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Abstract

The design of highway multi-girder bridge decks includes in the static analysis the evaluation of the deformed shape and stresses, in every member, due to a standard set of vehicles according to the applicable code requirements. So, it is necessary to compute the extreme values of mechanical quantities, which occur for different moving load positions on the deck, taking into account the redundancies of the deck grid.

In general, the used procedures evaluate these effects defining a moving load train for each element, based on different load transversal distribution criteria, and then adopt the most severe load position in each situation. Others use a finite element deck model to determine the effect of transversal distribution and, in sequence, study each element separately. A rigorous procedure to account all the variables involved and incorporating the prestressing dimensioning with losses evaluation and admitting also eventual iterations, can take more time than the design schedule may allows, if a consistent and automatic procedure is not used.

Looking further, one realises that the capabilities of modern microcomputers, in data storage and in computational velocity, are present on the work desk of every structural engineer. Under this view one presents an analysis methodology, conveniently implemented, to compute the amount of prestressing and mild steel to the above mentioned bridge decks. A pre-processor is included to minimize the input of data task.

A specialized computer program for the analysis of simply supported multi-girder highway bridge decks is developed, and commented herein, to automate this design task. Where code requirements are necessary to evaluate the acceptance of the solution under study, one uses the Brazilian NBR-7187 .

A finite element grid model is used for the deck, and the moving load, formed by any arrangement of vertical concentrated or distributed loads (according to the applicable code requirements), moves step by step, on all deck surface. By a suitable data manager scheme, the load is distributed to the grid and displacement and stresses are computed for every successive load position; the extreme values are conveniently stored. All these effects are obtained on the grid redundant model by a conventional displacement method of analysis. The dead load effects evaluation also is made on the grid model, as well as the prestressing dimensioning.

The design of a prestressed bridge deck has to consider three peculiar situations which require a special attentions of the analyst:

- prestress varies along the length of the cables and is a time dependent problem;
- concrete casting schedule can be divided in three or more phases and cross sections proprieties vary from phase to phase.
- deck structural system also varies from one phase to another as the assembling of new elements changes the system redundancies.

For the case of multi-girder precasted simply supported bridge decks these pecularities are still more important because the larger number of bridges which use similar solutions with several span repetitions per place. For this reason one is encouraged to work on a specialized routine to analyze these systems in a consistent manner which handles all the design phases, as much as possible, on the same grid model. The proposed methodology and the subsequent implemented program allow one to carry a consistent analysis of simply-supported multi-girder prestressed concrete highway bridge decks, taking into account all these peculiarities including the stiffness redundancies of the slabs.

One example illustrates the application of the proposed methodology in comparison with an usual solution of the same case. One carries the analysis of a 43.10 m long simply supported highway bridge deck made of prestressed concrete, which has been designed and built in Brasil, sometime ago, using a less consistent procedure. It is shown an outlook of the program output which gives phase by phase, element by element, all the kinematics and internal forces and stresses of the grillage, including prestressing. Eventual hazard warnings show up where code provisions are violated. Several alternate solutions can be tested rapidly.