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Structural Parametric Modeling And Analysis Of A Ship Stiffened Deck Plate Based On The Patran Command Language

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Abstract. As a numerical calculation method in math, Finite Element Analysis (FEA) has been imported into the structural analysis field for more than 30 years. MSC. Patran was launched by the MSC Corporation into the field as a pre-processing and post-processing module of FEA, its strong potential of secondary development has played an important role in the structural parametric modeling analysis. Patran Command Language (PCL) is the built-in language of MSC. Patran. In this paper, in order to introduce PCL's theory and using method, the author created a GUI by PCL which contains a lot of response functions in a ship stiffened deck plate project.

Introduction

In the recent years, the Finite Element Analysis (FEA) Method has been the dominant method in the structural analysis field. Many countries have developed their own FEA software. As one of the most famous FEA program in the world, MSC.Nastran has a very long history .In its initial years, it has been used by NASA for strengthening the nation defense of USA. However, it is widely used in many fields now, such as machinery aerospace, automotive, bridges, ships, weapons, railway, and materials. The numerical calculation result of MSC.Nastran is accurate and stable. In order to develop the efficiency of FEA, MSC Corporation launched MSC.Patran. As the pre-processing and pre-processing platform for MSC.Nastran, MSC.Patran is easy to learn and use, it constitutes a complete Computer Aided Engineering (CAE) simulation system with MSC.Nastran.

A very huge potential of the secondary development makes MSC.Patran become the most famous Graphical User Interface (GUI) software in the domain of the CAE. By the Patran Command Language (PCL), which is the built-in language of MSC.Patran, users can finish their tasks more efficiency. Similar to C language and Fortran, PCL is easier than them. It does not have complex modules, such as the pointer and the struct of the C language, which is an advantage of PCL. In order to satisfy the requirements of different kinds of projects, program codes can be written in PCL by users to accomplish some repeated and tedious operations. Also, users can customize their own GUI, which can make more people take part in the task; the cycle of the project will be shortened.

In this paper, an example of structural parametric modeling and analysis on a stiffened deck plate will be used to introduce the theory and method of the secondary development by PCL.

The Theory and Method of the Secondary Development of PCL

The summary of PCL and its function compilation. As the built-in language of MSC.Patran, PCL is very similar to C language and FORTRAN, users who have the basic knowledge of C language and FORTRAN can use PCL skillfully. Each operation in MSC.Patran by users can be realized in PCL language.

Besides some basic math functions, PCL also own many built-in functions, such as modeling functions, mesh functions, load cases functions and post-processing functions, which have played an important role in FEA. Many manuals of PCL[3,4] published by MSC Corporation will be referenced, which help users to compile their own can function by the built-in function of PCL.

With the help of the "!!input" command which is used in the command line of MSC.Patran, functions that complied by users can be imported into the FEA model database. After the process, users can call functions directly. It is also allowed to compile the text format function to the binary format, which will generate a file suffixed by ".plb", the file suffixed by ".plb" has less space usage than the text file. The file suffixed by".plb" can be imported by the "!!library" command into the FEA model database.

In the installation root directory of MSC.Patran, a file named "init.pcl" will be executed firstly when MSC.Patran is opened by users. In this file, there is a vital code which its content is "!!input p3epilog.pcl NOERROR" will exist. Users can type "!!input user_function.pcl" or "!!input user_function_database. plb" into the file named "p3epilog.pcl",which will import functions into the FEA model database. When this method of import functions is used by users, the functions that compiled by users will be imported firstly when MSC. Patran is opened.

Customize the GUI (Menus, Windows) by the secondary development. A lot of FEA software grants users the secondary development function and invokes them to solve problems efficiently. However, users cannot solve all kinds of problem by compile functions using PCL. Users may be confused by massive PCL functions in some huge projects. In order to solve the problem, GUI is the best choice. By using PCL built-in functions, users can customize their own GUIs. A GUI consists some elements, such as menu, form or databox. Some built-in functions of PCL can create these elements. For example, a menu can be created by the built-in function "ui_menu_create()". Other GUI functions such as "ui_form_create()", "ui_databox_create()" are similar to "ui_menu_create()",users can obtain some introductions in PCL manuals[1,2]. The size of GUI can be decided by users, the numerical size (in inches) can be input by users in function codes. In harmony with the MSC.Patran built-in GUIs' style, users can use a file named "appforms.p" in the "customization" directory which exists in the installation root directory of MSC.Patran. Only "#include appforms.p" is added in the first line of the codes, users compile the PCL codes by "cpp.exe", which will generate a file suffixed ".cpp", the MSC.Patran built-in GUIs' style will be create in the file.

There are some codes in the example of structural parametric modeling and analysis on a stiffened deck plate:

```
CLASS Parametric_Modeling      /* Create the Class of Parametric Modeling */
FUNCTION init()                /* the init() function is essential in a GUI */
WIDGET menubar,menu       /* Define the variable of menu */
menubar = uil_primary.get_menubar_id()
menu = ui_menu_create(menubar ,"deckcsh_menu"," Parametric_Modeling ")
ui_item_create(menu,"CP_1","Modify 1D Elements Properties", FALSE)
ui_item_create(menu,"CP_2","Modify 2D Elements Properties", FALSE)
ui_item_create(menu,"CP_3","Analysis", FALSE)
ui_item_create(menu,"CP_4","Post-Processing", FALSE)
END FUNCTION
FUNCTION deckcsh_menu()   /* The response function of the menu */
…………..
END FUNCTION
```

There are some codes which will generate a GUI Window in the example:

```
#include "appforms.p"  /* In order to create the MSC.Patran GUIs' style */
CLASS property_1D    /* The Class of the window in the GUI*/
CLASSWIDE WIDGET form_id,mat_lb,sec_lb,oneDname_lb
CLASSWIDE string beam_pro_n[31]
FUNCTION init()
……………  /* The init() is essential and used to create the window */
END FUNCTION
FUNCTION display()
……………  /* The display() is essential and used to display the window */
```

END FUNCTION
FUNCTION response()
…………… / The response() is the core response function in the window */*
END FUNCTION
END CLASS

In this section, some methods about the GUI secondary development are introduced; users can refer the codes and modify their own codes, which will create their own GUIs.

The core response functions in a GUI. In a GUI created by users, the core sections are response functions. The GUI style can be modified easily, but the core response function is only compiled by users. Users who compile core response functions should have a whole and deep understanding of processes in the project, which will cost lots of time to look up PCL manuals. Modifying session files of MSC.Patran is a very effective way, which can be used in some repeated and tedious operations.

The Example of Structural Parametric Modeling and Analysis on a Stiffened Deck Plate

In order to introduce the secondary development of PCL, the author customized a GUI which contains both parametric modeling and FEA analysis. In the project, 80.0 N/mm2 pressure is applied on the top face of the stiffened deck plate. The deck is modeled by four-node shell element, and stiffness is modeled by two-node beam element. The length and width of the deck, total number of stiffness, and model boundary conditions are constant. The thickness of deck and the shape of cross section of the stiffness are design variable. Von Mises stress and intrinsic frequency are significantly concerned. For these reasons, the author developed the GUI which contains four parts:

Modify 1D Elements Properties
Modify 2D Elements Properties
Analysis
Post-Processing

The first part is used to modify the cross section of 1D beam elements; the second part is used to modify the thickness of 2D shell elements; the third part is used to submit both static analysis and normal modes analysis, the final part is used to show the fringe pictures and output reports.

The detailed description of the example is shown in the following pictures:

The FEA model is shown in Fig.1.

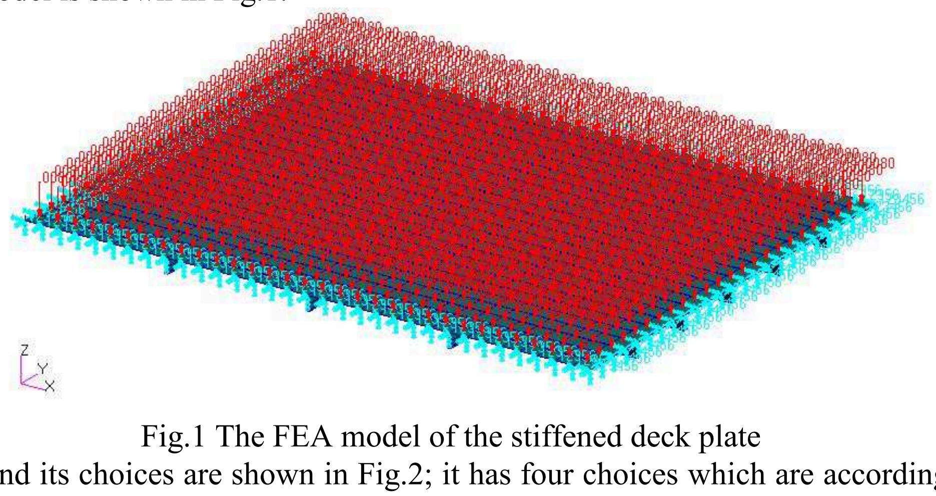


Fig.1 The FEA model of the stiffened deck plate

The menu and its choices are shown in Fig.2; it has four choices which are according to the four parts of the GUI.

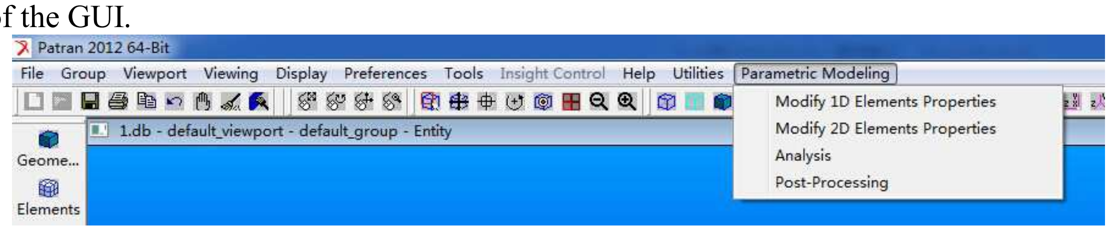
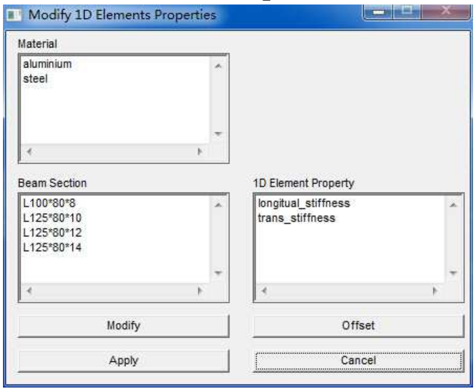


Fig.2 The menu part

The function of modifying 1D elements properties is shown in Fig.3, by selecting the 1D elements property names, users can modify the material and the shape of cross section. In order to simulation the real condition of the deck plate, the function of adjusting the stiffness offset is essential.



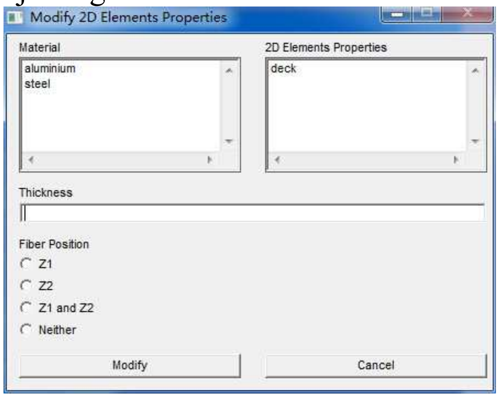
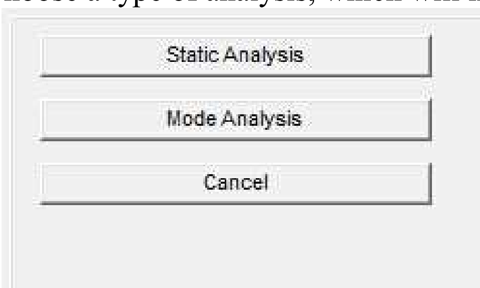


Fig.3 Modify 1D Element Property Fig.4 Modify 2D Element Property

The function of modifying 1D elements properties is shown in Fig.4, by selecting the 2D element property names, users can modify the material and input the thickness of shell elements. In order to obtain the surface stress of shell elements, the author added the function to adjust the calculation stress position of shell elements.

According to the third part of the GUI, the analysis part is shown in Fig.5. The part contains two kinds of structural analysis, one is static analysis, the other is normal modes analysis. Users can click a button to choose a type of analysis, which will invoke MSC.Nastran to calculate the FEA model.



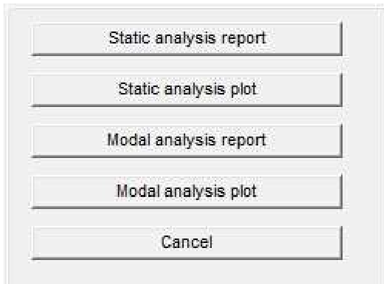


Fig.5 Analysis Part Fig.6 Post-processing Part

The post-processing part is shown in Fig.6. After access the result into MSC.Patran, Users can get the plots and also can get result reports of the model.

Conclusion

In this paper, the author used an example to introduce the theory and method of secondary development in MSC.Patran by PCL. As an advanced language, PCL is easy to learn and use, users can compile their own function codes or customize their own GUIs. Nowadays, structural parametric modeling is widely used in the FEA field; people can improve their efficiency by using PCL in their tasks, which will make a contribution to the whole domain of FEA.

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