Abstracts of MMA2009, May 27 - 30, 2009, Daugavpils, Latvia

COUPLING OF ZONES WITH DIFFERENT RESOLUTION CAPABILITIES IN STRUCTURAL FINITE ELEMENT MODELS OF UNIFORM STRUCTURES

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The approach discussed in this work enables to present the finite element model of a large uniform structure by an assembly of zones of different resolution capability. A dense girder structure has been analyzed in our recent work [1], where the equivalent membrane model exhibiting similar features under static and dynamic loading has been obtained. The criterion of the behavior similarity of the two models was assumed to be the coincidence of corresponding nodal displacements. Displacements of all nodes of the models within the domain of size $L \times L$ have been taken into account when formulating the optimization task, during which the parameter identification of the membrane was performed. The penalty-type target function expressed as a sum of squares of differences between the displacements of corresponding nodes of each model was used as $T(\vec{p}_j^{\,i}, \vec{q}_j^{\,i}) = \sum_{j=1}^{m} \frac{\sum_{i=1}^{n} (\vec{p}_j^{\,i} - \vec{q}_j^{\,i})^2}{\sum_{j=1}^{n} (\vec{p}_j^{\,i})^2 + \sum_{j=1}^{n} (\vec{q}_j^{\,i})^2}$, where $\vec{p}_j^{\,i}$ is the vector of i-node displacements of the j-model of membrane, $\vec{q}_j^{\,i}$ is the vector of i-node displacements of the j-model of girder, $n = (N+1)^2$ - total number of the nodes of each model, N - number of cells along the side of the model, m - number of models.

In this work the further development of the approach is presented. The continuous membrane model, which can be used in multi-scale models and presents adequately the behavior of the girder structure under static, as well as, dynamic loads has been synthesized. The investigated example structure contains the girder structure presented as a small patch in the central zone of the equivalent continuous membrane, which should imitate a vast continuous girder structure. While actions imposed upon a structure are located in finer resolution patches, the rougher resolution zones serve as a surrounding for finer ones in order to present the overall behavior of the structure. The girder zone is coupled to the equivalent membrane by using contact elements CONTA171 and TARGE169 in ANSYS environment.

The least squares method and the artificial neural network approach have been employed for the identification of the geometric and physical parameters of the equivalent membrane. The efficiency of both approaches has been compared. In static and dynamic analysis under the same mechanical loads the equivalent membrane model provided satisfactory approximation of the behavior of the girder structure even when the membrane element side length was twice greater than the dimension of the girder cell.

REFERENCES

[1] V. Rimavičius and R. Barauskas. Obtaining simplified finite element models by minimization of residuals of static and dynamic responses. *Information technology and control (Kaunas)*, **37** (3), 2008, 211 – 218.