SUPERELEMENTS WITH THERMAL LOADS

1. INTRODUCTION

The superelements are commonly used with a stiffness matrix [KAAX] and a load vector {PAX} which provide the equivalent stiffness and the loading coming from the condensed structure.

Apart from the mechanical loads, sometimes thermal loading is also used to load the finite element models. This document deals with the analysis where the thermal loading is included on a model with a superelement embedded by means of a stiffness matrix and a load vector.

2. SUPERELEMENTS AND THERMAL LOADING

When a superelement is created the output matrices include:

- [KAAX]: Stiffness matrix
- {PAX}: Load vector
- [MAAX]: Mass matrix
- [BAAX]: Viscous Damping matrix (dynamic analyses)
- [K4AAX]: Structural Damping matrix (dynamic analysis)
- [AAX]: Fluid-Structure coupling matrix (analyses that require this coupling)

The superelement is normally created for a set of load cases, and therefore, the load vector is normally transformed into a matrix whose columns are the load vector corresponding to each of the load cases in the same order that they are on the input file. This set of load cases can potentially include thermal loading on the case control (TEMP(LOAD)) and the consequence is that the load vector {PAX} or the corresponding column of the [PAX] matrix contains the influence of this thermal loading.

The thermal loading on the model where the [KAAX] and {PAX} are included has to be exactly coincident with the one on the model from which the [KAAX] and {PAX} were obtained.

If the thermal loading is not included on this model or the thermal loads are not coincident, then the results will be totally incorrect, as the influence of the different thermal loading on the boundaries is normally huge.

Therefore, if a new thermal loading has to be tested on the model where the [KAAX] and {PAX} are included, the condensation of the model from which [KAAX] and {PAX} come from has to be repeated with the new (TEMP(LOAD)) card on the case control. This step has to be completed as well if the materials used on both model are the same but the expansion coefficients are not exactly matching. The slight differences on these values can create stresses that are not correct.

The reason for this is that the condensation of the model does not include a matrix with the condensed thermal expansion coefficients (a kind of [ALFAAX]) which would be useful in order to be able to test different temperatures once the model has been condensed. The influence of the temperature is condensed on the [KAAX] and {PAX} and cannot be changed later by changing the TEMP(LOAD) on the model where these matrices are included.