Izmit Bay Suspension Bridge
Global Analyses incorporating Local Sub Models

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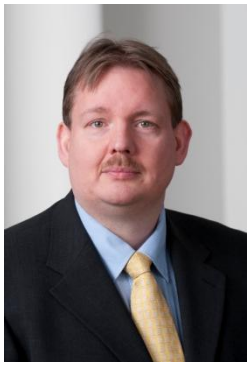


Born 1973, received his civil engineering masters degree from Aalborg University Denmark in 2000. He has worked with COWI A/S in the Department for Bridges, International for 13 years specialising in Finite Element Modelling of Large Cable Supported Bridge Structures.

1. Summary

This paper describes advantages of incorporating local analysis models in a Global Analysis Model (GAM) as compared to a more traditional design approach. Time History Analyses introduce a problem for detailed local analyses of special structural elements as the influence from the super structure is dynamic time dependent and thus more traditional verification approaches are not feasible.

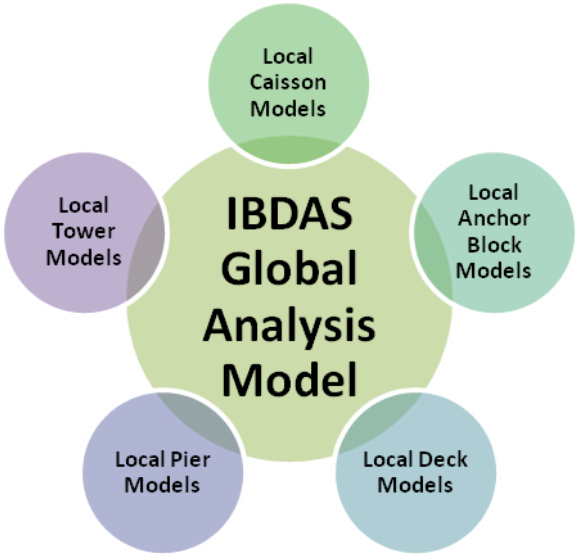
Incorporating local models in the GAM requires special software capable of handling the complexity of exchanging integral parts of the combined model. The detailed design of the Izmit Bay Suspension Bridge is used as an example, and descriptions are given of the local models prepared during design as well as the used analysis software.

Keywords: Suspension Bridge, Seismic Design, Finite Element Analysis, GAM, Local Model, Caisson, SSI, Masing

2. IBDAS Global Analysis Model (GAM)

The GAM for the design of the Izmit Bay Suspension Bridge was created using the general computer aided structural design and analysis system IBDAS (**I**ntegrated **B**ridge **D**esign and **A**nalysis **S**ystem), developed by COWI A/S.

IBDAS is a powerful computerized system which is based on 3D solid modelling, and it provides powerful features for fully integrated design of load bearing structures and includes facilities for specialized analyses.



An IBDAS model is to a great extent based on element geometry, and most of the information needed for the generation of the finite element model is extracted from the geometry model. The models are generated fully parametric and are thus highly flexible in regard to quickly handling design variations.

It is possible to create a parametric IBDAS model, using a combination of Beam, Shell and Solid elements, making it possible check local effects in the GAM.

The local models have direct interface to the GAM and can be activated inside the GAM to get

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correct boundary conditions for any further analyses carried out.

Figure 2 gives an overview of the local models integrated in the GAM for the Izmit Bay Bridge.

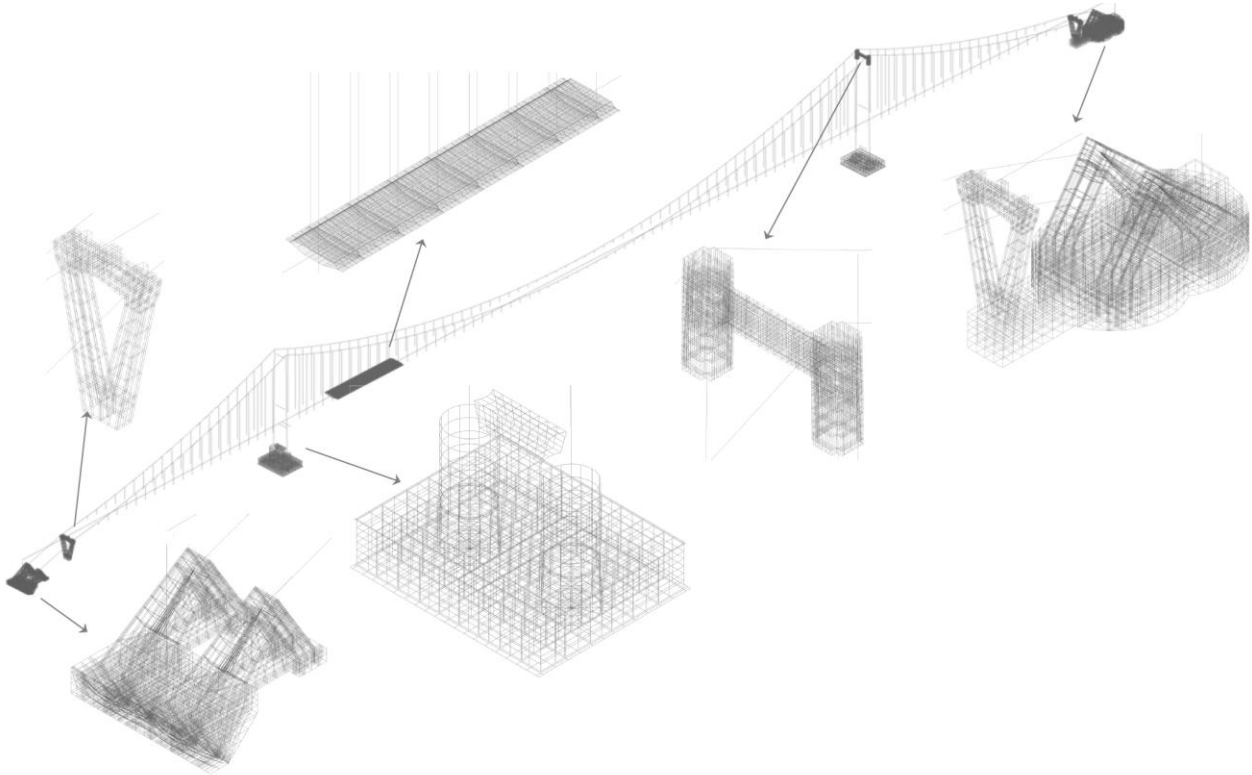

Figure 1: Local Models included in the GAM

The element types used in the local models are either shell or solid elements or a combination of these.

3. Advantages of Including Local Models in the GAM

A traditional approach is to verify the structure using two steps, i.e. loads are first taken out from the GAM, and the local model is then verified by applying these forces in a completely separate analysis model. Furthermore, this approach will limit possibilities for e.g. including material non-linearity in the local model, as non-linearity in the local model will have an effect on the boundary forces from the GAM.

Advantages of integrating local element detailing in the GAM compared to the more traditional approach:

1) Boundary conditions are automatically correct. This eliminates the need for ensuring that the correct boundary conditions are applied to the local models
2) Geometric changes made in the Global Model are automatically included
3) Loads and Load Combinations can be taken from the GAM
4) Design verification can be done directly in the GAM
5) Non-linearity can be introduced in the local model and can be correctly analyzed

Many elements in the design of the Izmit Bay Suspension Bridge are governed by the seismic Time History forces.

Time History Analysis introduces a problem for detailed local analyses of special structural elements as the influence from the super structure is dynamic time dependent and thus more traditional verification approaches are not feasible. Full non-linear Time History Analyses can be performed on the local model when integrated in the GAM.