TECHSUMMARY *July 2020*

State Project No. DOTLT1000146/ LTRC Project No. 16-2P

Transportation Infrastructure Asset Damage Cost Recovery Correlated with Shale Oil/Gas Recovery Operations in Louisiana

INTRODUCTION

With the rapid growth of shale gas industry started from 2008 in Louisiana, there were 3,536 horizontal wells drilled in this state by the end of 2016 and most of the wells are concentrated in the Haynesville area. Due to the drilling and operating of the shale oil/gas wells, a large number of truck trips are required for transporting equipment and materials, hauling fresh water, and disposing salt water to and from the shale oil/gas recovery sites. As a result, roads and bridges that were designed for agricultural purposes and/or residential accesses are now subjected to heavy traffic loads that are far beyond the original design limits of the infrastructures. It is noticed that the transportation infrastructure damages in northwest Louisiana due to oil/gas recovery activities have been increasing drastically. However, there is no existing approach available for Louisiana to estimate the damage costs and recover the costs from the oil/gas industries. Therefore, it is necessary for the Louisiana Department of Transportation and Development (LADOTD) to assess the infrastructure damage costs so that the damage costs can be recovered from the oil/gas industries.

OBJECTIVES AND SCOPE

The objectives of this study include: (1) to quantify the pavement damage caused by the shale oil/gas development activities; and (2) to estimate the damage costs and recommend a strategy of fiscal remedies.

The overweight truck trips within the Haynesville region from 2006 to 2016 were collected from the Permit Office's database and analyzed using ArcGIS. The vehicle miles traveled (VMT) was calculated in terms of roadway classification, and the damage costs were estimated thereafter in network level. A matrix approach based on the shale gas well numbers was also developed to quantify the distribution of shale gas related overweight truck in project level. There were 12 damaged roads investigated, and a pavement life cycle cost analysis was conducted to calculate the damage costs. The overweight trucks with different gross vehicle weight (GVW) were also studied to update permit fee regulation in Louisiana.

METHODOLOGY

RStudio software was employed to extract and reformat the overweight trips in the Haynesville area in 2006-2016 from the oversize/overweight (OS/OW) permit database, the Origin/Destination pairs were prepared for the recognized overweight trips. Network Analysis in the ArcGIS was utilized to assign these extracted overweight trips directly on the roadway network according to the shortest path method. With the analyzing results of Network Analysis, the occurrence frequencies of the roadway segments on the four categories of Louisiana roadway including interstate, US highway, Louisiana roadway (ADT>2000), and Louisiana roadway (ADT≤2000) layer were counted by RStudio. VMT on a roadway segment was calculated by multiplying the frequencies of the roadway segment by its length. The damage cost for Network-level analysis was estimated based on the unit cost per ESAL consumption of each type of roadway classification.

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Project-level analysis was conducted on the 12 damaged routes in Haynesville area. The impacted area was divided into 15 shale-gas well zones and an interaction matrix was developed by summarizing the roadway relationships among zones. Based on this matrix approach, the overweight truck trips on these damaged routes were estimated. The details of the selected roadways such as pavement structures, design traffic, and construction data were collected from Pavement Content Manager. The Pavement ME was adopted to obtain the pavement distress due to shale gas development, and the results were matched to data collected from Pavement Management System (PMS). Then scenarios with no overweight truck loads were simulated to obtain the difference of service lives with/without shale gas truck traffic. Life-cycle analysis was applied to obtain the damage costs of overweight truck trips for the 12 Louisiana low-volume routes. Another approach with AASHTO 93 was also conducted to estimate the project level damage cost. The equipment trucks with gross vehicle weight (GVW) from 80-200 kips used in oil-gas industry were investigated to update the current DOTD permit fee regulations.

CONCLUSIONS

Based on the observations from the Network-level analysis, the following conclusions can be drawn:

- It is feasible to investigate the impact of the overweight trips in the shale gas development on roadways by using RStudio and ArcGIS based on the overweight permit database. The methodology adopted in this study can be used for other permit types, such as mining, seasonal agricultural activities, oversize trips, etc.
- It was estimated that there were 130,000 overweight trips related to the shale gas development in the Haynesville area during the dramatic rise of the shale gas industry between 2008-2016. The VMT of these overweight trips approximated 9.7 million miles on the Louisiana roadway system. With an estimated overweight truck factor of 6.41, and the unit costs per mile on different types of roadways, the VMT was translated into a damage cost of $17 million.
- On average, the damage cost due to the overweight trips in the construction of a single well approximates $5,264 and the damage cost per overweight mile approximates $1.74. These average costs may serve as a reference for the future damage cost recovery.

The conclusions from the Project-level analysis includes:

- Overweight truck traffic could be obtained based on zone interaction analysis and shale-gas well numbers. This method is suitable especially under the conditions that the truck permit information is unavailable.
- The AADTT, truck type distribution, axles per truck and axle load spectrum for Louisiana local trucks and shale-gas overweight trucks were combined as input in Pavement ME. Based on Pavement ME analysis, the average damage cost per overweight truck is $20.86 per trip mile on the 12 selected LA low-volume routes (AADT<2000).
- The results obtained from Pavement ME are compared to the results from AASHTO 93 method. It was found that the damage costs obtained by AASHTO 93 is not adequate to compensate the reconstruction investment, if it is adopted as future permit fee. The Pavement ME results are recommended for updating the permit fee regulation.
- The equipment trucks with various GVWs were investigated considering DOTD regulation about axle configurations. The damage cost per truck mile on GVW ranges within 80-252 kips were obtained, and a new permit fee regulation involved GVW and travel distances following the current overweight truck permit fee schedule was suggested.
- In addition, single trip permits and annual permits with various GVW levels are also recommended.

RECOMMENDATIONS

This research project developed a network level analysis method to estimate the traffic impact of overweight truck traffic on Louisiana roadways, which is based on overweight/oversize permit database and ArcGIS. This method is convenient for summarizing the vehicle miles travelled (VMT) into desired roadway categories and therefore the damage cost for each roadway type could be obtained correspondingly. It is recommended that DOTD adopt this method for analysis of other permit types such as seasonal agricultural activities, oversize trips, etc.

In addition, a new permit fee schedule considering gross vehicle weight (GVW) and travelling distance is recommended, based on the damage costs obtained from project level analysis on LA low-volume routes (AADT<2000) and the statistic from network level analysis. It is suggested that DOTD consider this permit fee schedule in making overweight truck-related policy.

Furthermore, it is recommended that the DOTD truck permit database should include more information (e.g.,, actual routes travelled and frequency of annual overweight permit) in the future to develop a more detailed network level analysis. Studies on other roadway types (interstate, US highway and LA routes with AADT over 2000) should also be pursed to improve the recommended permit fee regulation.