Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Feasibility Study: Alternatives to Prevent Settlements and Bumps at Bridge Approaches in Nebraska

Research Objectives

The proposed research pursued two principal goals: (1) improve the current design practices of the approach slab foundation in Nebraska, and (2) examine the feasibility of applying geosynthetic reinforcement of soils for preventing the settlement issues at the bridge approaches with less cost.

Research Benefits

1. In-depth review of current practices of bridge approaches in Nebraska identified an opportunity of improvements in the design and construction with less cost and still superb performance.
2. Extensive survey and review of cases and solutions in other states provided relevance to Nebraska conditions and insights into possible other strategies to prevent the "bump at the end of the bridge approaches" problem.
3. The proposed project provided the detailed analysis of feasibility on the geosynthetic reinforcement as a foundation soil of the approach slab for site-specific Nebraska geologic conditions.
4. Therefore, the proposed project contributed to effectively preventing the issue of bridge approach settlement with less cost tailored to the Nebraska soil conditions via the improvement of current design practices and the introduction of economically viable soil reinforcement strategies.
5. Subsequently, the proposed project greatly reduced the construction cost for a new bridge as well as the maintenance cost and time for existing bridges.

Principal Investigator

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Background

There is an important research need to provide more details and make necessary revisions to the current grade beam policy to minimize the settlement and bumps at the bridge approaches with less cost and same confidence level as before. Besides, there is a research need to investigate other potential alternatives to prevent such a differential settlement not only at the interface of the bridge abutment and the approach, but also at the interface of the approach and the roadway pavement. One of the feasible alternatives to mitigate such "bump at the end of the bridge" and the different settlement of an approach slab is the application of geosynthetic reinforcement (or geosynthetic reinforced soil, GRS) underneath the approach slab.

Conclusion

This project aimed to examine the feasibility of improving the current design practice of the approach slab foundation in Nebraska and the alternative of using geosynthetic reinforcement of soils to prevent the bump issues near the end of bridge approaches via an in-depth numerical simulation study. A large-scale pullout test is also conducted as complementary to provide input parameters for the interaction between the regional soil and selected geosynthetics. Based on the results, it is recommended that the number of grade beam piles could be reduced to 40-50 % of the total number of abutment piles while maintaining the same dimension and length to sufficiently prevent the “bump” issue not only near the interface of the bridge abutment and the approach but also at the interface of the approach and the roadway pavement. In the geosynthetic reinforcement case, 2-3 layers of individual geosynthetic reinforcements at both near the interface of the bridge abutment and the approach and the interface of the approach and the roadway pavement could be recommended to efficiently prevent the bump issue. Unlike individual geosynthetic reinforcement, extended geosynthetic reinforcement is not recommended due to its less efficacy, constructability, and economic reasons. Alternatively, a combination of grade beam piles (current design practice) and 2-3 layers of individual geosynthetic reinforcement near the interface of the approach and the roadway pavement could also be recommended to prevent differential settlements at both areas. Such an approach can also be used for the repair of an existing bridge approach and the roadway pavement. Considering the estimated costs for the installment of grade beam piles and geosynthetics, the alternative design of using geosynthetic reinforcement could be a more cost-effective and economical method compared to the current design practice.

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NDOT Research Website

NDOT Recommendations Based Off Research Project

After some internal discussion between the Geotechnical Section and Bridge Division, The Department will be looking for a feasible site for the installation of grade beam piles and geosynthetics. The Department would look at the cost benefit of using the geosynthetic reinforcement method and compare to the current design practice. The proposed follow up, as follows:

- Geosynthetic reinforcement method effectively prevented bridge approach settlement
- Geosynthetic reinforcement method reduced the construction cost and time for a new bridge, as well as, the maintenance cost.

- *As provided by Fouad Jaber and Nikolas Glennie, Lead TAC Members*

Research Readiness Level (RRL) Assessment

RRL 4

Level : Implementation with Follow up

Research/Technology refined and adopted by the Department. Benefits of the implementation will be evaluated for a time frame of 2 year after construction.

Technology Transfer

Principal Investigator did not have any technology transfer for this research project.

This brief summarizes Project SPR-P1 (20) M106
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