

Influence surface analysis and Vehicular moving load analysis for Bridge Design

An influence surface represents a selective component of analysis results shown at the points of unit load application in a plane surface of a rigid frame or slab bridge. The unit load is applied to all the locations of possible loading on the bridge deck surface, which provides the basis for static analysis. Through an influence surface algorithm, MIDAS/Civil thus performs analysis for the vehicular moving load in a rigid frame or slab bridge where the effect of two-way distribution of moving loads is significant.

MIDAS/Civil adopts the following procedures for analyzing the influence surface and vehicular moving load:

First, Model the structure.

Second, Define the ranges of traffic surface lane and influence surface in the structural model considering the vehicle moving paths, number of design traffic lanes and traffic lane width.

A traffic surface lane represents a zone in which traffic vehicles actually travel and is defined in accordance with various standard specifications. The Influence surface zone basically includes the traffic surface lanes, and it can be additionally defined by the user. The traffic surface lane and influence surface zones are defined by plate elements. The traffic surface lane comprises traffic surface lane elements and the line of traffic lane nodes. The line of traffic lane nodes is entered by a series of consecutive node numbers. And caution should be exercised defining the line of traffic lane nodes, as the order determines the direction of traffic.

Third, Define the vehicle loads to be applied to the traffic lanes. The standard vehicle loads defined in AASHTO or other standard databases can be used. Alternatively, user-defined wheel loads or traffic lane loads can be also specified.

When a group of two or more concentrated axle loads are applied as a moving load condition and if their loading values or axle spacings are different, bi-directional vehicle loadings must be applied, as the directions of the moving loads affect the results.

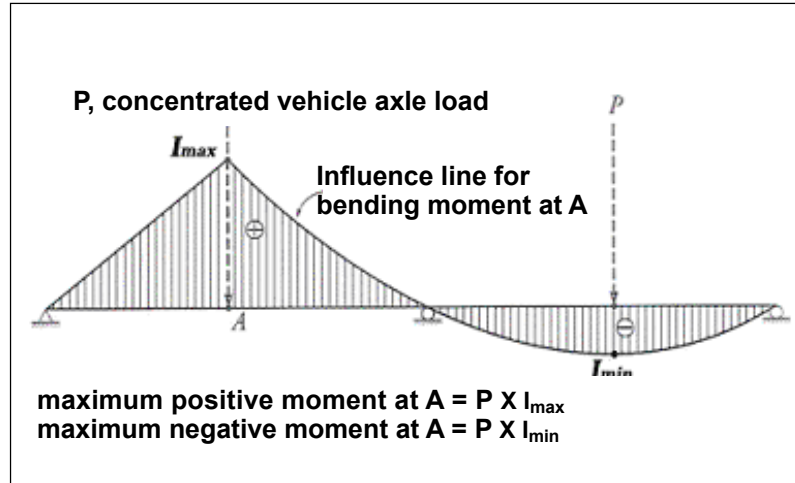
Fourth, Enter the vehicle loads, traffic surface lanes and the loading conditions for the design requirements.

MIDAS/Civil calculates the maximum/minimum design variables among all possible cases through a

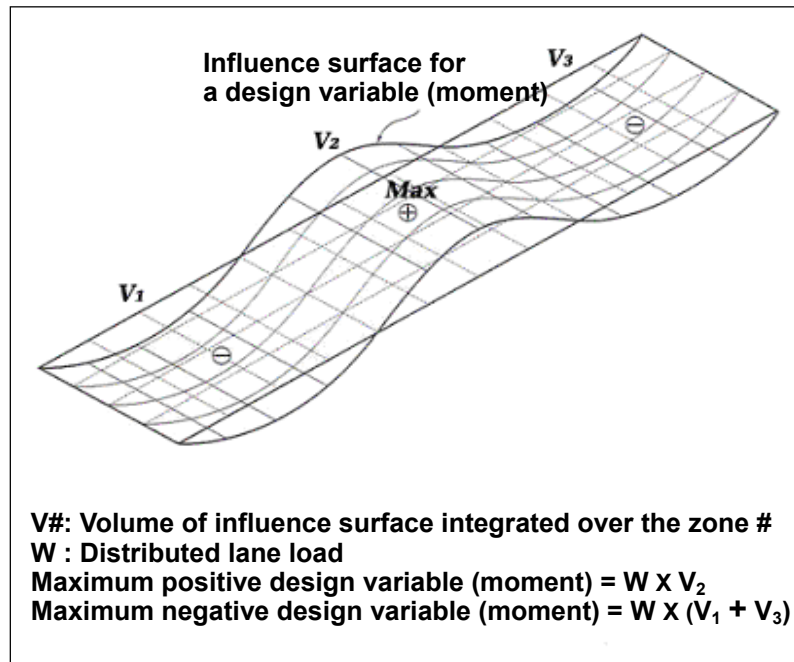
permutation process considering the entered design conditions. In the case of concentrated axle loads, the maximum/minimum design variables are calculated by multiplying the maximum/minimum influence line values pertaining to the required variable by the concentrated axle load values. In the case of a uniform traffic lane load, the maximum and minimum design variables are found by the following. First, we identify the positive (+) and negative (-) zones of the influence surface within the traffic lane pertaining to the required variable. Second, we integrate the influence surface values in the two separated zones and multiply them by the uniform traffic load.

Fifth, Specify the plate elements that are connected to the supports. The information is used to obtain the maximum negative moments due to traffic lane loads in a continuous span to satisfy the requirements specified in various standards such as AASHTO. The loading condition for finding the maximum negative moment at a support is that two adjacent spans on each side of the support in question is loaded with the specified distributed load, and in addition, a concentrated load equivalent to the total distributed load is placed on each span at the most unfavorable location.

Sixth, Combine the analysis results of the vehicle loading condition and other static or dynamic loading conditions.



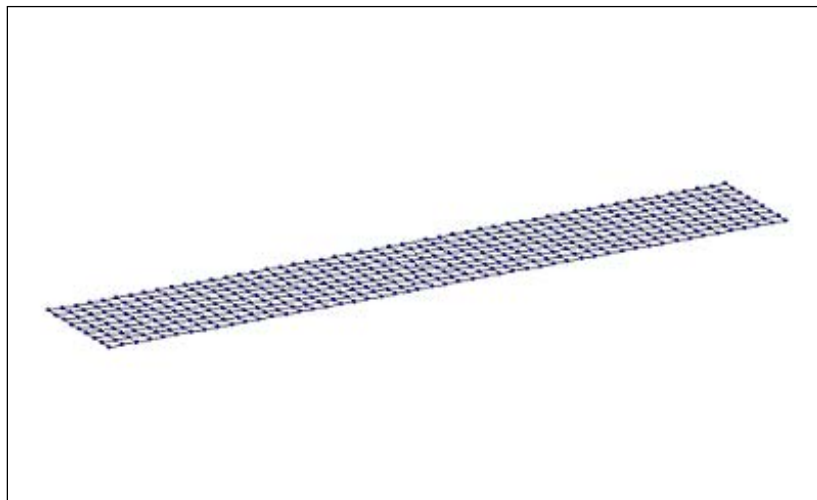
a) Concept of calculating maximum/minimum design moments subjected to a concentrated vehicle load (P)



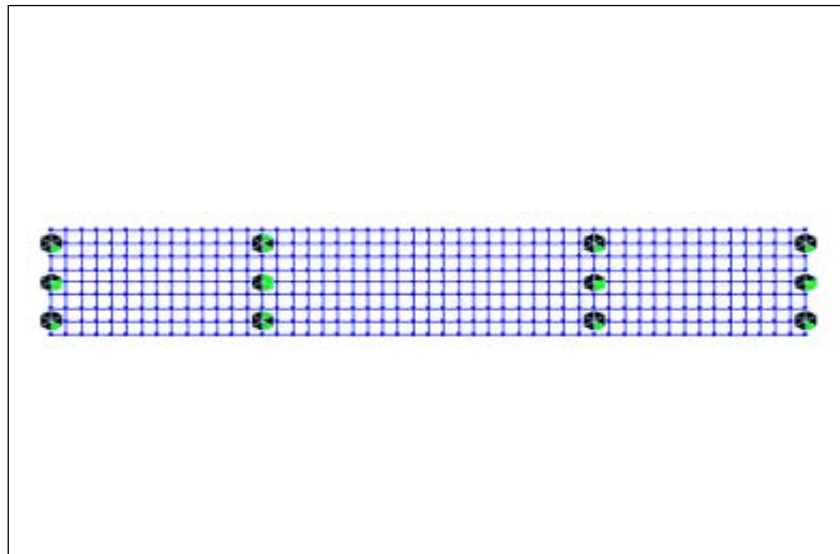
- b) Calculation of maximum/minimum design moments due to a distributed lane load (W)
 <Figure 1> Calculation of maximum/minimum design variables (moments) due to concentrated and distributed loads

The following examples illustrate the procedure for modeling a slab bridge and the analysis results using the MIDAS/Civil program:

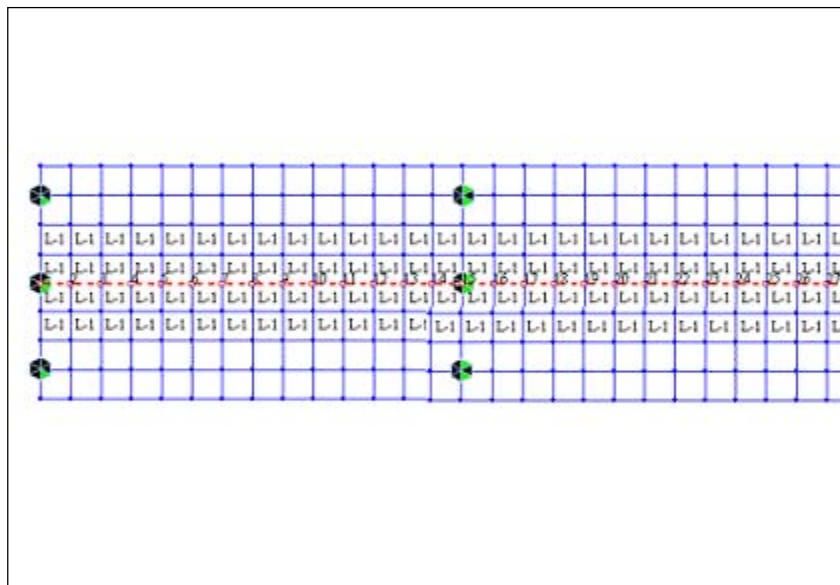
Modeling procedure



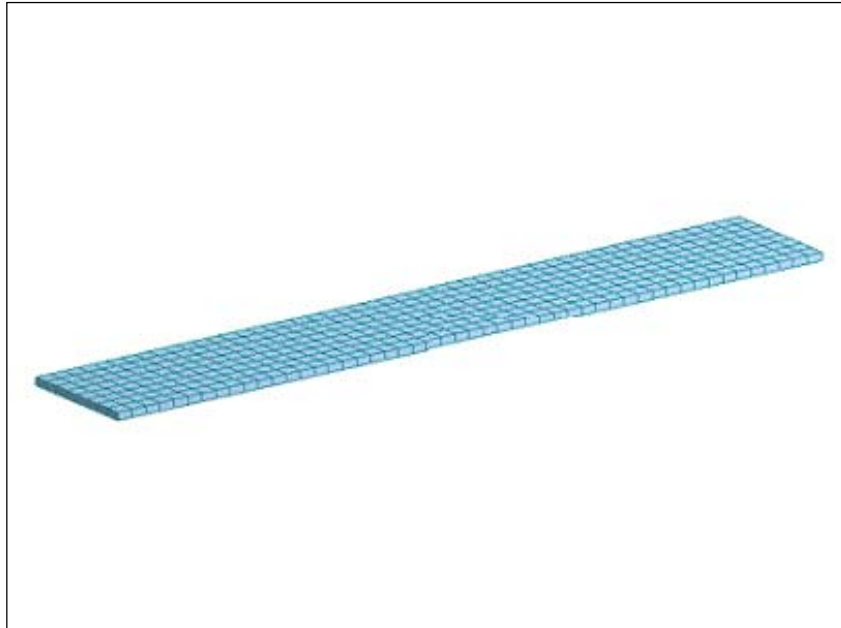
<Step 1> Generate the slab bridge using plate elements



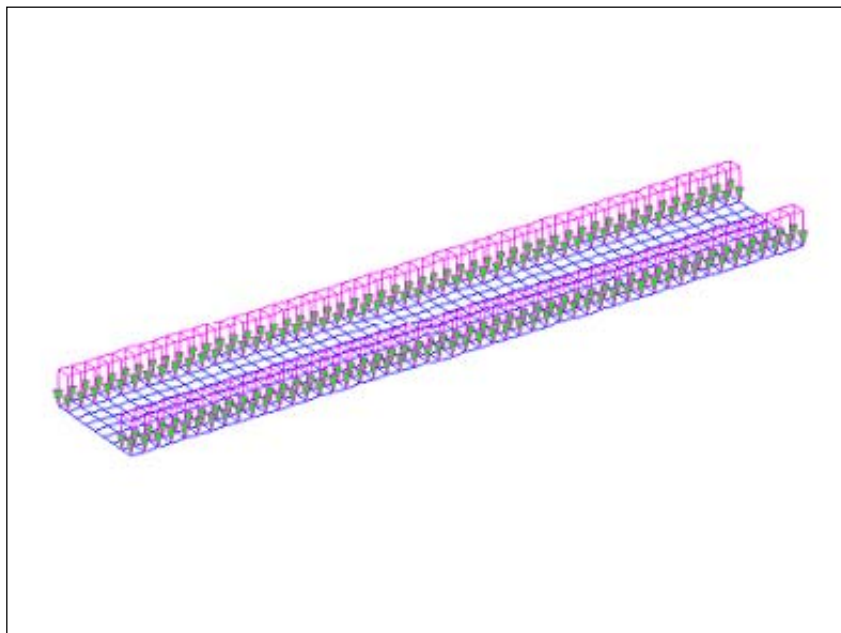
<Step 2> Enter the support boundary conditions of the bridge



<Step 3> Enter the influence surface by assigning the traffic surface lane

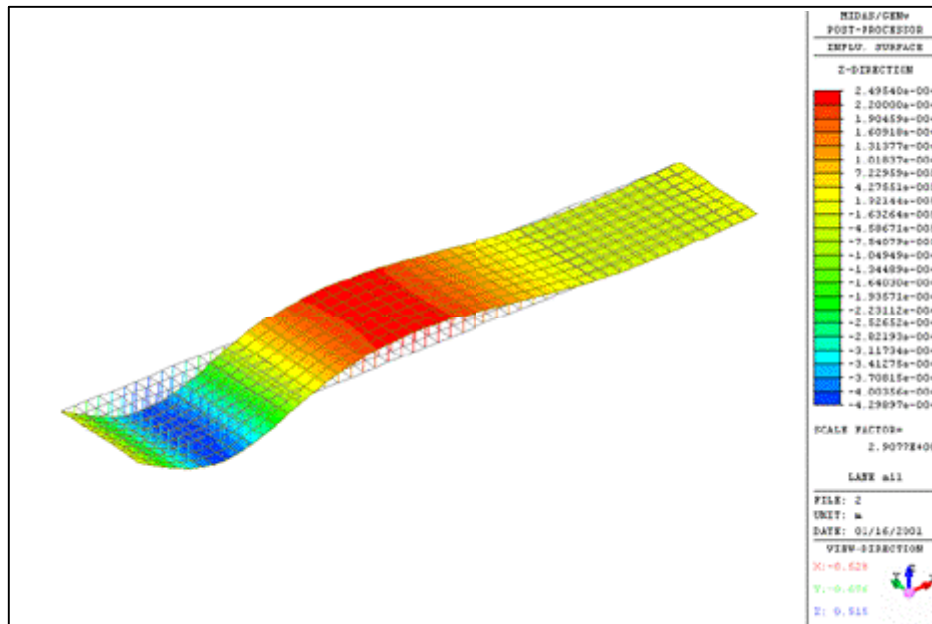


<Step 4> Completed model of the slab bridge

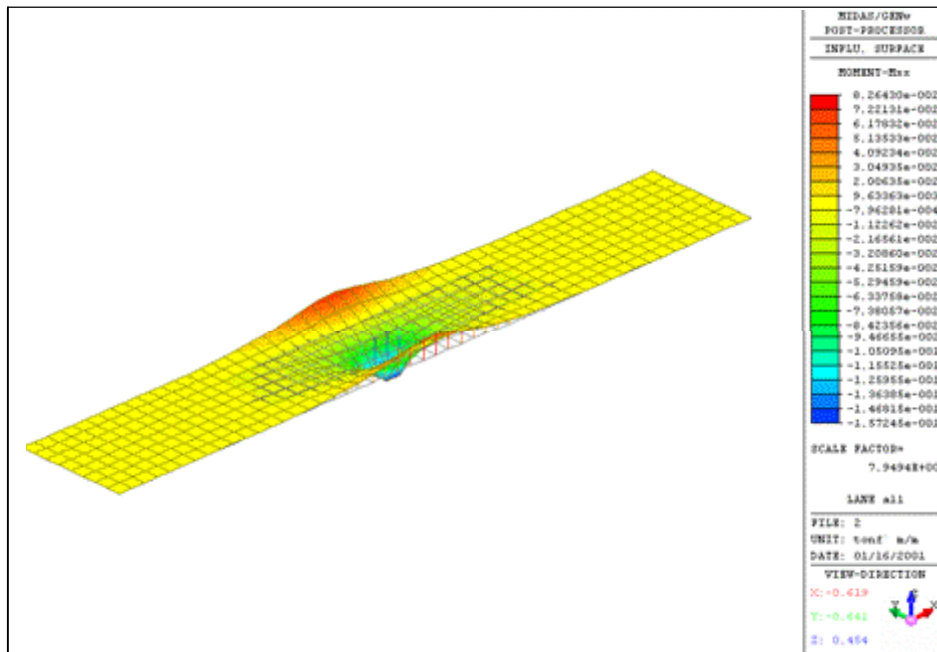


<Step 5> Enter additional load conditions

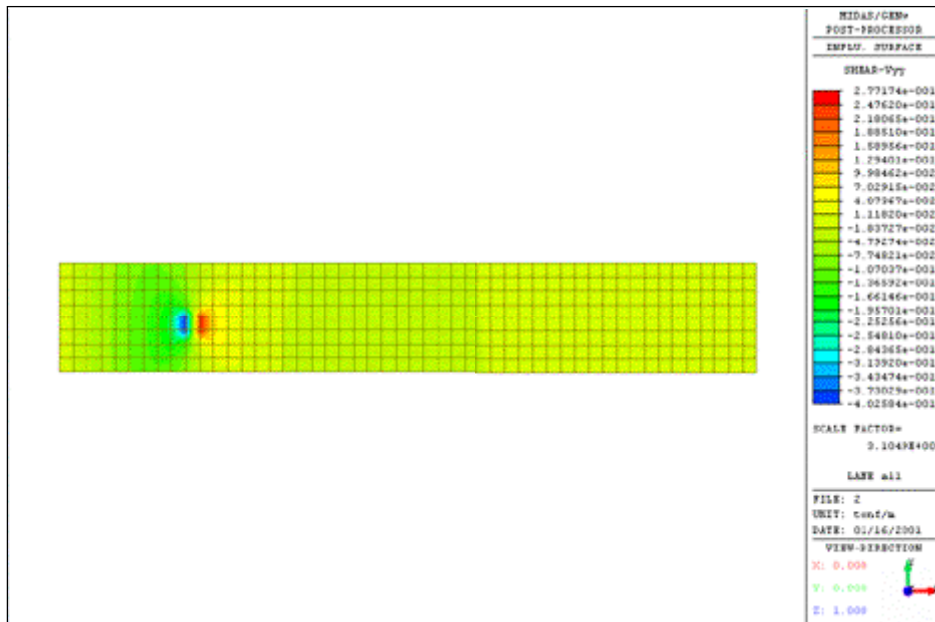
Analysis results



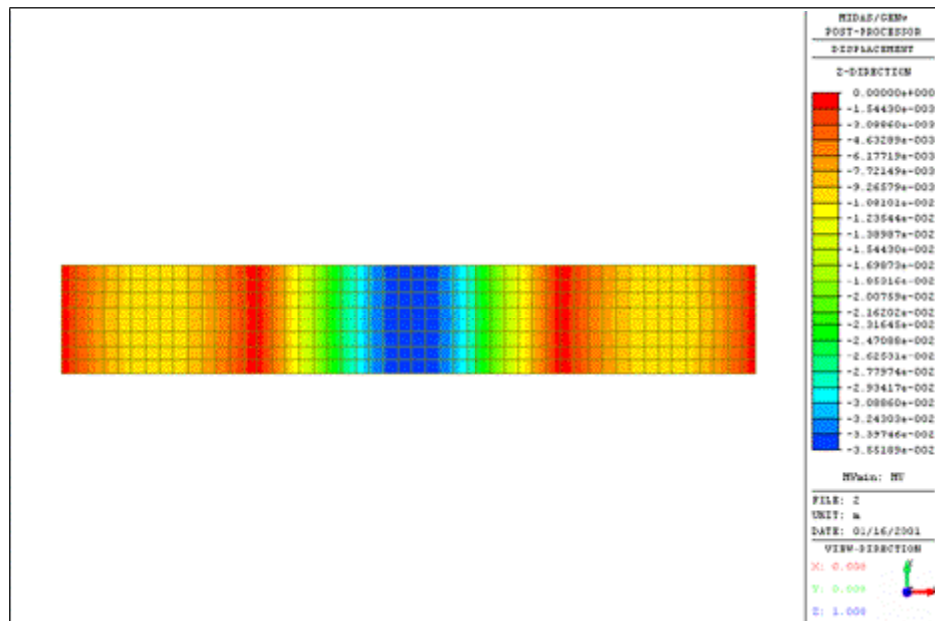
<Step 1> Influence surface of the displacement at the center of the first span



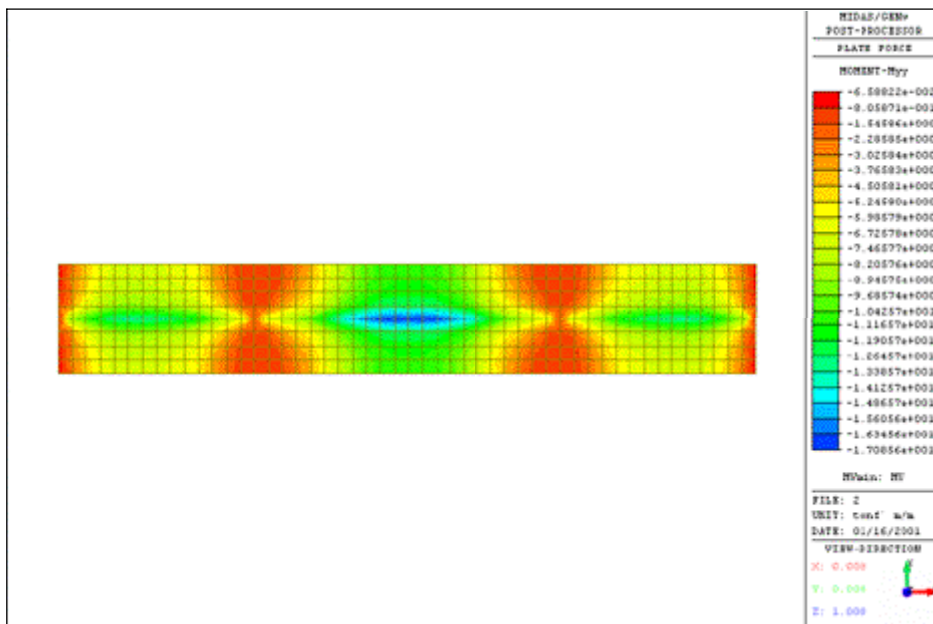
<Step 2> Influence surface for moment (Mxx) at the center of the second span



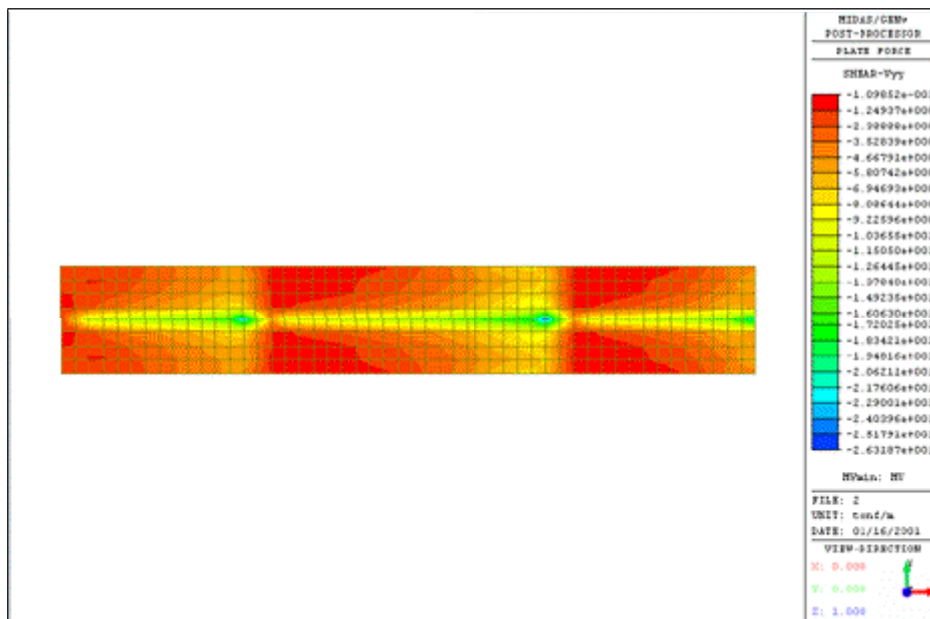
<Step 3> Influence surface for shear (Vyy) at the center of the first span



<Step 4> Maximum displacement caused by the moving traffic load



<Step 5> Maximum moment (Myy) caused by the moving traffic load



<Step 6> Maximum shear (Vyy) caused by the moving traffic load