INTEGRATION OF GID WITH A TENSION STRUCTURE COMPUTER ANALYSIS PROGRAM USING ADA95

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Abstract. *The use of structures built with metallic masts, high resistance cables and synthetic fabric for different purposes has had a quite significant growth. The research goal was the integration of Membrane, Lights and GiD programs for preliminary geometry and tension analysis of the Community Center roof at the Universidade de Brasília because although the program Lights solves problems faced by other systems in structures analysis with finite displacements, it doesn't have pre and post processing methods. GiD was a program made for this purpose, using systems developed by the user. The programs Membrane, Lights and GiD were integrated using Ada95, making it possible to exchange files and results among these programs, besides the graphic visualization in GiD of the tensions and displacements calculated. A manual was created with an example step by step which includes all these integration possibilities. The obtained results with static wind load and pre tensioning show how important it is to know the parameters that define the membrane mechanical characteristics to be used and how complex is the analysis of this type of structure. To evaluate properly the effects of the wind, it is necessary to make wind tunnel tests. The results analysis of the Community Center was not very accurate due to lack of information about the materials used in the construction and a detailed project.*

1 INTRODUCTION

The use of structures built with metallic masts, high resistance cables and synthetic fabric, called tensioned fabric structures, had a reasonable growth in the last decade of the 20th century. Constructions for different purposes were built with this technology. This structural type has important advantages, such as: it allows large spans, has low self weight, it can be easily produced, transported and assembled.

A tension structure project is usually divided in three parts: shape finding, cutting pattern and structural analysis. The membrane final shape is the result of architectural design and structural studies considering the following loads depending on the case: pre stressing, wind, snow, self weight and accidental loads.

To have a lasting and stable tension structure, the membrane must be always prestressed, guaranteeing an anticlastic surface. To be able to make a good project, the tension-deformation relation of the material has to be tested if it is not already known.

2 GOAL

The research goal was the integration of Membrane, Lights and GiD programs for preliminary geometry and tension analysis of the Community Center roof at the Universidade de Brasília because although the program Lights solves problems faced by other systems in structural analysis with finite displacements, it doesn't have pre and post processing methods. GiD was a program made for this purpose, using systems developed by the user[i,ii].

3 INTEGRATION OF PROGRAMS USING ADA95 AND RESULTS

Membrane, Lights and GiD were integrated through the development of smaller programs called GiDLights, GiDMembrane and MembraneLights and the adaptation of the program Lights into LightsGiD using Ada95[iii], making it possible to exchange files and results among these programs.

Lights[iv] is a program that calculates and allows the analysis of tension structures using finite element method, including the membrane, cables and frame elements. The stable equilibrium configuration of the structure is calculated by minimizing the total potential energy with Quasi-Newton method[v].

LightsGiD is a version of Lights with procedures developed in this research that calculate, organize and create files with necessary data for graphic visualization of tensions and displacements results in GiD.

With the basic geometry data of the structure that is going to be studied, it is possible to make the contour drawing in GiD pre process mode or to import the drawing from another program. Then inside GiD a three node triangle finite element mesh is generated and exported.

If only the initial shape is desired, with GiDMembrane program the input file for Membrane is created. After running Membrane, the results can be seen in GiD post process mode.

When a satisfying shape is found, with MembraneLights program it is possible to create one of the input files for LightsGiD, which can load the structure with different combinations.

LightsGiD may also include cable and frame elements, and not only membrane, in the analysis according to the needs of the project. The results from this program may be seen in GiD post process mode.

Another possibility is to use the program GiDLights to make one of the input files for LightsGiD right after generating the mesh in GiD.

If only part of the mesh is generated at first and then mirrored (Fig. 1), it is recommended to use GiD version 8.0 or the latest one available because these newer versions maintain the normal vector of a mirrored mesh in the same direction of the original mesh. The older versions reverse the direction of the normal vector when a mesh is mirrored, causing problems when loading the structure.

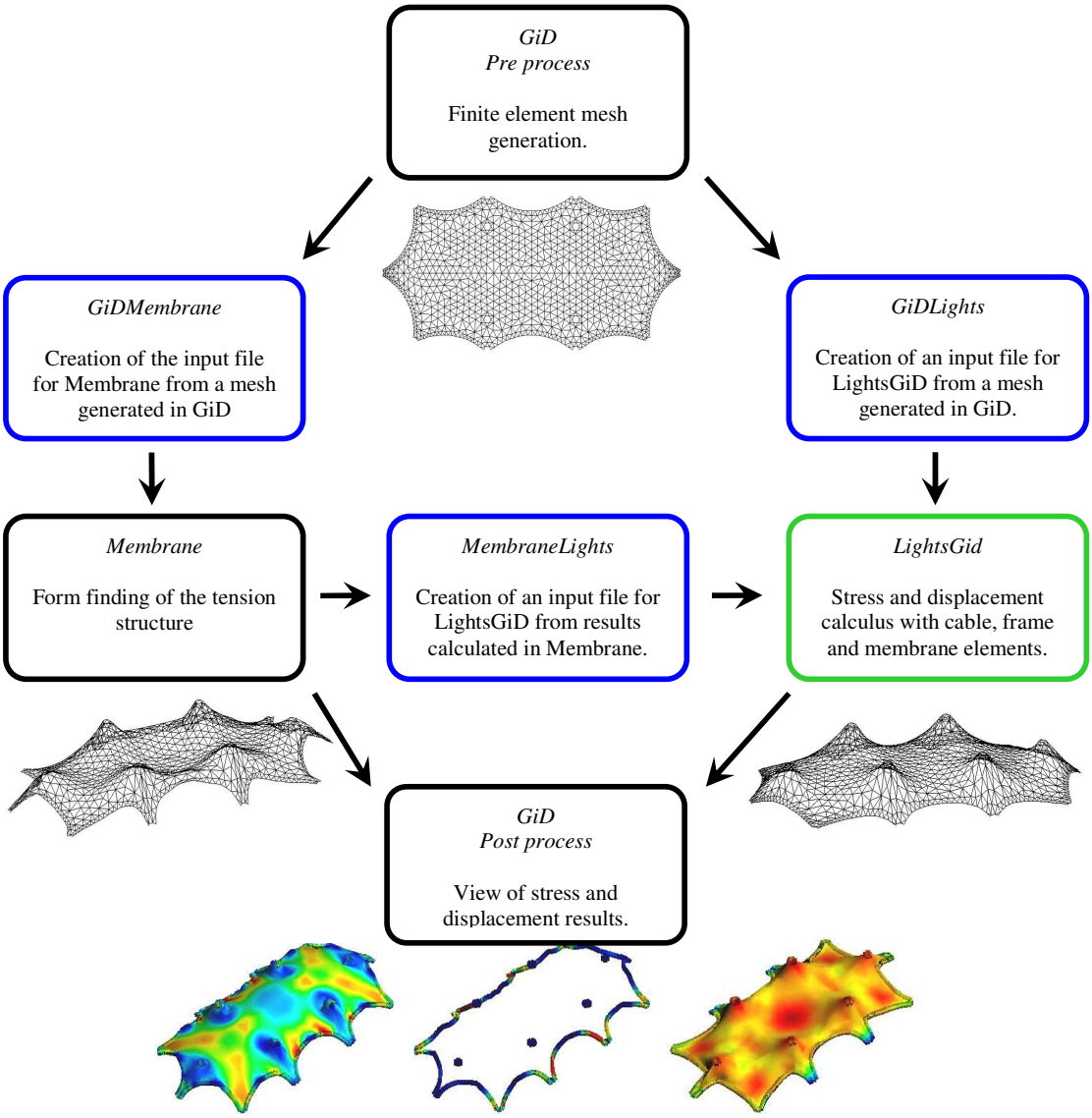

Figure 1: Scheme of the developed (blue) and modified (green) programs with examples of results[vi].

This routine with all the programs was tested with simple examples of tension structures, steel towers with cables and with a tension structure built for events at the Universidade de Brasília called Athos Bulcão Community Center. The graphics shown in figure 1 are from the analysis of this structure in Brasília.

During the studies of this specific case, loads were distributed on all membrane elements to simulate a static wind load of 75 kgf/m^2 in each direction. After that, the cables were stressed to search for a configuration without compressed membrane elements.

A manual was created to make it easier to use these programs with an example step by step which includes all these integration possibilities. The master thesis[vi] presented with this work also includes a CD with examples and source codes of the programs.

4 CONCLUSIONS

The obtained results with static wind load and pre tensioning showed how important it is to know the parameters that define the mechanical characteristics of the membrane to be used and how complex is the analysis of this type of structure. To evaluate properly wind effects it is necessary to make wind tunnel tests.

The results analysis of Athos Bulcão Community Center tension structure was not very accurate due to lack of information about the materials used in the construction and a detailed project.

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