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Mechanistic Analysis of a Slab Track System and Its Applications

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Name of Student: Shao-Tang Yen **Advisor:** Dr. Ying-Haur Lee

顏少棠 李英豪 博士

Abstract:

The analysis of slab tracks is similar to that of concrete (rigid) highway pavements except that loads are applied to the rails connected directly to the concrete slab or through rubber booted block ties. Consequently, the main objective of this study is to investigate their theoretical discrepancies, develop adjustment factors and analysis procedures based on elastic track theory and medium-thick plate theory to account for various practical track conditions more realistically.

The idealized theoretical solutions are first investigated. Together with the principles of dimensional analysis as well as its similarity to a rigid pavement system, several dominating mechanistic variables are identified and numerically verified.

The well-known three-dimensional finite element program (ABAQUS) will be adopted in this study. According to earlier literature, various elements will be carefully chosen to simulate different components of the slab tracks system, i.e., block elements, beam elements, and spring elements will be used to model concrete slabs, rails, and various rail fastenings as well as the subgrade support, respectively. A systematic approach was utilized and implemented in a Visual Basic software package to study the effects of mesh fineness and element selections using the ABAQUS three dimensional (3-D) finite element (FEM) program. The convergence characteristics of various 2-D shell and 3-D solid elements are investigated. Subsequently, an automated analysis program was developed using the Visual Basic software package to automatically construct FEM models, generate the input files, conduct the runs, as well as summarize the results. Several mesh fineness and element selection guidelines are subsequently recommended to build an adequate and efficient 3-D FEM model.

The track-slab system was separately analyzed using the concept of free body diagram. Based on the elastic track theory and plate theory, several dimensionless parameters were identified and various prediction models were developed. A systematic analysis procedure was developed for future slab track analyses. The applicability of the proposed procedure was further verified through a completely different database generated using various input parameters. Finally, the proposed procedure has been implemented into a Windows-based prototype computer program (TKUTRACK) with many user-friendly graphical interfaces.

KEY WORDS:

Slab Track, Concrete (Rigid) Pavement, 3-D Finite Element Model (FEM), Dimensional Analysis, ABAQUS, Predictive Model, TKUTRACK