

Master Thesis Review

Effects of temperature change on pavement performance evaluation using FWD

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General overview:

The submitted master thesis deals with the influence of temperature variation on pavement performance assessed using Falling Weight Deflectometer (FWD). This is a topical subject that is of certain interest in the international scientific community. The thesis contains experimental merit and promises insightful/potential results since it not only uses one of the commonly used non-destructive testing (NDT) tools, FWD, on two types of pavements (i.e., flexible and semi-rigid), but also employs two types of thermometers (Arduino and FWD infrared) to measure the relevant temperatures. Performing the ambient air temperature and the temperature at different pavement layers and depths using two thermometer types and correlating those data adds to the experimental value of the thesis. Moreover, it is significant to have those measurements under different weather and season conditions (between day & night and between spring & summer seasons).

The thesis contains all the expected sections. Although the introduction part explains shortly what the thesis is about, it could be a bit more explanatory. The current state of the technology and knowledge was given in Chapter 2. Pavement basics with a brief summary of the design of the asphalt mixture and possible causes of road failure, diagnostics and evaluation of pavements serviceability, use of FWD for testing pavement bearing capacity, methods of measuring road pavement temperature and its effects on pavement performance were described to a good extent with relevant references. Reference documents were used efficiently for the background and the experimental design. AASHTO (guide for Design of Pavement Structures) and Czech standard ČSN 736192 were referred. Only as a minor issue for chapter 2, a higher number of recent references could be used in addition to the existing ones. The author set the overall aim and the partial goals very well (although some of the goals seem to be repeated) and selected the appropriate method to achieve them. Methodology and experimental framework were both successfully expressed. Experimental design and workflow were written diligently and fluently by describing all the necessary steps to perform the experiments and measurements. The description of the testing site was indicated and stated very clearly. Used equipment and accessories were described soundly. Calibration processes of the geophones, time-pulse and force-load were explained very well. The flowcharts on pages 48 and 49 add a visual explanation about the work done (although those charts could be combined and compacted in one page, they are helpful for follow-up and comprehensibility). Many good observations were made. For example, Figures 23 a and 23b (on page 55) well differentiate between the deflection patterns on a cracked pavement and those on a normal pavement free of cracks. Results and Discussion Chapter was presented. Limitations of the present work, however, were not specified. Finally, the conclusion and future recommendations were expressed clearly.

The student involvement was obvious in the design and undertaking of the experiments. He seems to have gained the knowledge of operating FWD and the mentioned thermal sensors and thermometers under different weather conditions on the different types of pavements. Relationships between the

temperature measurements made by the FWD thermometer and the Arduino thermometer were derived. Moreover, correlations between the temperature and the pavement deflections were obtained.

However, some minor editorial/structural issues along with some major linguistic issues were observed.

Minor Editorial/structural issues:

- Fig. 5: which one is summer and which one is spring?
- Chapter 2.4.2 Temperatures variations through day and night (Also seasons are mentioned so maybe the title can change accordingly)
- Description of the equipment is undertaken in detail which informs the reader well. Only a minor issue exists in Chapter 4.1, where it is written that “This chapter explains the important parts used in the experiment, divided into two parts, where the first section covers an overview of the parts of the falling weight scale with an explanation of its parts and the program used on it. While the second part covers the method of assembling installing and programming the Arduino temperature sensor, with an explanation of its programming code.” However, the author begins describing first the Arduino temperature which was mentioned to be the second part and for FWD it is vice versa.
- Although most figures and tables are referenced within the text, some of them are not cross-referenced (e.g., table 2 on page 30, figure 7 on page 32, figure 10 on page 35, figure 23 on page 47, Table 7 on page 73, and table 8 on page 74) and some others are referenced wrong (e.g. table 2 and table 3 on pages 50 and 52)
- On page 45, the depths of the placed temperature sensors mentioned in the text are not compatible with the depths shown in Figure 21.
- There are two figures named Figure 23. One of them is on page 47 and the other is on page 55. Some of the acronyms do not have full names explained before using them. Acronyms should be used just after the full names for them are spelled first.
- In Figures 26 and 30, it was difficult to distinguish between the Subgrade temperature and Mid depth Asphalt temperature since the colors representing them are almost the same. More contrasting colors can be used for better visualization.
- A legend in Figure 38 seems missing describing which line is for the FWD device and which one is for the Arduino thermometer.
- There are some repetitions at the end of pages 58 and 62. Even the observations could be similar, the author could use different wording.
- In my opinion, subsections 5.2 and 5.3 could be combined and shortened under one sub-section as the contents of those subsections are very similar and use the same set of data. There exist remarkable effort and work on practical/experimental part and as a result, good sets of data were obtained. However, a minor point regarding the presentation of the data could be that similar data could have been grouped and some repeating parts could have been simplified.

Major linguistic and punctuation issues:

I understand that it is not the native language of the candidate and minor errors in the English language, in this case, could be tolerable, however, in this work, there are major issues with the English language and main text composition. Partly, the terminology is not consistent, and the transition from one sentence to another sometimes was not performed smoothly and it feels like the meaning and the aim of the paragraph are lost at times. Many observations of noun/adjective misuses, comma/full-stop misuses, verb conjugation errors, tense errors, grammatical errors, the atypical structure of sentences

were made, which make the thesis very difficult to follow and understand. Although there are a lot of good values in it, those cannot be reflected properly to the reader due to the major language issues and minor presentation lackings.

Although I am quite familiar with the subject of the thesis and the methodology used therein, at times I had even remarkable difficulty in understanding what the author is trying to communicate due to insufficient and erroneous level of the language use. Any reader who is not familiar with the subject of this thesis will not understand most of the text because of the current state of the language and structure and it might not make much sense for most of those readers.

Questions:

- 1) On page 64, at the beginning of Chapter 5.2, It is written that “This part study the relationships between temperatures at different layers e.g., relationship between air temperature and mid-depth pavement temperature, the second relationship between air temperature and surface pavement temperature and third is relationship between surface pavement temperature and mid-depth pavement temperature. But first, it beginning with the relationship between air temperature and mid-depth pavement temperature, because it is the most important temperature on the experiment.” Could you please comment on the statement in the last sentence of the above paragraph as to why the relationship between air temperature and mid-depth pavement temperature is the most important? Or why is mid-depth pavement temperature regarded as the most important temperature?
- 2) Could you please comment more on the slight differences between the temperature measurements made by the Arduino thermometer and the FWD Device (for Figures 32 & 33, Figures 34 & 35, and Figures 36 & 37, and also for Figure 39)?
- 3) Could you please comment on the reason why did you need to use the deviation values in Table 10? Could you please clarify the point that how those deviation values were calculated?
- 4) On page 81, as an explanation to Figures 42 and 43, it is written that “The coefficient of determination was $R^2 = 0.5607$ & 0.0048 respectively for pavements type flexible and semi-rigid. It’s noticed the coefficient of determination on flexible pavement record higher that coefficient of determination on semi-rigid pavement. For this experiment, mean the flexible pavement is more effected by temperature that the semi-rigid pavement.” Could you please comment more on the last sentence that why flexible pavement was impacted by temperature more than the semi-rigid pavement?
- 5) Could you please comment also on the limitations or restrictions of this work (if there are any)?

Final evaluation:

As a result, the submitted thesis fulfills the thesis assignment to an extent. **Finally, I assess the master thesis with a mark of D** due to the major issues in the language and minor points in the structure, however, ***I recommend it to be defended*** thanks to the value of the substantial experimental works and promising results. However, I just would like to kindly place a note that the current state of English in the thesis is far from the desired level and obviously seems not to have been revised by a native language speaker, and/or by a professional who has full proficiency in English.