

Using 3D Brick and Grillage Models for Complex Bridge Superstructures

The modern procedure for bridge deck analysis typically employs commercial computer programs to analyse load effects on bridge girders using the Finite Element Method (FEM). These programs predominantly calculate displacements at the nodes of bridge elements. Recently, grillage models have been frequently used for bridge deck analysis due to their simplicity in undertaking structural analysis. However, using grillage models for complex superstructures, such as those with super T beams and box girders, is significantly more challenging. Guidelines for developing grillage models for these intricate girder types can be found in Edmund Hambly's "Bridge Deck Behaviour" (1976) and Eugene J. O'Brien et al.'s "Bridge Deck Analysis".

Successful grillage modelling of these superstructures necessitates numerous assumptions regarding the properties of the grillage members. For instance, in a grillage model, primary beams are located at the centroid of super T beams despite the voids present, and transverse deck slabs are idealised as perfect transverse members, disregarding both flanges.

While 3D brick models offer the most accurate simulation of deck bridge behaviour, they are resource-intensive, demanding substantial effort in both model development and post-processing, in contrast to grillage models. For rapid structural analysis, grillage models should be employed with reasonable assumptions based on structural mechanics and a firm grasp of the underlying parameters within commercial software. Thus, it is required that bridge designers understand structural analysis techniques and verify load effects before use.

This paper aims to present, compare load effects, and their distributions in complex bridge superstructures using both 3D brick models and equivalent grillage models. Based on these findings, best practice approaches will be recommended for the rapid practical development of effective grillage models for undertaking safe structural analysis of complex bridge superstructures.