11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

RECENT ADVANCES IN MASS MATRIX TEMPLATES FOR STRUCTURAL DYNAMICS

Carlos A. Felippa[1], Qiong Guo[2] and K. C. Park[3]

[1] Department of Aerospace Engineering Sciences and Center for Aerospace Structures, University of Colorado, Boulder, CO, 80309, USA, carlos.felippa@colorado.edu
[2]Commercial Aircraft Corp. of China Ltd., Shanghai, China, grace.guo@eb.manpower.com.cn
Formerly at Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO, 80309
[3] Department of Aerospace Engineering Sciences and Center for Aerospace Structures, University of Colorado, Boulder, CO, 80309, USA, kcpark@colorado.edu

Key words: *structural mechanics; finite elements; dynamics; mass; vibration; waves; templates.*

This paper summarizes recent advances in the template approach to the construction of customized mass-stiffness pairs for selected applications in structural dynamics. The main focus is on adjusting the mass matrix. Two well known discretization methods, described in FEM textbooks since the late 1960s, lead to diagonally-lumped and consistent mass matrices, respectively. Those models are sufficient to cover many engineering applications but for some problems they fall short. The gap can be filled with a more general approach that relies on the use of templates. These are algebraic forms that carry free parameters. Templates have the virtue of producing a set of mass matrices that satisfy certain *a priori* constraint conditions such as symmetry, nonnegativity, invariance and momentum conservation. In particular, the diagonally-lumped and consistent versions can be obtained as instances. Availability of free parameters, however, allows the mass matrix to be customized to special needs, such as high precision vibration frequencies or minimally dispersive wave propagation. An attractive feature of templates for FEM programming is that only one element implementation as module with free parameters is needed, and need not be recoded when the application problem class changes.

Initial developments on mass templates were reported in [1]. The state of the art by early 2013 regarding one-dimensional structural elements was presented in [2]. The present paper illustrates advances made since, with focus on two-dimensional elements.

REFERENCES

[1] C. A. Felippa, Construction of customized mass-stiffness pairs using templates, *ASCE J. Aerospace*, **19:4**, 241–258, 2006.

[2] C. A. Felippa, Qiong Guo and K. C. Park, Mass Matrix Templates: General Description and 1D Examples, *Arch. Comput. Mech. Engnrg*, to appear.