	**Its classification according to FHWA**
C1	Cars (less than 3.5 tons)	Class 1 + 2 + 3
C2	Medium good vehicles (3.5-10 tons)	Class 5
C3	Buss	Class 4
C4	Trucks (single unit)	Class 6 + 7
C5	Articulated (trailer)	Class 8 - 13

3. C4 class according to Turkish classification system is opposite to wide range of FHWA classes from (Class 8-13). These classes are the most important classes used by MEPDG.

A comprehensive study must be conducted in Turkey for the identification of each class of traffic according to FHWA classification system to be used by MEPDG.

Weight in Motion WIM Survey 2. This type of survey is the main difference between the A93 and the MEPDG. In this type of survey, the weight of each type of axle (Single, Tandem..) of each type of vehicle (Bus, Trailer, ..) is measured when the vehicle passes over the WIM instrument which is installed beneath the road section as shown in Figure 12 (Ramachandran, Taylor, Stone, & Sajjadi, 2011; Sayyady et al., 2010).

The most important results of this survey is the Load Spectra LS which represents the variation of load of each axle (Single, Tandem) of each Vehicle class (Class 4-13), during different seasons. Figure 13 shows an example of the results of WIM survey and load spectra concept.

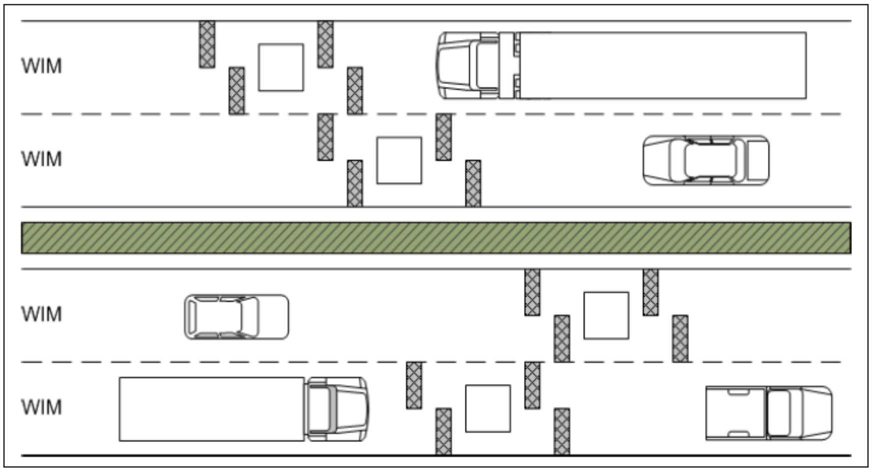

Figure 12. WIM system setup

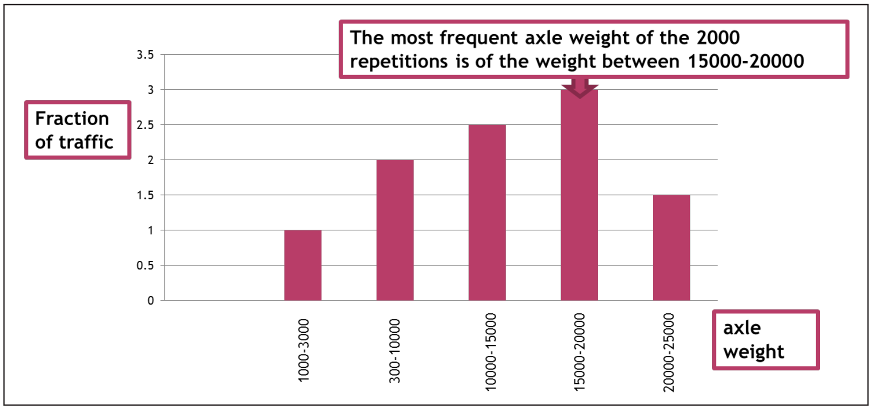

Figure 13. Example of the results of WIM survey and load spectra *Concept*

Options of Preparation of Traffic File 3. There are two options to prepare the Traffic file according to the Effort, Time and Cost available for each option.

Option 1 2a. In this option a Mixture of Level2+3 (Regional level) is selected, therefore a comprehensive study is conducted according to the following steps:

Step 1: Select sections in the same procedure mentioned in Material file preparation section to represent R3 roads. The selected sections must have permanent Automated Vehicle Classification AVC stations to complete the data required by MEPDG.

Step 2: Installing new WIM stations to collect the data required by the MEPDG according to "Traffic Monitoring Guide TMG." The TMG is the most important reference published by FHWA for this purpose(FHWA, 2013).

Step 3: The use of collected data to determine the R3 traffic default values instead of that provided by the MEPDG Level3.

The "Long-Term Pavement Performance Pavement Loading User Guide (LTPP PLUG)" is the main reference for the preparation of New Local Traffic Defaults that can be used by MEPDG to represent the traffic conditions of R3. For this option the LTPP PLUG SOFTWARE can be used for the preparation of New Local Traffic Defaults data for R3 (Selezneva & Hallenbeck, 2013).

Option 2 2b. In this option, Level3 can be selected; therefore, the default values provided by the MEPDG can be used. The most important disadvantage of this option is that the default values of level3 is based on data not representing the actual traffic loadings of R3.Accordingly, it is recommended that these defaults be changed by making a comparison between the traffic data of R3 and provided by The "Long-Term Pavement Performance

Pavement Loading User Guide (LTPP PLUG)". Based on the comparison results, a suitable New Local Traffic Default values can be selected from LTPP PLUG to represent R3 Traffic loadings. For this option the LTPP PLUG SOFTWARE can also be used.

Recommendations 4. The following recommendations are based on statistical data provided by the THPDM website.

1. The vehicle classes that frequently represent the traffic loadings in Turkey are shown in Figure 14. The classes in figure are based on FHWA system.

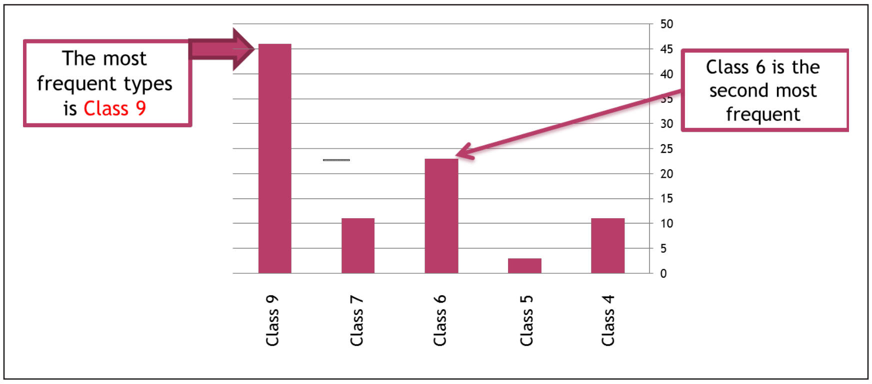

Figure 14. The most frequent vehicle classes in Turkey according to FHWA *Classes*

Figure 13, shows that there are 4 main classes to be taken into consideration in the stage of Traffic file preparation:

-Class 9
-Class 6
-Class 7
-Class 4

Concentration must be on Class 9 and 7 because they are the heaviest

2. It is important to use the available data in Turkish Transportation Administration (TTA) especially that provides data about the VCD system.
3. There are 106 stations in Turkey to measure the Average Vehicle Load. The data of these stations may be useful if there is a similarity with data that can be calculated by WIM stations.
4. The general data required by MEPDG such as (Growth factor, No Axle per Class ..) can be obtained from data available at TTA' website, and there is no need to use default values of the MEPDG.
5. The followings references and software are the most important ones that can be used for the preparation of Traffic file:

(a) Traffic Monitoring Guide TMG, from FHWA. Used for WIM survey.
(b) Long-Term Pavement Performance Pavement Loading User Guide (LTPP PLUG), from FHWA. Used for New Local Defaults of Traffic for MEPDG.
(c) LTPP PLUG SOFTWARE, from FHWA. Used for New Local Defaults of Traffic for MEPDG.
(d) TrafLoad SOFTWARE., from NCHRP, used to estimate vehicle classification statistics, load spectra, and traffic growth rates (Systematics, Center, & Corporation, 2005).
(e) MEPDG Part2 Design Inputs, Chapter4 Traffic, NCHRP Report 1-37A.

Conclusion 5. According to the selected option; either Option1 or Option2 as mentioned earlier, the followings shall be specified:

Task Duration (Option 2) 4a. This task needs about 12 months and can be established in 2018-2019.

Task Responsibility (Option 2) 4b. It is appropriate to be carried out by the University.

Task Duration (Option 1) 4c. This task needs about 36 months and can be established in 2018-2021.

Task Responsibility (Option 1) 4d. It's appropriate to be carried out by a Contractor. The QA and QC are the responsibility of TTA. The QA and QC shall be conducted according to The American Society for Testing and Materials ASTM Test Procedures.

Stage 2

After the preparation of Climate, Materials and Traffic data files, it is important to use these files to complete the Implementation processes of MEPDG. This stage consists of many Tasks that can be implemented step by step as explained in subsequent sections.

Task 1 (Sensitivity Analysis of MEPDG to Design Inputs). Not all Inputs are at the same weight of importance; some are very important and have a significant effect on the design results while others have minor effect on the results (Guclu & Ceylan, 2005; Guclu, Ceylan, Gopalakrishnan, & Kim, 2009; Hall & Beam, 2005; Kim, Ceylan, & Heitzman, 2005; McDonald & Madanat, 2011; Orobio, 2010).

Objective 1.

1. Study the effect of various Climate, Materials, Traffic, Structure, Reliability level and Calibration Coefficients inputs on the design results using MEPDG.
2. The use of the study results to focus on the inputs of high degree of importance.

Task Duration 2. This task needs about 12 months and can be established in the 2018-2019.

Task Responsibility 3. It is appropriate to be carried out by the University.

Task2 (Comparison of specific R3's Designs with MEPDG's Designs). There could be a differences between the design using MEPDG and using the design procedure followed by R3 administration (i.e. A93). Typical (3-6) sections will be chosen to represent the relevant designs in R3. A comparison between the as built designs of these sections with that of MEPDG can be made.

Objective 1. Study the differences between the MEPDG and design procedure followed by R3 Transportation Authority.

The use of the study results to recommend which procedure is more suitable and can satisfy the conditions of R3.

Task Duration 2. This task needs about 12 months and can be established in the years 2018-2019.

Task Responsibility 3. It is appropriate to be carried out by the University.

Task3 (Calibration of performance models for R3 in Turkey). This task is very important. The calibration of performance models needs a historical data about the International Roughness Index IRI and Distresses (Rutting, Cracks types) for at least three observations within the last 10 years so that the relation between the Time and IRI/Distress can be plotted and statistical solution can be achieved (Ali, Tayabji, & La Torre, 1998; Hall, Xiao, & Wang, 2011; Hoegh, Khazanovich, & Jense, 2010; F. Jadoun & Kim, 2012; Jadoun, 2011; Li, Pierce, & Uhlmeyer, 2009; Muthadi & Kim, 2008).

Objective 1. Study the needs of MEPDG performance models for local calibration to be suitable for R3 conditions.

Calibration of performance models to represent the condition of R3 in Turkey. By this way, the MEPDG can be used for the design of New and Overlay Pavements of R3 in Turkey without bias.

Calibration Options 2. The calibration (if needed) needs a historical data, so the calibration depends on the availability of historical data. Accordingly, there are two options:

Option 1: NO historical data is available 1a. This is the worst case scenario where the data is not available so that new study must be conducted to collect data of IRI/Distress. This study is a part of Pavement Management System PMS, so the study has two objectives:

1. Collecting data for Calibration of Performance Models.
2. Starting a program of PMS in R3.

The new study consists of the followings:

1. Selecting of minimum number of sections as required by MEPDG.
2. The selected sections must represent different Environmental, Road types, Traffic loads and Geographical conditions of R3 in Turkey.
3. Conducting a data collection study for IRI/Distress for these sections using Automated Pavement Distress Collection Techniques. The IRI/Distress units must be according to Long Term Pavement Performance LTPP requirements.
4. The data must be collected at least every two years within 8-10 years.
5. At the end of the study the calibration process can take place as in Option2.

Task Duration 1a-1. This task needs about 8-10 years and can be established in 2018-2026.

Task Responsibility 1a-2. It is appropriate to be carried a Contractor. The TTA is responsible for QA and QC.

Important References 1a-3.

1. NCHRP SYNTHESIS 334, "Automated Pavement Distress Collection Techniques"(McGhee, 2004).
2. LTPP pavement condition evaluation.

Option 2: Historical Data is Available 1b. This is the simplest case were a few effort and short period of time required.

The followings are the most important processes that must take place:

1. Collecting the available data from: (a) PMS source; (b) TTA; and (c) Researches and Academic institutions.
2. Arrangement of data according to LTPP units and MEPDG requirements.
3. Using of prepared data to conduct Calibration process according to "Guide for the Local Calibration of the Mechanistic-Empirical Pavement Design Guide" published by AASHTO-2010.

Task Duration 1b-1. This task needs about 18 months and can be established at the year 2019-2021.

Task Responsibility 1b-2. It is appropriate to be carried by the University.

CONCLUSION

The conclusions will be based on the results of the implementation of the previously mentioned plan. It is expected that the results will be important and have a significant effect on the transition of Turkey towards the new Mechanistic Empirical Pavement Design.

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