

Monthly Meeting (July, 2020)

Date: July 28, 2020

Time: 2:25pm - 3:25pm

Location: Park Seismic Office

Attendees:

In the office: Choon Park and Jin Park

Via Skype: Josefin Starkhammar and Nils Ryden

Greetings: talking about Summer vacation in Sweden, updates on situation in America and as well as Sweden regarding Covid-19.

Topics regarding Administrative work (All)

1. Monthly Payment: Jin asked Josefin to give more days (up to 60 days) for payment due in the monthly invoice from Norrfee Tech, if possible. It is because that, from now on, Jin would like to wire the monthly payment to Norrfee Tech after receiving the fund.
2. Jin asked Josefin if she plans to order some hardware components soon in the future so that Jin can make proper budget preparation as well as administrative arrangement. Josefin replied that she would like to wait a little more until more field test data sets are available and design parameters for the final 1D array are more reliably determined based on the test results.
3. Jin mentioned that the HMA blog contains all key information of this project (e.g., timeline and schedule of tasks and deliverables, budgetary table, etc.). So, she advised everyone should utilize it whenever needed.

Topics regarding Technical work

1. NRRRA Presentation on September 3rd, 2020:
 - Choon proposed to present about how this project developed, how much progress has been made, and which direction future developments will go for 45 minutes and leave 15 minutes for Q&A. His presentation will take about 30 minutes and leave all details about the hardware development to Nils and Josefin. He proposed the Team Sweden to prepare about 15-minute presentation. He mentioned more discussion about this will be made via emails in the following few weeks.
2. Hardware Development (Possibility of Expanding to 96-CH system)
 - Choon notified that Jason (and possibly Rebecca also) at MnDOT mentioned the possibility of 96-channel acquisition system (instead of 64-channel system) for the final deliverable system, making 4 of 24-channel arrays. This was mentioned as a feedback to the 2nd quarterly report that stated it would be a possibility. Choon

indicated that Jason and he basically discussed administrative aspects (e.g., budgetary aspects) if that will be the case.

- Choon asked Josefin if it will be possible to expand current system to a 96-channel system one and how much additional budget will be necessary. Josefin replied it is possible and will cost between \$10K and \$15K more. All agreed that it is too early at this moment to discuss this topic yet. But, all will take it as a possibility along the way.

3. Field Data Collected on a New Asphalt Road (July 22nd, 2020)

- Choon mentioned the data quality was excellent in general with well development of Lamb waves throughout all 48 channels. Josefin and Nils agreed that it was surprisingly good quality, especially considering the high temperature ($> 30^{\circ}\text{C}$) at the time of survey, which must have caused the seismic waves to attenuate severely. Choon was asking what was the main reason for it. Nils replied it must be mainly because of the asphalt road condition that is new with high and homogeneous stiffness distribution and relatively thick (e.g., ~ 10 cm) thickness, rendering the pavement layer to become a good waveguide.
- Choon asked if the thickness can vary much (e.g., $> 10\%$) because of unexpected conditions during construction (e.g., machine calibration, hidden subsurface conditions, etc.). Nils replied it is very unlikely because the asphalt materials are expensive and the construction companies do their best to avoid such results by executing all means pre and during the construction. Nils replied that, nonetheless, no one knows exactly about the consistency in stiffness and thickness of the new asphalt layer.
- Nils mentioned that they plan to run a similar survey on a "not-so-good" road in the near future to compare the seismic waves.
- Choon asked if this seismic approach will find its best utility on this kind of new roads, instead of old ones. Nils replied it should be the case at MnDOT because they will use this approach mainly on newly built asphalt pavements on major highways that need to be renovated every 1-2 years for QA/QC purposes. He mentioned it is critical to do the QA/QC at the right time, not too late, to save cost.
- Choon asked about the recent field testing, especially about the two impact balls front and back of the array. He was wondering if both can trigger recording. Nils replied both can do. Choon asked how to handle those records of forward- and reverse-impact shots coming from slightly different locations. Nils mentioned both sets should be used to display two separate velocity (V_s) sections so that one can examine if there were any noticeable differences between the two. The examination should tell if there were any influences of tilted array. Choon asked about the survey speed, and Nils replied it was about 30-35 KPH (15-25 MPH). Choon mentioned the triggering at the center channel (e.g., 24th channel) maybe more effective for both forward and reverse shots.
- Nils mentioned it was relatively windy and the data were still in good quality.

- Choon mentioned that this data set generated good curved part of A0 curve at low frequencies (e.g., < 10 kHz) and wondered what contributed to it. Nils commented that it was not always easy to observe it from his past experience. But, he thinks it needs a laterally homogeneous layer in both velocity (Vs), i.e., materials, and thickness and this new "fresh" pavement met such conditions. He also mentioned that when they first tested the microphone array on a glass plate, it generated very nicely developed curved part of A0 curve.
- Choon mentioned that presence of this curved part can also be used as a quality measurement in the future that can tell how homogeneous the pavement layer is. So, it is another important property of pavement that this approach can provide.
- As Jin mentioned any possibility of more hardware components purchase in the near future, Josefin and Nils replied that they would wait a little more until they come up with more reliable parameters for the 1D array configuration. They plan to go for, at least, two more field surveys to collect more diverse data sets.
- Nils and Josefin mentioned that they are now considering to make a separate vehicle (e.g., a small cart) to be pulled by car that carries all multiple (e.g., 4) arrays because they would be too heavy to be carried by current bike rack. Considering all of these, a new budget proposal for the hardware should be made in the near future.
- Josefin mentioned that the finalized system that includes the possible cart may face some difficulties in custom clearance. Choon mentioned that we can discuss it with MnDOT at that time.
- Josefin asked if there is timeline for the hardware development. Choon mentioned that it was included the original proposal posted online and the 1D system is supposed to be ready for the 1st joint-field-test (JFT) scheduled on October, 2020. Jin asked if software development has to be closely linked to the pace of hardware development. Choon mentioned it does not have to be because field data sets previously collected can always be used as sample data sets.
- Nils mentioned that getting more data sets is the highest priority at this moment to finalize the optimum configuration of 1D array. Diverse data sets should be collected under different temperatures and pavement qualities. He mentioned that in this sense he plans to collect a data set over a concrete bridge where a new pavement was built.
- Choon asked Josefin if the final acquisition software will be a regular executable without any dependency on LabVIEW. Josefin replied it will be the case. But, it will need several library components to be installed to run the hardware properly that can be downloaded from the NI site. Choon mentioned his ACQ part of the software will be delivered to Josefin before the JFT on October.
- Choon mentioned that an amended budget proposal should be made within next 1-2 months so that either reallocation of budget or request of additional budget can be made on time.
- Nils mentioned that simply for the NRRRA presentation we should not make hasty decision on the final configuration of system; e.g., number of channels per array, number of arrays, distance between arrays, etc. Instead, we should present there

are options for these parameters and seek for feedback through mutual discussion and communication.

- Josefin asked if the thickness evaluation is included in our deliverables or not. Choon replied it is. But, all agreed that the velocity (V_s) is the primary parameter that needs to be evaluated as accurately as possible. Then, the thickness can be less accurate and we can discuss details about it on the final report.
- Nils mentioned that A0 curve fit on the observed Lamb dispersion trend is not always straightforward. This is because of the temperature dependency of V_s . This means the thickness evaluation may not be as much accurate as velocity (V_s) evaluation even if the curved part of A0 mode is clearly observed. Choon replied that he is aware of it and that's why the Impact Echo (IE) is also included as an alternative/supporting means for thickness evaluation in addition to the A0-curve fit.

Agreed to do:

1. More data sets will be collected from different roads.
2. Decisions will be made as soon as possible for the final configuration of the 1D array.
3. More hardware components that are needed to build the array will then be ordered after obtaining a proper quotation.

The meeting adjourned at 3:25 pm.