INTRODUCTION OF THE SOFTWARE OF SEISMIC RETROFITTING DESIGN FOR EXISTING BUILDINGS IN IRAN

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ABSTRACT:
Computer program for analysis and design of structures with nonlinearity of geometry and materials consideration in finite element zone, which have been used of required elements node (unlimited) with respect to solve accuracy in static and dynamic situations. In final represents results with all required construction reports and drawings.
High speed personal computers make the research engineers able to get more details of natural effects which affected to human life.
Evidently , trying to control and speed up the logical results with computers, is one of the several ways which needs high technology to make transformation the physical space to mathematical space and solving them in computer and finally transfer the results to physical space again.
In the software which has been produced are divided to the four sections as follows:
- Data entry information
- Structure geometry construction with vertical and lateral loads estimation
- Analysis and design of all members and connections with emphasis to retrofitting design
- Make final reports and required construction drawings

This software which have been used for many structures and buildings that have been damaged in earthquake event in Iran e.g. bam city. In this paper we have discussed and described in above software with the relative pictures.

KEYWORDS: Existing buildings, Construction drawings, Stiffness method, Finite Element Method

1. INTRODUCTION

At present, progresses have conducted engineers and analyzers of scientific fields to change the natural events under study to new mathematic methods, formulas, and utilize personal high-speed computers for processing and observing mutual effects of the events on environment and reverse as seriously as possible.
Obviously, structure issue too, with all its wide scope of issues and diversity of subjects, is one of outstanding matters in scientific fields, which can be defined in various arithmetic forms, and the results can be interpreted.
This has been designed and prepared to a wide extent by software to be available shortly to specialists. This software is comprised of three major parts as below, having essential interactions to reach final stage:
- first part includes analysis and estimation of the powers and effective transformations of components and knots;
- second part includes designing of components, joints, and finally presentation of a plan for optimization;
- third part includes estimation of consuming materials and preparation of construction drawings.

Basis of this software is put on domestic and international reliable standards and regulations, and all analyses are done on this basis. Among important points of this software, we can refer to preparation of optimized executive drawings of structure, and finally physical estimation of consuming materials.
Present program is designed for acceleration of modeling, analyzing, and preparing executive drawings and their estimation for the two purposes of construction and presentation of proper solutions for vibratory optimization of existing structures, which is able to act at a suitable speed for each of the above purposes for metal, concrete, or combined structures.

Obviously, with regard to high potential of seismic hazard in our country, where up to 97% of the areas are classified in high or very high potential of earth-quake, importance of this software will be very high, due to its high speed and precision. With experiences obtained from Roudbar, Bam, Brujerd… earthquakes, we can reduce various critical routes, and have more percentages of assurance regarding the executed activities. Marginal goals of this software are optimum use of steel and concrete in projects, avoidance of very heavy plans under pressures resulted from job volume, which in turns causes reduction of pressure on the price of key construction products in critical situations.

Further, benefiting from the method of models preparation for operational programs, which are already referred by engineers, gives a capability to program by which in every stage, operator is able to transfer his model to a side program, and use it to continue or confirm the results. As per capabilities and functions of the program, it includes six major parts connected to each other as below: modeling, model editor, analysis, designing, preparation of executive drawings, and physical estimation of materials. Most of them are described below:

2. MODEL CREATING

In this stage, the program is able to receive specifications of the structure through digital data by operator together with products wizard or the files prepared in the format of other available programs; and includes the following stages:

2.1. Preparation of model through data entry
- Standard option (reading and saving the information*)*
- Project option (documentation)
- Geometry option
     a) Geometry of structural levels
     b) Floors height
- Loading option
     a) Vertical loading
     b) Concrete sections
- Structure supplements option (specifications related to openings, location of braces and their positions, placement of (cutting) walls, position of stairs, etc.)
- Execution (preparing the data and loading them in memory)
- Model editor (graphical specification of input data)
- Confirmation (preparation of as-built model from input data)

2.2. Preparation of model through input of other programs
In order to make better and faster use of the program features, it is possible to get through the stages of part merely by reading and loading the data by the files previously prepared by known software packages (Safe, Etabs, and Sap) too.

3. MODEL ANALYSIS

The basis of model is stiffness method, which makes analysis of the structure possible under static and dynamic loads in the linear and non-linear form (geometry and materials), and by finite element method (FEM). In general, each node enjoys six degrees of freedom (3 degrees of freedom in deflection and 3 degrees of freedom in rotation), which can be reduced in case of request for limitation. The procedure for equitation is designed in a way that increase in effective knots of the structure due to the need to necessary precision has not considerable affects on analysis and designing period and the desired result can be reached within a reasonable time with regard to the number of degrees of freedom.

Accuracy of model is such that in steel structures, all the components (beams and columns), joining plates, hardeners, angles, under-column plates, and even welding are defined as solid elements, and their stiffness shares are counted in structure stiffness share, and are evaluated independently in reaction with the structure.

In concrete structures, all components (beams and columns), longitudinal and transverse bars, arrangement conditions of bars in joints, anchor bars, and roof systems are defined as solid elements, and their shares of stiffness in the matrix of the structure stiffness is considered, and each is evaluated independently and in reaction with the structure.

4. MODEL DESIGNING

Designing of the model may be performed in two ways:
- considering present regulations and in allowed tension method and final resistance method;
- which, in case sections do not respond, it is possible to choose more resistant section in domain of the sections dependent on that element, to reach the favorable result.

At final, after completion of all frequent selections and procedural confirmations, it will analyze and re-design and confirm final selected section. With regard to elasto-plastic model of behavior of materials, all elements and their dependent knots have a specific model of behavior, and are evaluated directly. It is obvious that in this method too, in case of development of plastic joints and breakage of elements, it is possible to choose more resistant section in domain of sections dependent on that element to reach a favorable result. At the end, after completion of all frequent selections and procedural confirmations, it will analyze and re-design and confirm final selected section.

5. PREPARATION OF CONSTRUCTION DRAWING

In this stage, considering the input data and final confirmation of the analysis and designing part, it will draw true geometry of the structure with full under-study details. The necessary details of executive drawings including plans, beams and relevant sections, columns and relevant sections, joints, braces, (cutting) walls, under-column plates, bolts, etc., will be available automatically sub-divided from main structure. As mentioned above, the samples outputs of this software are shown in figures 1 to 7.
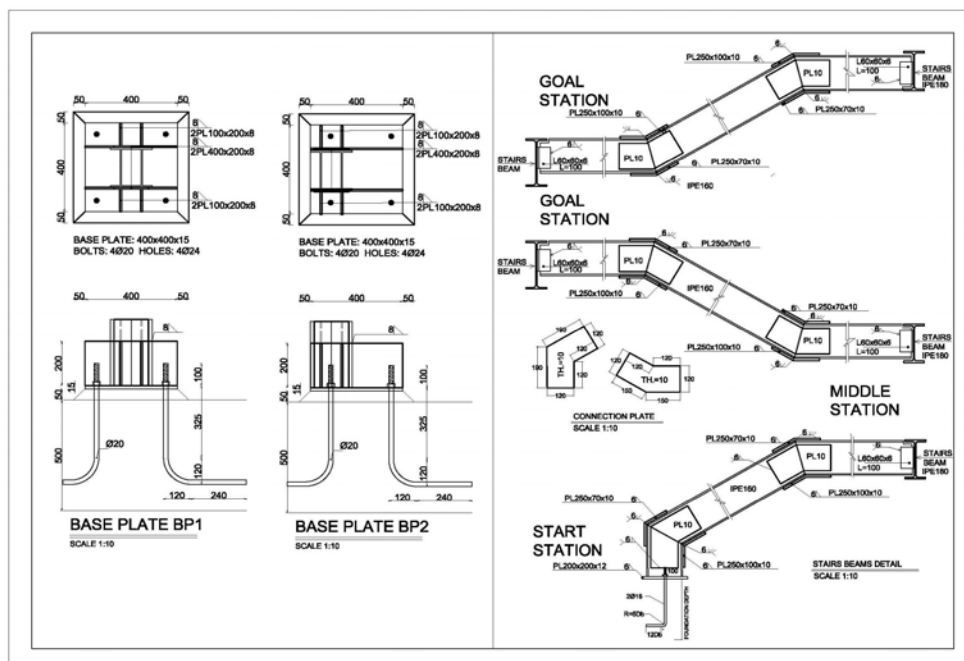

Figure 1. Details for steps and Plate of under-column from the sample of structures
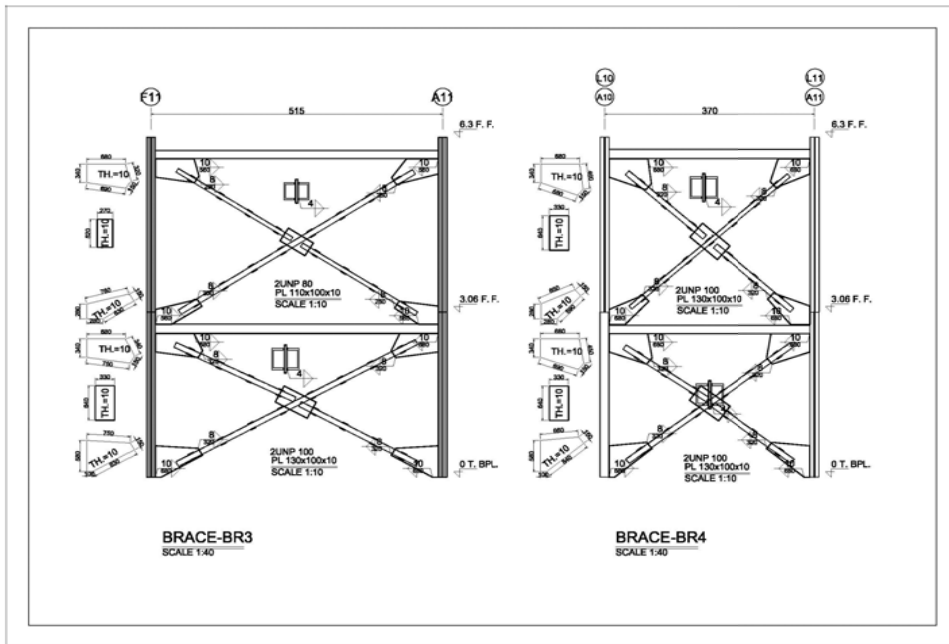
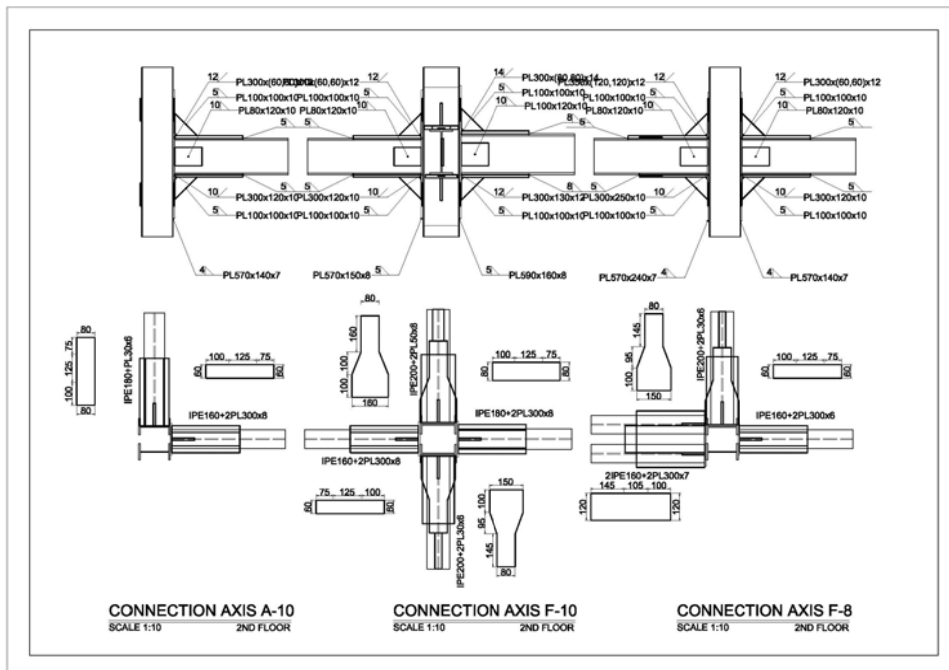Figure 2. Details for bracing systems from the sample of structures

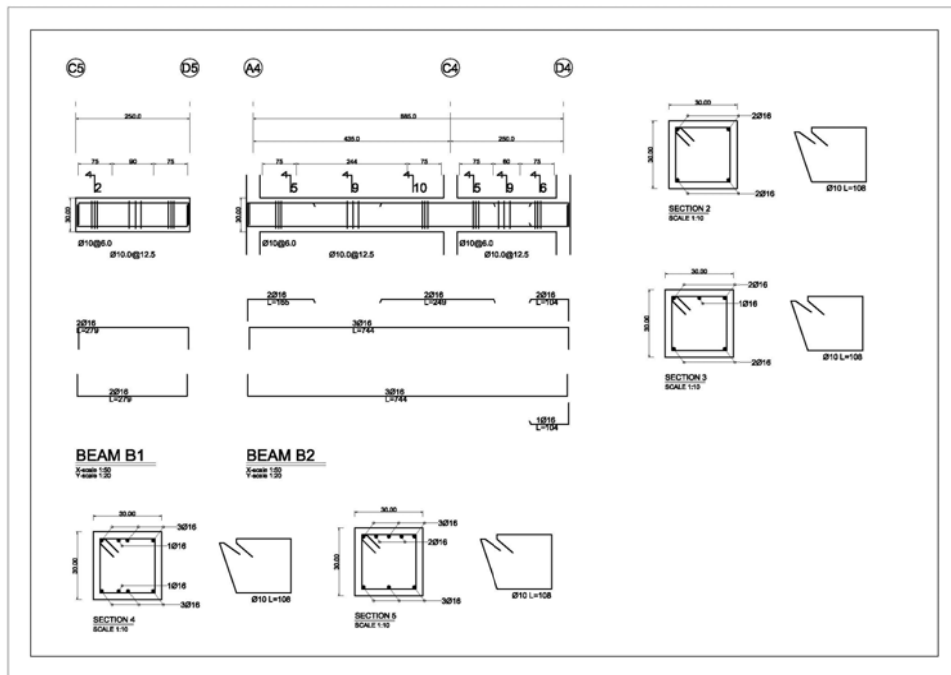Figure 3. Details for steel beam and column from the sample of structures

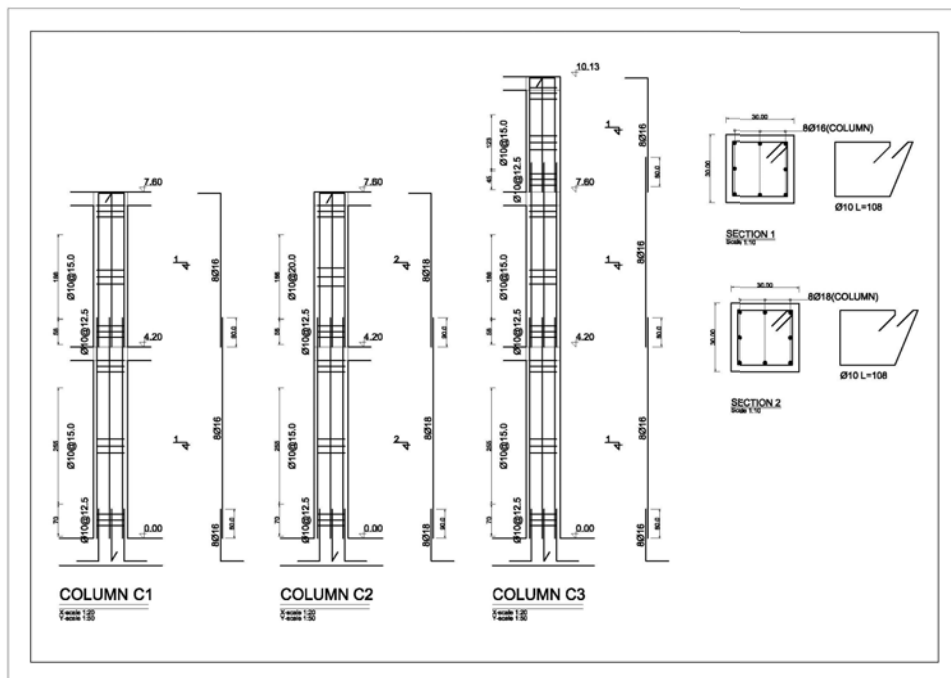Figure 4. Details for concrete beam from the sample of structures

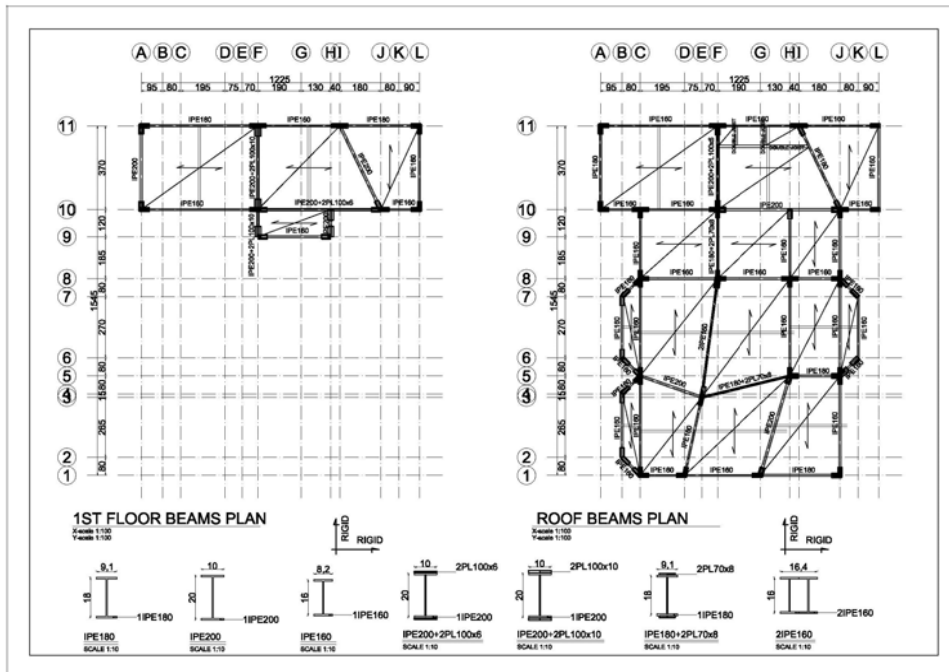Figure 5. Details for concrete column from the sample of structures

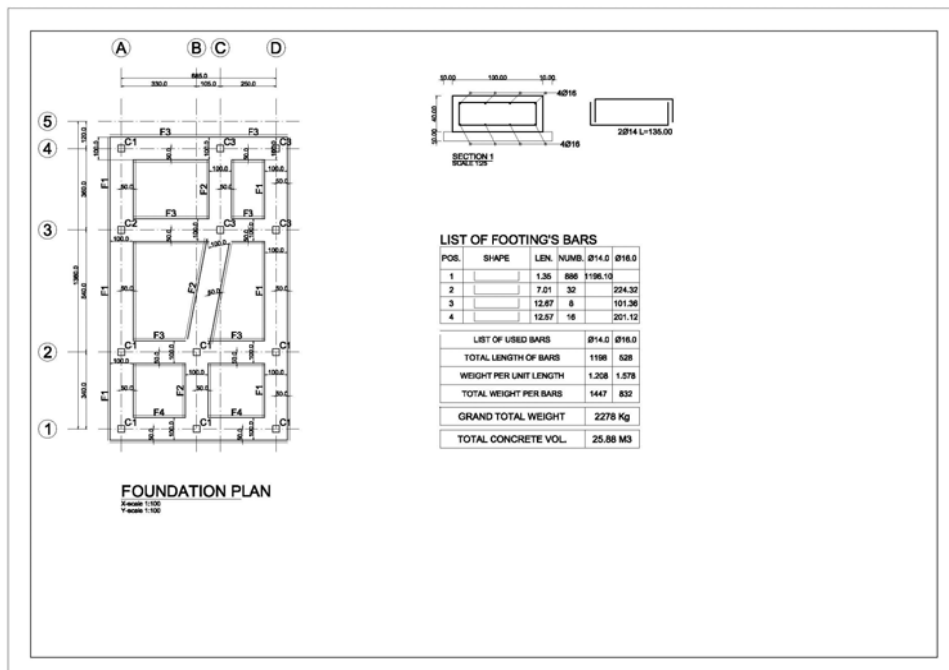Figure 6. Details for framing plan from the sample of structures

Figure 7. Details for foundation from the sample of structures

6. PHYSICAL ESTIMATION OF MATERIALS

In this stage, considering drawing of all components with full related details, estimation of consuming materials will not be complicated, and it can easily prepare the table of materials, and calculate the relevant volumes and weights.

7. CONCLUSIONS

As mentioned above, the conclusions of this paper are as follows:

- The complex of created capabilities enables structural managers and engineers to act from modeling to estimating materials of understudy structures. Allocating a small part of their times, specialists and managers of the plans will be, using this software, able to devote all their powers to optimization, precision, and speed in executing their plans, while avoiding involvement with the jobs such as employing numeric qualified labor forces, producing similar models and construction drawings, which in proportionate would require preparation of construction estimation. Further, they will care about the goals of their employers and quality of their products, avoiding useless multi-lateral views which are sometimes accompanied by human faults.

- Further, this software is considered as a good leader for critic managers in improper circumstances, keeping them away from the issues which may spoil their time in vain, and leading them to care about the quality and quantity control over their products.

- Meanwhile, by presenting accuracy drawings, this software can cause optimum and proper consumption of key products (steel, bar, cement, etc.), and reduce their excessive consumption in critical situations, which is demanded sometimes by managers in order to make sure of final products; causing that not only trust/confidence is not reduced but also consumption is done optimally and properly.

- At the end, this software will enable specialists and managers of the country to increase quality and quantity of the required structures. This software has been used for retrofitting the buildings after the bam earthquake (2004) with good results.

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