# A model for the future

In the course of a bridge design project many levels of detail are required from the numerical models describing the structural system. As the amount of information about a structure increases throughout the individual project phases this information must be included in the analysis model. It is important for the practising engineer to know how adaptable a computer model is and how easy it is to apply modifications and extensions of an existing model.

Every structural analysis is based on mathematical models. The quality of the answers gained from such models depends strongly on the quality of the approximations and generalisations that underpin each particular model. Such approximations are necessary to describe geometric properties and the resistance behaviour of structures. Each structural problem requires a certain level of accuracy in the modelling. Specialist TDV's bridge design software RM2000 is designed to give exactly the level of accuracy required for any given modelling situation in bridge engineering.

For example it is often the case that a numerical model for a preliminary project will be expanded into a model for a much more detailed analysis at a later stage. Some recent developments in the RM2000 software emphasise the need for the capability to model some very specific and delicate problems in high-end bridge engineering while also providing solutions for a quick and simple approach at an earlier stage. While this software offers a solution for all bridge-related analysis problems, the most recent developments are highlighted here.

One of the areas addressed is the degree of accuracy required in the definition of prestressing cables. Obviously this varies greatly depending on the planning stage at which a computer model is intended to be used. In a preliminary project, the exact geometry of individual prestressing cables is often unknown and rough assumptions must be used to estimate and define the properties of the prestressing. RM2000 allows the user to define a preliminary prestressing geometry and calculates the response of the structure according to this definition. As information about the prestressing becomes more detailed, the software offers the necessary tools to upgrade the existing model to include this information.

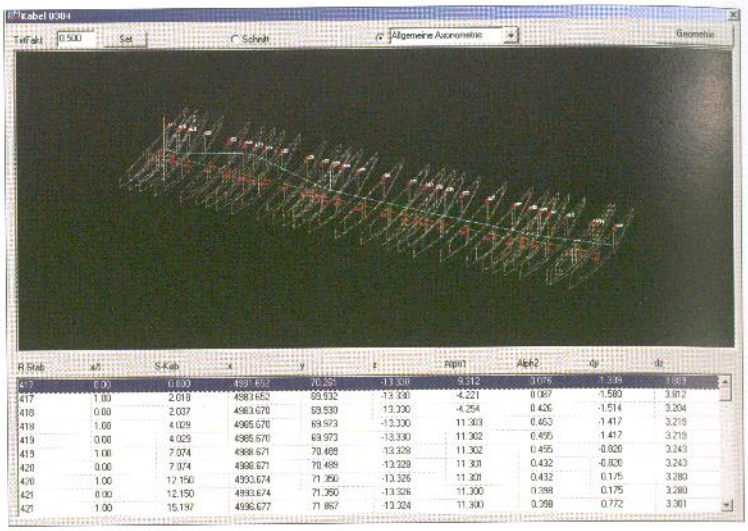
For example it is common practice to group a number of strands together for a preliminary analysis and then assign the exact geometry and tensioning sequence to each individual strand when this information becomes known.

A newly-developed module makes management of this information easy. The module provides all prestressing data for the structural analysis of bridges and also supports the management of prestressing information needed at the construction site - including the exact geometry of individual cables, prestressing sequences and jacking actions. This module was developed in cooperation with VSL-Singapore and provides a powerful link between structural analysis and practical work on site.

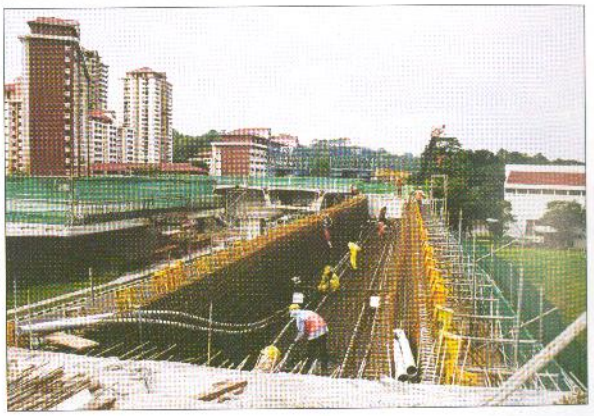
All these functions are available for internal and external prestressing. A new feature allows the geometry of the deviators for external prestressing to be considered. External and internal prestressing can be combined for individual strands - an important feature for the design of extradosed bridges.

Another aspect of the design process that has been enhanced in TDV's new software is that of construction schedule. Information about the construction history is especially important when time-dependent effects must be included into the analysis of a structure. For example, the time of each structural modification and load application must be taken into account when applying the CEB/FIP creep model. However, the sequence of construction for a bridge also evolves over time and often gets modified as certain planning aspects becomes clearer.

While only scarce information is often considered for a preliminary analysis this information must be expanded to much greater detail for a more precise analysis at a later stage of the planning process. RM2000 supports the analysis of all types of erection methods and



A new module allows easier management of prestressing data providing a powerful link between structural analysis (above) and site work (right)



provides many specialised tools for the analysis and optimisation of all types of bridge structures. Specialised features support the input of construction sequences and certain tools allow for a seamless upgrade from a simple preliminary model to a very detailed general design model. Most recently, a powerful tool for the analysis of bridges built by incremental launching has been implemented. This new module supports the comfortable definition of the launching process and automises all associated geometric and structural changes.

Managing data generated by the design and analysis procedure is another important aspect of the program. As the degree of detail increases in a model throughout the planning process, so does the amount of resulting data - at times it can become overwhelming. Specific tools to manage analysis results are vital so that the bridge engineer can concentrate on the important issues of a design. RM2000 now offers a new feature which allows the automated generation of analysis reports and calculation sheets containing selected result tables, free text and also structural drawings and diagrams.

The amount and the nature of the data included in these automated reports can be adjusted by the project engineer. Interface functions allow for a broad range of post-processing options with other software products including CAD-packages, word processors and spread-sheet software.

TDV is currently implementing a further range of new elements into the software in order to increase its versatility further and to allow for even more detailed analysis. This includes expansion of the element library, to include several new types of finite element, enabling bridge engineers to go into even greater detail within a single model. This development is part of the Fembridge project in cooperation with the Graz University of Technology and the University of Western Sydney. ■