STRUCTURAL ANALYSIS PROGRAM OF PLANE FRAME WITH VISUAL BASIC LANGUAGE

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ABSTRACT

Adjustment of curriculum with the development of science and technology has spurred efforts to improve the learning system available today. One effort to achieve specific targets in the improvement of learning systems is through create a structural analysis program (ANSTRUK). This application program has an advantage in teaching and learning, so students are easier to perform structural analysis. In addition, this application program can be used by practitioners involved in the planning structure to support civil infrastructure development.

KEY WORDS: learning system, structural analysis, plane frame, visual basic

1. INTRODUCTION

Structural analysis is a subject commonly found in civil engineering. Based on results of evaluations so far, students have had less interest to this subject because usually it consists of long procedure of calculation and tedious. However, this subject unavoidably should be mastered as a required subject. Beside that, it is difficult for beginners who areanalyzing a structure to imagine the shape and type of analyzed structure without its visualization. Another obstacle is limited time of meeting to finish up tasks given in class, even though computer and LCD projector have been used.

Along with curriculum adjustment to science and technology, those obstacles have encouraged to improve the available learning system. An effort to achieve a particular target in improving learning system of structural analysis is by creating application program of structural analysis to make the learning process is more effective and efficient. This application program prioritizes the students' learning process become easier to meet the allocated time.Later, this application program also can be used by people who are involved in structural design.

In this article, the author briefly explains about the results of the making of this program called "ANSTRUK". This program has been made since 2007. There are six types of structures can be solved using stiffness method. For this part, the author particularly looks at case example of Plane Frame.

2. LITERATURE REVIEW

1. Structural Analysis

When choosing structural analysis method, several methods are commonly used. However, a method used in the making of this program is Stiffness Method.

Stiffness method (as also known as displacement method) is a method usually used in structural analysis with matrix. One of the advantages compared to flexibility method is can be programed easily in a computer. In load method, unknown load is included in redundant load chosen randomly. While in stiffness method the unknown is the diplacement of structural joints that are stated automatically. In other words, the amounts of unknowns in stiffness method are similar to indeterminacy of structural cinematic.

Stiffness method can be developed from equilibrium of joints written in stiffness coefficient and unknown displacement of joints.

Particular cinematic version of prior structure (by restraining the joints displacement) will be used to formulate balance condition as equilibrium of action (load) superposition.

In stiffness method, restrain actions are frequently needed due to many reasons. Therefore, some systematically arranged functions are needed based on loading cases for partial structural beams. These support functions can be found in tables of primary moments or edge loads for restrained beams.

For more complete explanation about this stiffness method can be studied in many text books, such as: Matrix Analysis of Framed Structures (Weaver, W.Jr and Gere J.M, 1980).

2. Visual Basic Programing Language
Programing language is basically instructions with specific compiled language rules and then understood by computers to do specific tasks. Until now, there are many programing language available.Assembly language, Fortran, Cobol, Ada, PL/I, Algol, Pascal, Basic, Prolog, LISP, PRG, also simulation language such as CSMP, Simscript, GPSS and so on.

Visual Basic Language is one of many programing languages that commonly used by programmers. Visual Basic is visual programing language using Basic language. Word "Visual" shows the method used in designing Graphical User Interface (GUI), by inserting fixed objects to the screen and the arrangement is done directly on the screen, visually. While word "Basic" stands for "Beginner's All-Purpose Symbolic Instruction Code". Basic is also a program based on programing language that previously was in DOS version and is one of the oldest programing languages in computer history. One of the reasons why the author chooses visual basic language is because it capable to work with huge numbers of variables.

3. The environment of Visual Basic 2005 Express Edition
When Visual Basic is run, figure 1 will appear. This screen is the development environment of Visual Basic 2005 Express Edition application that will be used later in creating application program for structural analysis.

Visual Basic screen is a huge environment consists of some parts with characteristics:

- *Floating*: can be moved to any positions. To move the element of Visual Basic screen, click and hold mouse on *little bar* of that element, and then move it to preferable position.
- *Sizeable*: the size is changeable, like change the size of window. To change the size of an element or window, click and hold mouse on the window border, and then move it to preferable position.
- Dockable: can be placed next to each other. For moving screen element of Visual Basic closed to other element, just put the edges of those elements next to each other, and they will be united automatically.
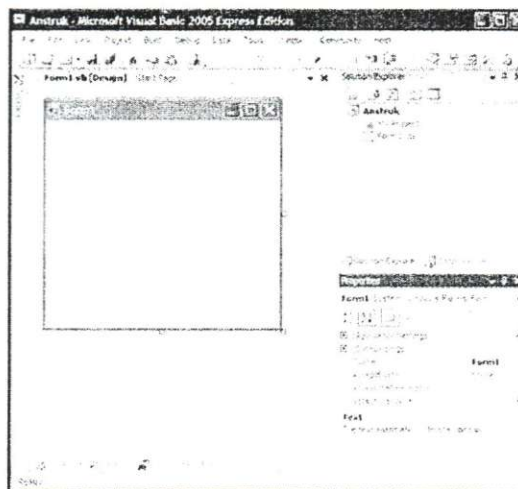

Figure 1. Visual Basic Program Appearance

A. Control Menu
Control menu is a menu primarily used to manipulate Visual Basic window. Using this menu, we can change size, move, or close visual basic or other windows. To activate this control menu, just click mouse on the left up side of window. Control menu will appear and can be found some options:

- *Restore*: change window size to the previous size
- *Move*: to move window position
- Size: to change window size
- *Minimize*: to minimize the window size
- *Maximize*: to maximize window size
- *Close*: to close window.

Visual Basic menu consists of all instructions of Visual Basic that can be chosen to do specific

task. Most of all contents of these menus are almost the same as other windows programs.

B. Toolbar

Toolbar is buttons represented special instructions from Visual Basic. Every button can be clicked to do particular instructions, usually these buttons are instructions that are frequently used and also can be found on Visual Basic menu.

Figure 2. Visual Basic Standard Toolbar

C. Window Form

Window form is primary work area to make Visual Basic application programs. On this form, we can put any interactive objects for example texts, pictures, instruction buttons, scrollbars, etc. Initially this window form seems small, but the shape can be changed according to application needed. When application program is run, everything inside the form will be shown on the *window* screen. This window from later will be appearance of application. Start with plain window form, and then added with many objects, and finally will become a complete Visual Basic application.

Figure 3. Window Form

D. Toolbox

Toolbox is a "tool box" consists of all objects or controls needed to create an application program. Control is an object that will be an interface between application program and user which afterwards put on that form.

E. Properties Window

Properties window is a window that consists of all information about object found in Visual

Basic application. Property is a characteristic of an object, like name, color, size, position, etc. each object mostly has the same property, but can be made differently (Rivani, A., 2009).

[a]   [b]
Figure 4. (a)Toolbox; (b) Properties window

F. Code writing with Visual basic language

Code/instruction writing cannot be separated from program creation. To make access easier and avoid unexpected mistakes, this program has been briefly written in interface form (Rivani, A., 2011).

This program has thousands of codes which are impossible to be shown in this article. Therefore, a cited code is given for this following scale (Rivani, A., 2009):

```
PublicSub SetDrawingScale()
Dim xMin AsDouble = 0
Dim xMax AsDouble = 0
Dim yMin AsDouble = 0
Dim yMax AsDouble = 0
Dim zMin AsDouble = 0
Dim zMax AsDouble = 0
bStr = 0
hStr = 0
zStr = 0
'Find max and min value
Dim j AsInteger
For j = 1 To ANSTRUKModel.ObjNodal._
        Nodal.Length
With ANSTRUKModel.ObjNodal.Nodal(j-1)
If xMin >= .X Then xMin = .X
If xMax <= .X Then xMax = .X
If yMin >= .Y Then yMin = .Y
If yMax <= .Y Then yMax = .Y
If zMin >= .Z Then zMin = .Z
```

```
If zMax <= .Z Then zMax = .Z
EndWith
Next j
    bStr = (xMax - xMin)
    hStr = (yMax - yMin)
    zStr = (zMax - zMin)
Dim Rect As Rectangle =_
AnstrukNameSpace.f_Child.ClientRectangle
    spasiX = CInt(80 / 2)
    spasiY = CInt(80 / 2)
    RectInf =AnstrukNameSpace. f_Child._
                ClientRectangle
    RectInf.Inflate(-spasiX, -spasiY)
'DRAWING SCALE
If hStr = 0 Then
    skalaX = (RectInf.Width) / bStr
    skalaY = skalaX
ElseIf bStr = 0 Then
    skalaY = (RectInf.Height) / hStr
    skalaX = skalaY
Else
    skalaX = (RectInf.Width) / bStr
    skalaY = (RectInf.Height) / hStr
EndIf
'APPLIED PROPORSIANAL SCALE
If skalaX > skalaY Then
        skalaY = CSng(skalaY)
        skalaX = skalaY
Else
        skalaX = CSng(skalaX)
        skalaY = skalaX
EndIf
EndSub
```
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3. OBJECTIVES AND ADVANTAGES OF RESEARCH

Several objectives as well as advantages of this article are:

1. Specific Objective:

   Creating structural analysis application program, so the learning process in structural analysis subject can be done effectively and efficiently.

2. General objective:

   Launching structural analysis application program thus can be used whether by students or by people those are involved in structural design, thus can support development of infrastructures.

4. APPLICATION METHOD

1. Program Flowchart

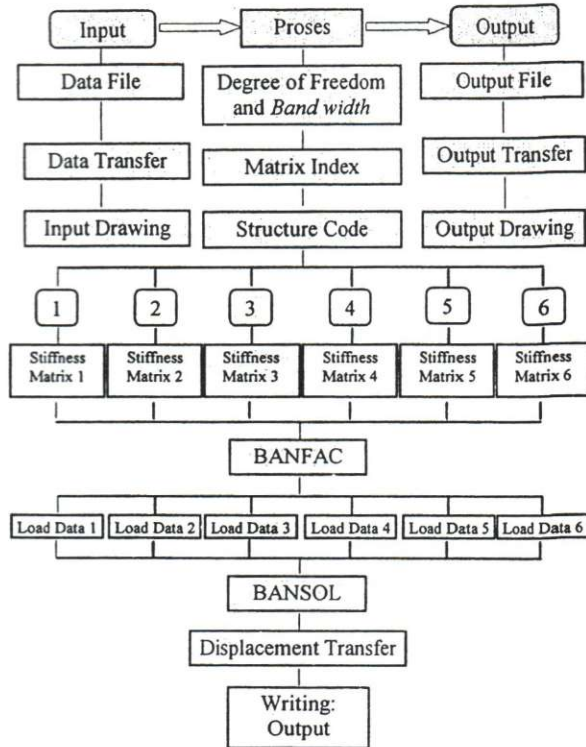The flowchart of ANSTRUK Program is as follow:

Figure 5. ANSTRUK Program Flowchart

2. Software used

Software used is Visual Basic 2005 Express Edition version 8.0 made by Microsoft Corporation. This software provides relatively complete features to produce any computer program, especially those that based on Windows.

5. RESULTS AND DISCUSSIONS

Input data are given as in Figure 6. Those data will be analyzed using "ANSTRUK" program.

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Figure 6. Input Data Plane Frame

Based on those input data, at least structure identification name "Portal" and 10 data blocks will be analyzed are:

1. Control Data, consist of units will be used, structural code and the numbers of loading system. ANSTRUK program has some optional units and work with 4 basic units. In order all are written in load unit, length unit, and temperature unit for instance: Kgf cm C. Time unit is always seconds. All unit options, the values will be converted automatically by program based on those basic units.

    While structural codes are:

    (1): for Continuous beams
    (2): for Plane Truss
    (3): for Plane Frames
    (4): for Cross Beams/Grid
    (5): for Spaced Truss
    (6): for Spaced Frames

2. Material Data, consist of: amount of materials, names of materials, types of materials, elasticity, Poisson's ratio, heat distribution coefficient and shear modulus.

    In this part clearly seen that the types of materials could be different even though have the same modulus of elasticity, for example Steel and Concrete.

In plane frames, shear modulus will not be evaluated, so Poisson's ratio will be automatically ignored.

3. Section data, consists of: numbers of sections, name of sections, materials used according to Material Data Block and the shape of sections as well as the parameter. Section's shape parameter are:

   • GENERAL: appearance will be back to *default* RECTANGULAR shape. Height and width parameter of sections are still appear but will not be evaluated. Needed parameter and will be evaluated are the areas of sections, moment of inertia, shear section area, section modulus, modulus of plasticity, and radius of gyration as can be seen on Figure 7.

   • BOX: beside parameters of height and width, there are other parameters of thickness of web and thickness of flange. Other parameter will be counted automatically by the program.

   • RECTANGULAR: Parameters needed are height and width of sections. Other parameters will be counted automatically by the program.

   • PIPE: parameters needed are diameter and thickness of pipe. Other parameters will be counted automatically by the program.
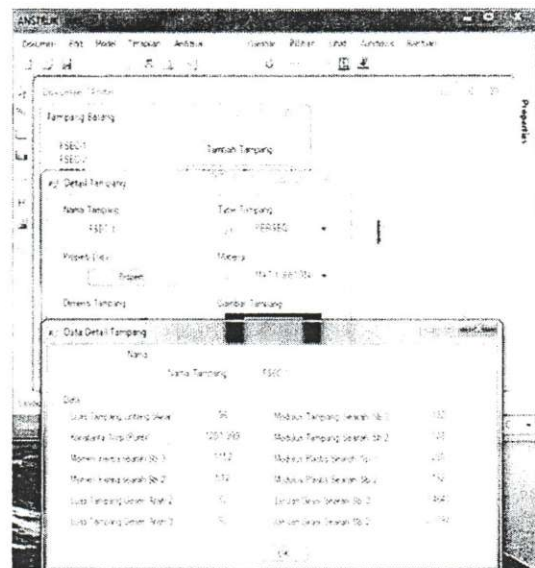

Figure 7. Section Detail Data

4. Coordinate data, consists of numbers of nodal, names of nodal and their coordinates in X, Y and Z directions.
5. Bar connectivity data that consists of number of bars, name of bars, initial nodal, end nodal and sections according to Section Data Block.
6. Support data, consists of number of supports, name of support nodal and restraint parameter.
7. Nodal Load Data that consists of the amount of nodal load, loaded nodal, and the parameter of loads.
8. Bar load data, consists of number of bar loads and bar load parameter arranged on Continuous Load Data Block (9) and or Trapezoidal as well as Point Load Data Block (10).
9. Continuous Load, consists loaded bar, load directions and load numeric values.
10. Point Load Data consists of loaded bar, load directions, load numeric values and the load distances. For plane frame, axial load will be ignored and all types of loading will be shown as on Figure 8.

When all data block are complete, it will be ended with END to state that inputting data has been done. These input data will be recorded into computer's memory later.
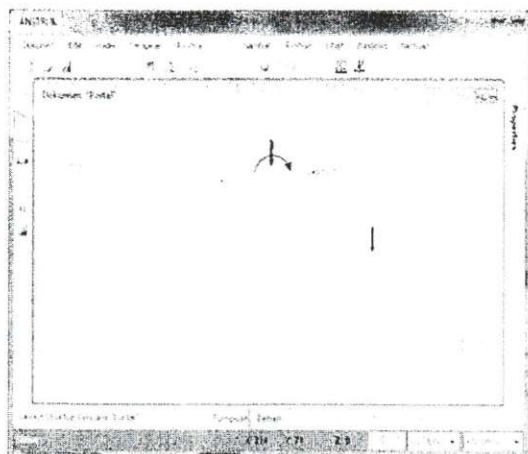

Figure 8. Area Frame Loading

Input data which are explained above will be formed into a data file, with extension "text" or "TEXT File" when Browsing File will be filtered into "Input Files (*.text)|*.text".
For the sake of initial figure, the input data will be transferred into a data figure by inserting scale factor and offset. It is important to do that, so in structural analysis process, executed data will be inserted that have not been transferred and the appearance of figures will be more optimal.

The next process is analyzing the structures. In this process, the analyzed structure data will through all steps of analysis process as explained on the flowchart of ANSTRUK program.

Determination of Degree of Freedom (DOF) will be directed according to structural code. In general, number of DOF depends on exchange coordinates for all joints and number of support restraint.

Besides that, determination of band width should be arranged, so the position and size of stiffness matrix become very efficient. In this case stiffness matrix that has been indexed will be recorded in rectangular array after passing factorization method (BANFAC). This factorization method is important because there is no calculation out of track that is necessary to do.

After that, loading process on the bar will be evaluated and equivalent become actions in nodal. In this step, the actions will be merged based on each index.

Next step is call the sub routine BANSOL which is solution of unknown in previous equation system, so from this process free nodal deflection vector will be found.

The final step of this analysis process is evaluating the movement of joints by taking notice of support condition of processed nodal. All results from this step will be prepared and then transferred in the form of deflection table, bar action table, nodal action table and reactions as on Figure 9 to 12. Besides that, all data from the results of calculation can be kept in a file form, database and figures, and then can be printed according to options in the program.
Final figure is analysis of result diagram as can be seen on Figure 13, 14, 15, and 16. Additional diagram is partially given on alternative diagram as shown on Figure 17.
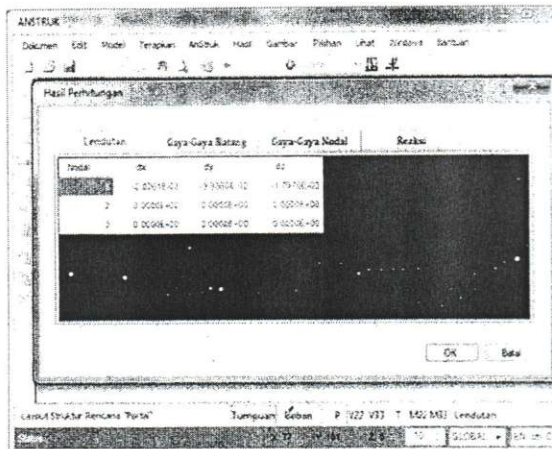
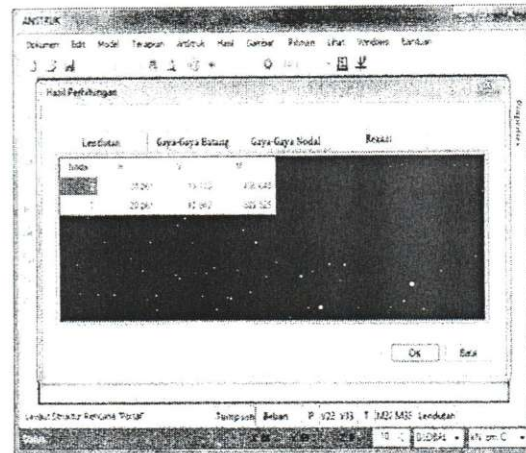*Managing Assets and Infrastructure in the Chaotic Global Economic Competitiveness*

Figure 9. Deflection Output
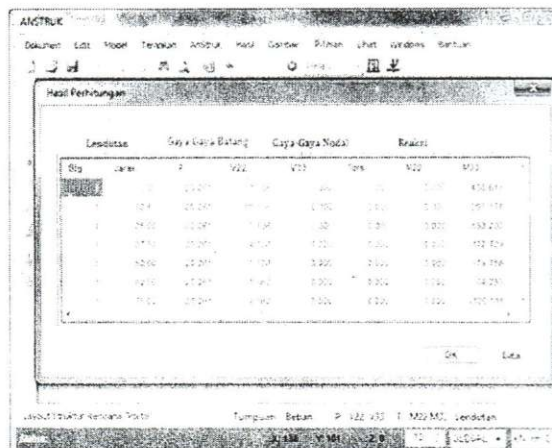

Figure 12. Reaction Output
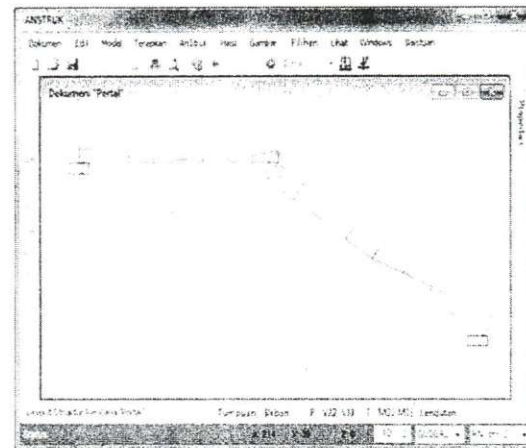

Figure 10. Bar Actions Output
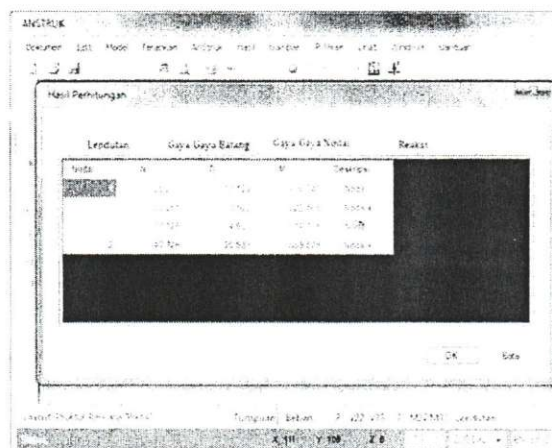

Figure 13. Moment Diagram
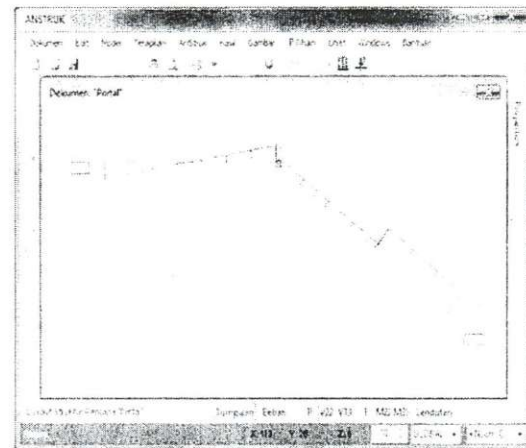

Figure 11. Nodal Actions Output
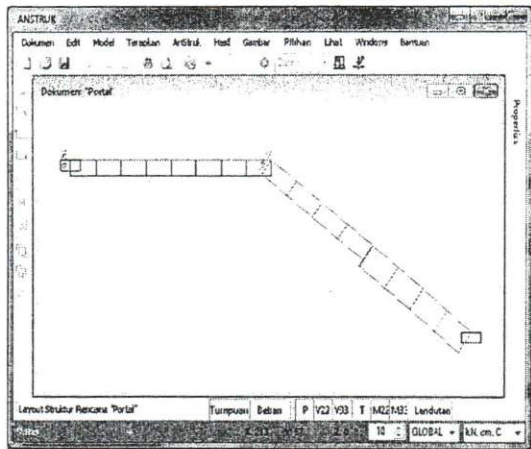

Figure 14. Shear Action Diagram
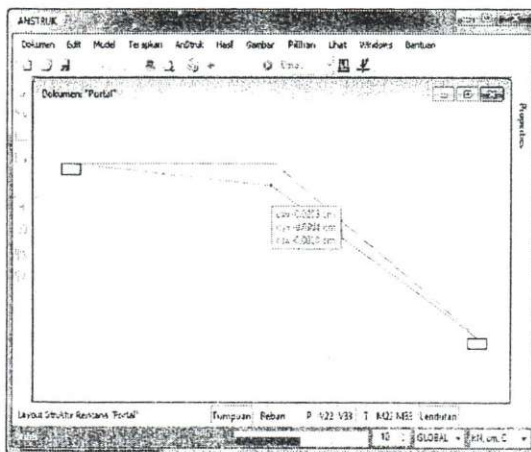
Figure 15. Axial Action Diagram
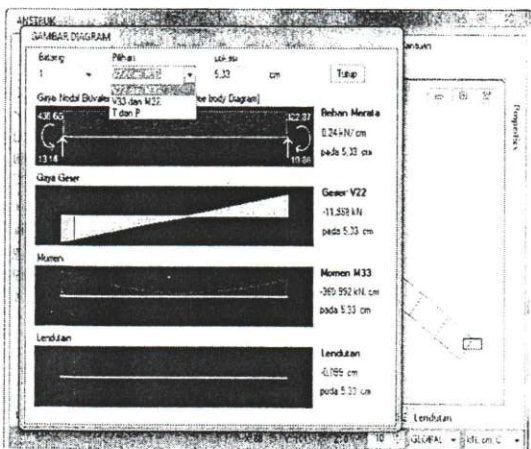

Figure 16. Deflection Diagram

Figure 17. Diagram Detail and Analysis Results

All appearances are very interactive. It can be seen from diagram visualization or figures that can help students/users to do logical thinking process towards numeric values from data input or counting results.

This structural analysis application program has high level of effectiveness and efficiency because it is made and arranged according to general program standard and analysis process that relatively fast. Based on verification results towards all program's output, there is no significant difference compared to manual calculations.

This program contribution of course can motivate students in studying Structural Analysis subject and can enhance their interest of it, so the meeting will be much more effective. Along with that effort, now has been done curriculum adjustment with science and technology development, so this can be very beneficial and can push ahead learning system improvement.

6. CONCLUSION AND SUGGESTIONS

Based on discussion results in this article, can be concluded that:

1. Verification results of program output and manual calculation do not have any significant difference and appearance is very interactive.
2. This program can motivate students in studying Structural Analysis subject and improve their interest, so it will be beneficial and can push ahead the effort of learning system.

Suggestions are because this ANSTRUK program is still in verification, so unexpected mistakes may be appeared. Therefore, the authors welcome corrections to make this writing better.

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