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THE ADVANTAGE OF USING A FILE DATA TRANSFER METHOD IN A PLANT DESIGN

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ABSTRACT

In general, there are two methods to pass on design information in a petrochemical plant design: the manual data key-in method and the file data transfer method. The manual data key-in method is a basic method to pass on data; but this method is time consuming to assign data in one by one fashion. The file data transfer method is a mapping file data from one program to another program under certain specific function and criteria.

This paper starts with how to use a file data transfer method to create a stress analysis model, and then proposes an approach to transfer the stress analysis result to a structural analysis program by using the Pipe Loadings Transfer Program.

In a piping design using 3D plant design software for modeling, the piping design information can be directly transferred to the stress input file by using point vectors to create a stress analysis model. The concepts of a pipe support vector and a beam vector were introduced to transfer the pipe loadings from stress analysis results to a structural analysis program.

The advantages of using a file data transfer method are simple, fast, and accurate.

INTRODUCTION

A large amount of data will be generated in a petrochemical plant design, these data flow from one engineering department to another in order to fulfill the project requirement as shown in Fig. 1. The method of conveying design information can be divided into two categories: the manual data key-in method and the file data transfer method. The manual data key-in method is a basic method to pass on data; but this method is time consuming to assign data in one by one fashion. On the other hand, the file data transfer method is to map data from one program to another through data files under certain specific function and criteria.

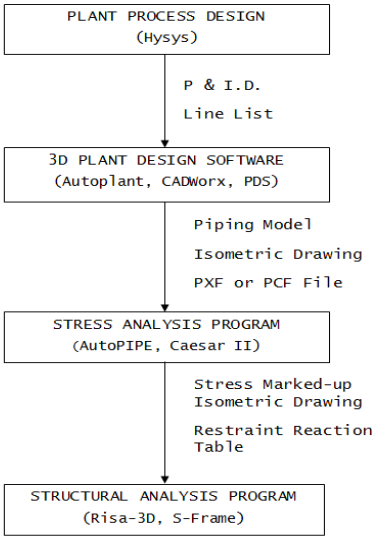


FIG. 1. ENGINEERING DESIGN DATA FLOW

The drawback of using manual data key-in method is obvious. For example, a piping stress engineer carries out the stress analysis based on isometric drawings to manually generate a stress model; usually a huge amount of data need to be input during the transfer process which may cause a bottleneck on the project. In the meantime, a structural engineer after receiving the stress marked-up isometric drawings often struggles to find out where are the pipe support locations on the structure. The structural engineer may spend a lot of time to go through pages of stress marked-up isometric drawings and the related restraint reaction tables to look for the piping forces for each pipe support. Also, these forces have to be re-input manually to a structural analysis program. This tedious work has to be repeated again and again for every pipe support in the structural system. More importantly, the manual data key-in method is prone to errors.

In recent years, several commercial software developers apply the file data transfer method to create a stress analysis model with a success [1, 2]. In regarding transferring pipe loadings to a structural analysis program, to the author's best knowledge, only Bentley [1] has made some development. Bentley proposed a method to perform piping stress analysis and to obtain pipe support loadings on a structure model at the same time. An example is shown in Fig. 2. However, the proposed method has not been commercially adopted by industry due to following limitations:

- Pipe ends on each line were modeled by full anchors. Because the full anchor conditions are not easy to define, the stress analysis on this model cannot provide a meaningful solution;
- The complexity and difficulty of managing design data will increase sharply as numbers of lines data increase in the model;
- The complicated procedure in switching the analysis between the piping stress analysis and the structural analysis, as well as the uncommon workflow contribute to a limit use on this method.

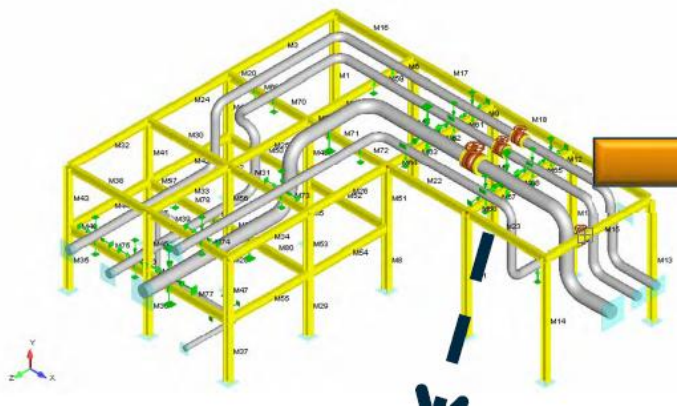


FIG. 2. BENTLEY MODEL

In real industrial practice, a piping system based on the process design has its own characteristics and function, the piping stress analysis shall be carried out separately for each piping system to achieve the piping flexibility as required by piping codes, projects and equipment vendors. Consequently, the piping loading data on the structural model are the collections of loading data from many stress analysis systems. What is the best way to transfer these loading data to a structural analysis program? This paper shows a systematic data transformation from a piping stress analysis to a structural analysis program.

In following, we first introduce how to use a file data transfer method to create a stress analysis model. And then, how to seamlessly and easily transfer the stress analysis result to a structural analysis program by using the Pipe Loadings Transfer Program is addressed. The User's Guide of this program is listed as reference [3].

STRESS ANALYSIS MODEL

In a piping design using 3D plant design software for modeling, the location of every model point is determined by its coordinates in a plant space, for that reason, each set of point coordinates is represented by a point vector for every element. Based upon process requirements, piping designers develop the piping model with all required piping data such as line number, length, material, flange rating, pipe size, pipe supports, valves, insulation thickness as well as the weight of piping components. These information can be directly transferred to the stress input file by using point vectors and by means of a PXF [1] file or a PCF [2] file. A stress analysis model produced from these file data shall obtain all exact information associated with the point vector as laid out by piping designers as shown in Fig. 3.

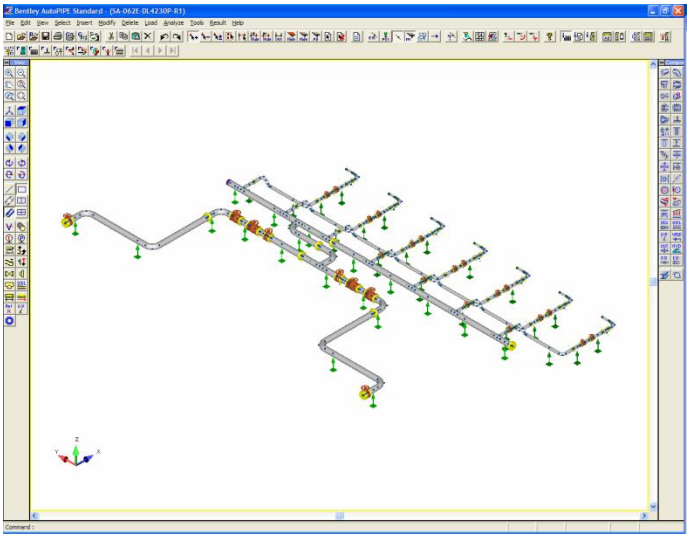


FIG. 3. STRESS MODEL CREATED FROM PXF FILE

The method of using a PXF file or a PCF file to create a stress analysis model is quick and error-free. The benefit to the project is significant, as time-saving in stress modeling means quicker to confirm the piping design to be satisfactory and faster to deliver piping loadings to the structure engineering department. All these will contribute to a shorter project schedule as well as a lower engineering cost.

PIPE LOADINGS TRANSFER PROGRAM

The Pipe Loadings Transfer Program transfers an output file data from piping stress analysis to an input data file of a structural analysis program. The program flow chart is shown in Fig. 4.

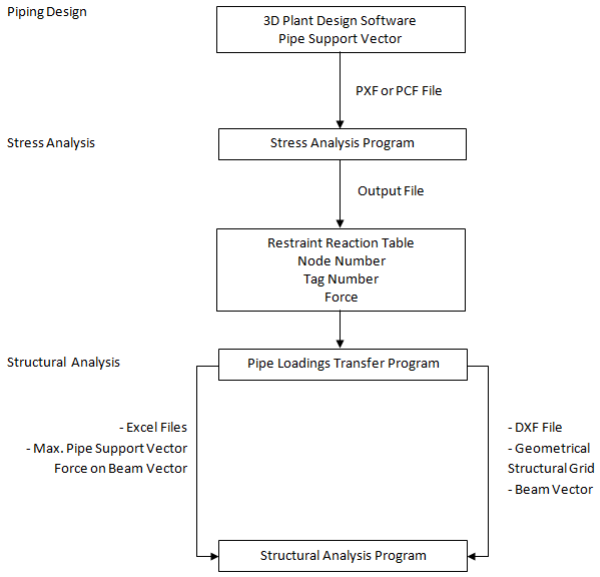
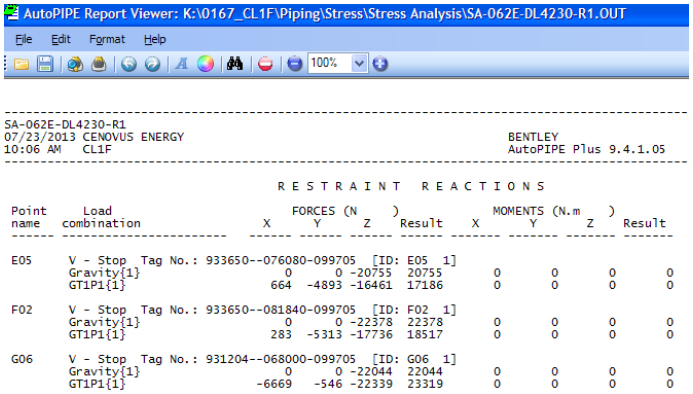


FIG. 4. FLOW CHART OF PIPE LOADINGS TRANSFER PROGRAM

The concepts of a pipe support vector and a beam vector are employed in the Pipe Loadings Transfer Program. They are the key of the success of the file data transfer method. First, piping designers locate a pipe support with a tag number to identify the pipe support coordinates as a pipe support vector; then this tag number is picked up by the plant design software in a file export menu of a PXF file or a PCF file. When a stress analysis program opens a PXF file or a PCF file, it will treat this tag number as the name of a pipe support vector. The analysis results of a stress analysis program then assign a restraint node number with the tag number, and the forces of a pipe support in a restraint reactions table as shown in Fig. 5. All these information for a pipe support will form a unique database system and the file data contained in this system unit can be manipulated in later analysis.


AutoPIPE Report Viewer: K:\0167_CL1F\Piping\Stress\Stress Analysis\SA-062E-DL4230-R1.OUT

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10:06 AM CL1F AutoPIPE Plus 9.4.1.05

R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (N) X	Y	Z	Result	MOMENTS (N.m) X	Y	Z	Result
E05	V - Stop Tag No.: 933650--076080-099705 [ID: E05 1]								
	Gravity{1}	0	0	-20755	20755	0	0	0	0
	GT1P1{1}	664	-4893	-16461	17186	0	0	0	0
F02	V - Stop Tag No.: 933650--081840-099705 [ID: F02 1]								
	Gravity{1}	0	0	-22378	22378	0	0	0	0
	GT1P1{1}	283	-5313	-17736	18517	0	0	0	0
G06	V - Stop Tag No.: 931204--068000-099705 [ID: G06 1]								
	Gravity{1}	0	0	-22044	22044	0	0	0	0
	GT1P1{1}	-6669	-546	-22339	23319	0	0	0	0

FIG. 5. RESTRAINT REACTIONS TABLE

The Pipe Loadings Transfer Program has the capability to build a DXF file for a structural frame, and to assign beam numbers in a form of beam vectors for a structure as shown in Fig. 6. For a given beam, the coordinates at a start point with a beam direction are represented as a beam vector of a piping frame. This will be accomplished by filling in the origin of a structural frame at its X, Y and Z coordinates and the increments of the structural grid in the eastward, or northward and the elevation respectively as shown in Fig. 7. This program has a unique feature to link pipe support vectors to a beam vector; accordingly, this program has the ability to group all pipe support loadings, which belong to a beam, to form the beam loadings. Because the format of a beam vector is similar to the format of a pipe support vector, once an individual beam is chosen, then the elevation and the direction of the beam are determined. Those pipe support vectors with the same elevation and the same directional coordinate along the beam can be linked together as a pipe support vector group based on a beam vector, and the loadings of these pipe supports become the beam loadings.

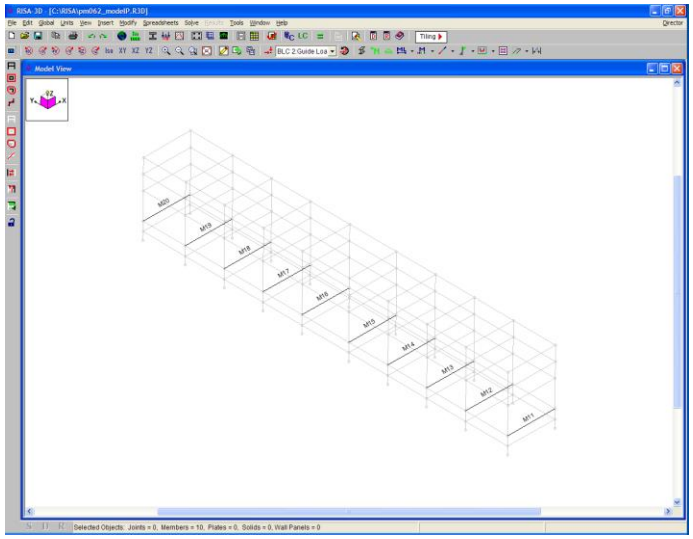

FIG. 6. A STRUCTURAL FRAME CREATED FROM A DXF FILE WITH BEAM NUMBERS

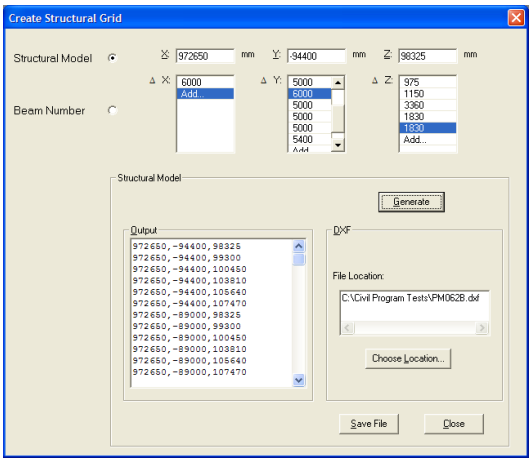

FIG. 7. STRUCTURAL GRID AND BEAM NUMBER GENERATOR

The structural analysis program [4, 5] has the Excel format for inputting point loading data, and the location of point loadings along a beam which are determined by ratios of the support distances divided by the full span length of a beam. The Pipe Loadings Transfer Program has the ability to sort the maximum loading for pipe support loadings under different design and operating conditions from the stress output files, and to store the loading data in according to the structural loading input format. As a result, the piping support loadings from stress analysis output files can be precisely transferred to a structural program by using the copy and paste method as shown in Fig. 8.

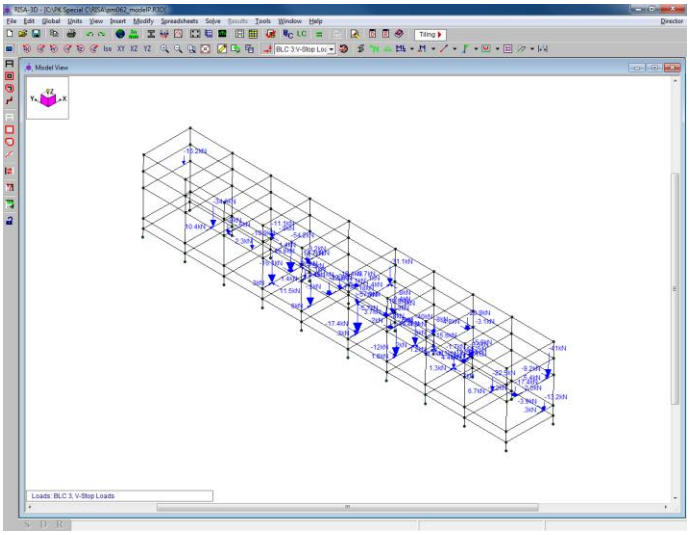

FIG. 8. PIPE SUPPORT V-STOP LOADINGS TRANSFERRED TO A STRUCTURAL FRAME

The Pipe Loadings Transfer Program is the most efficient method to transfer the pipe support loadings from stress analysis results to a structural analysis program. Only a few of simple copy and paste steps can transfer hundreds or thousands of pipe support loadings to a structural program. The time required to input pipe support loadings to a structural program will be drastically reduced.

CONCLUSIONS

The file data transfer method eliminates tedious manual work to streamline the design data flow in order to save engineering time and reduce errors during the data transfer process. This will improve scheduling on a plant design and reduce the engineering cost.

- It is time-consuming in a manual data key-in method by transferring a large amount of design data manually from one engineering department to another department;
- The use of a PXF file or a PCF file to create a piping stress analysis model will obtain all exact information as modeled by piping designers;
- The Pipe Loadings Transfer Program is developed to build an unique database in order to satisfy the requirement of the pipe loading input data for a structural analysis program;
- The concepts of a pipe support vector and a beam vector were introduced to make the cross-functional data manipulation possible.

A series of projects [6] have employed the file data transfer method and proved that this method is reliable and applies the most advance technology in a plant design. The advantages of using a file data transfer method are simple, fast, and accurate.

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