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DIGITAL MAP FOR SEISMIC RISK CONCENTRATORS

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Abstract: *This paper presents the results of our research based on a digital map in order to manage the seismically risk. The static loads used in this example consist of the dead, live, earthquake and wind loads acting on the building in order to create a map for the seismic risk flow concentrators in a build structure. The first step of the algorithm proposed by the authors is using a specialised software solution starting from a model of the building (build structure) that will be analysed. Based on the results obtained in the second step we can generate a map with the arias that must be avoided when evacuating the human resources and the materials because of the high possibility that the structure will fall thus slowing or blocking the evacuation.*

Key words: *digital map, flow concentrator, risk concentrator.*

1. INTRODUCTION

A structure analyze for seismically resistance follows the next fundamental aspects:

- Geometrical, physical, mechanical and mathematical resistance structure modelling (materials, component elements, substructures and connections, etc.).
- Geologically, geotechnical and dynamically modelling for the local field conditions corresponding to the construction placement [1].
- Cinematic and parametric modelling of the seismically movement in time history.
- Numerical analyse estimating the instant or maximum response described by the structure in history time of the earthquake.
- Obtained results of the whole quality and quantity operations process elaborated through conventional calculus models interpretation and extrapolation.
- Designing and effective production of the construction within the limits of on insurance level, according with placement seismic aria and the importance of the implemented object.

All the described aspects are subjected (more or less) to approximate from modelling bases and analytical solutions in which errors may occur in admitted schemes and estimating primary data, and also subjective elements (sometimes even arbitrary) for which the decisional act can be elaborated.

Even the fact that the actual seismic analyses are applied to ensure a construction to a future unknown earthquake is a major risk factor. Thus, any real future earthquake will be a real surprise for a designed and executed construction in conformity with knowledge acquired from anterior seismic socks research. In order to avoid this situation, the authors proposed an adaptive algorithm, in two steps, that will configure a map with seismic concentrators that represents the maximum risk arias based on structure behaviour simulations; the map will adapt in time do to the build structure mechanical properties evolution.

2. ANTI-SEISMICALY DIGITAL CONCEPTS

The structure dynamic response caused by powerful earthquake can be determined through three distinct methods (or variants) that are presented as it follows:

Static-equivalent seismic force method. This method is conventional and approximate and it is included in designing regulation and normative. It is a simplifying method, specific to the global analyses in which the seismic ensures level is prescribed depending on the aria seismicity and the structure dynamical characteristics (own periods and dissipation capacity), as well as on a certain allowed ductility level.

Response seismically spectres method. It is also an approximate character method that is utilised in direct design of the structures resistant to earthquakes.

The method offers the possibility to separate the structure dynamical characteristics (from the seismically movement ones) defined through “response seismically spectres”. This approach method is used in present in designing anti-seismically structures and can be considered an analysis instrument in preliminary design guaranteeing a more precisely calculus.

Beside the importance that these spectres have in structure design, they also deliver information regarding the intrinsic characteristics definitions of the seismically detected movements.

In this way one can identify field magnifying properties, spectral composition of the accelerate-grams, and also the majority components (including periods) of the movements. Response spectres theory can be used for both elastic behaviour systems and inelastic behaviour systems (elastic-plastic).

Direct integration method. The solution of this method based on “step by step” procedure offers the possibility to represent the seismically response based on the historical time of the earthquake. The method is laborious and formal; it has an exact character, thus it is specific to automatically numerical analyses.

Anti-seismically design in dynamic concept: The dynamic behaviour of the structures, in historical time of the seismically movement, is much more complex then the static behaviour under the gravity load action, there for designing and anti-seismically ensuring needs more refined numerical analyse and structural conformity techniques [2].

The fundamental objectives that are considered in designing and anti-seismically insurance are based on non-structural deteriorations limitation on minor earthquakes, preventing structural damages and minimizing the non-structural ones on moderate earthquakes and avoiding disaster and human lost in case of high severe earthquakes.

In order to do that, the parametrical studies developed in the last decades, with important contributions for the seismically engineering general progress made by edifying many controversial aspects from the past, led to choose and hierarchy arrange the most signifying phenomenon that rule a structure behaviour at intense seismically actions.

Anti-seismically designing concept is based on the definition and synthesise [3] of the structure configuration (shapes, dimensions, components, connexions, etc.) according to the field movement characteristics (intensity, duration, spectral frequency-composition content, etc.), to the structures' elastic and dynamic properties (inertial, dissipative, rigidity, ductility), to the infrastructural type (foundation) and the placement environment (field local conditions).

When designing a structure (with precise destination) for a standard earthquake action (given), also called "designing earthquake" there are more possible variants regarding the choosing possibilities for the three-dimensional structure configuration [4, 5].

Taken this into consideration the adapted structural type and the material used can have a great influence on local and assembly rigidity, attenuation capacity, possibility of moving forward the behaviour elastic limit, seismically response expressed in stress and deformations [6].

Anti-seismically designing must give a special attention to the field local conditions and to the most efficient structural solutions of foundation, because in many real situations malfunctions and collapses are caused by the field giving in and not to the resistance elements from the high-structure.

In moderate earthquake case, structural response is generally in the elastic behaviour domain; it depends strictly on the dissipative and elastic inertial characteristics.

These characteristics can though be influenced, in the earthquake real time, by the interaction between structural and anon-structural associated components (compartment and closing walls). In case of powerful earthquake if there are not established some secure and framing supplementary methods, the collaboration between these components is practically inexistent.

Non-structural components presence with important dynamic function in some situations (thru resistance, rigidity and balancing capacity) can have a favourable role when their participation in the earthquake duration is certain.

It is also possible for some unwanted effects to appear when premature and unplanned degradation of the elements happen, thus there will be some main resistance structural significant un-balancing that will favour the general or local level torsion phenomenon. By alteration of the vibration fundamental period the linear seismically response will be modified, with unpredictable and uncontrollable consequences, when considering a designing standard response spectre.

If the seismically movement is powerful, then the structural response with incursions in the post-elastic domain behaviour is practically unavoidable. The inelastic response of the structures is extremely sensible if reported to the initial dynamic characteristics and seismically shock intensity.

Post-elastically incursions are very much depending on the hysterical properties, on the material ductile behaviour and structural and non-structural components as well as on the connections realisation mode that insures the mutual transfer of the deformations between the constitutive elements.

Thus, we can say that the difference between the designing criteria is basically dictated by the seismically movement intensity and the behaviour domain of the structural elements (elastically or in-elastically), as well as economical and technological considering.

Following the aspects given above, we can conclude that in order to design in dynamical concept of an earthquake resistant structure we must optimally associate the next fundamental properties which define the components and the structural units: resistance, rigidity capacity, energy dissipation and ductility capacity, ability to guaranty a seismically insurance level to a construction, in the established limits. In the same time it is necessary to give a special attention to the local placement conditions, taking into consideration the decisive influence that this can have in the designing process [7].

The dynamic concept of anti-seismically structures designing, regarding an admitted insurance level, is a recent concept notion that includes many aspects specific to seismically phenomenon.

When elaborating a resistance project one must keep in mind the next global characteristics that define the geometrically configuration and the calculus method of a structural unit: local or general inertial characteristics; elastically characteristics of the sections, elements, substructures and connections, expressed through rigidity or flexibility; dissipative characteristics and characteristics of attenuation corresponding to the structural and non-structural components, in the elastic and post-elastic behaviour domain; ductility characteristics and inelastic behaviour characteristics of the sections, elements, substructures and structures from the assembly; resistance and deformability to gravity and side actions characteristics; field characteristics specific to the established placement.

The dynamic concept, element, substructure or three-dimensional structure notion, when regarding designing structures for seismically actions of high intensity, has an extremely complex character and cannot be defined with the usual saying "engineering common sense".

This kind of simplifying a fundamental notion in seismically engineering that has large technical economical and social implications, often led to confusions and grate errors.

Structural dynamic concept notion implicates much theoretical and technical knowledge as well as a long experience in the seismically engineering domain.

The dynamic concept of resistance structures treating (regarding as well the participation of the elements called “un-portant” or “non-structural”, from gravitational point of view, but with important dynamical function) means studying every detail and component element up to the hole structural assembly.

This is the reason for which we used a special informatics solution from the seismically engineering domain; ETABS programme (Integrated Building Design Software) produced by Computers and Structures Inc. Berkeley, California USA in order to complete the first step of the proposed algorithm.

3. THE STRUCTURE DYNAMIC MODEL

The elements used in the modelling process by the ETABS programme are as follows: graphical interface based on object (Fig. 1); database for most of the metal of concrete structural systems; created models using structural terminology: column, grinds, walls, floors, etc.; elements type “grind”, “column”, “ bracing”, “wall”, “floors”, “big dale” with intern discrete; floor definition using the “similar floor” concept; same name for the elements placed on similar floors; editing with the help of the commands: “move”, “merge”, “mirror” and “replicate”; in detail definition with guide lines and “snapping”; rigid semi-rigid and flexible diaphragms definition for floor; possibility of generating ramps with “extrusion” command; automated contour conditions for irregular digitization of the walls; fast drawing options for creating objects (elements); drawing command for fast and easily adding holes in the floors; multiple systems of footing coordinates; grouping and selecting options; automated generating for the side loads from wind or earthquake; direct loads transfer from floors to grinds and walls.

The elements used in the analyse process by ETABS programme are mentioned below: statically and dynamical analyse for frame type structures or structural walls; response spectre based analyse with ritz own vectors; rang ii analyse; automatic calculus of the rigidity centre; loads given by the gravitational force, pressure and temperature; frame type objects drawn as physical elements; digitization with finite elements for disc / dales for the horizontal diaphragms analysis; modelled wall / disc / dale as “shell” “plate” or “membrane” type element; statically and dynamical analyse corresponding to the execution phases; considering of the plastically articulations from the axial force, flexural torque, cutting force and torsion; incremental nonlinear analyses (“push-over"); structural response control by isolating the base or viscose attenuation units; nonlinear in time analyses by wilson fna method; big displacements systems analyse.

This example also applies a UBC97 static earthquake load to the building and an ASCE 7-98 wind load to the building. The forces that are applied to the building to account for the earthquake and wind load are automatically calculated by the program.

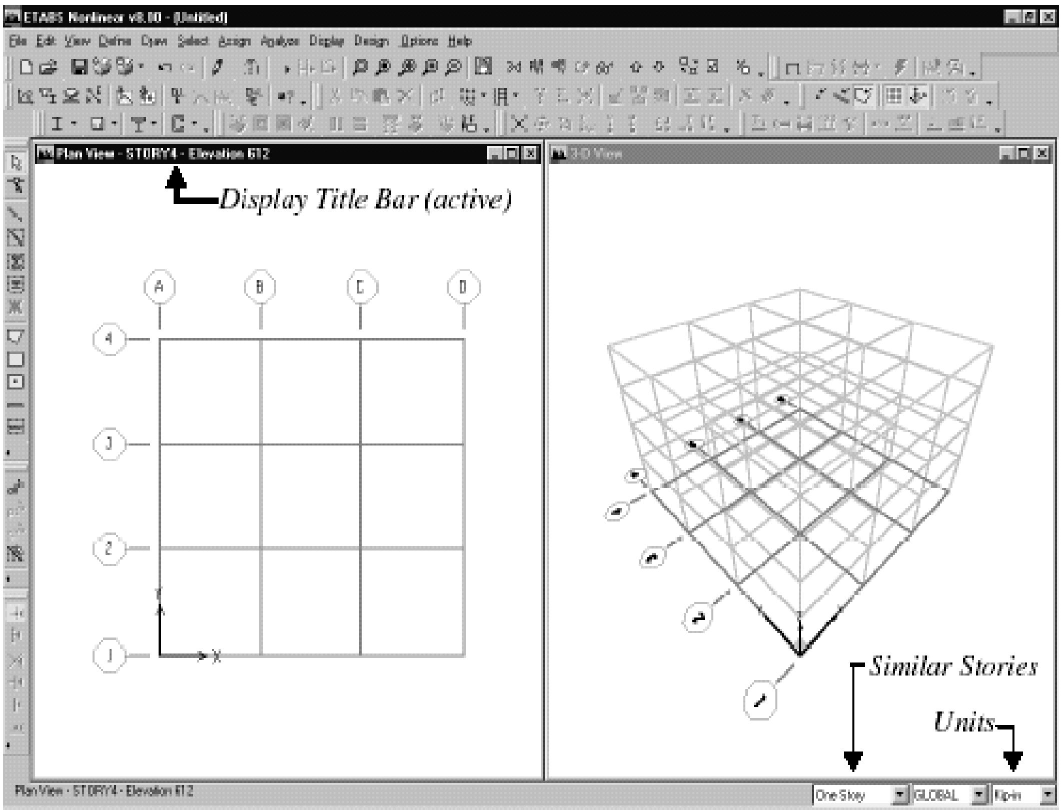

Fig. 1. ETABS programme main window.

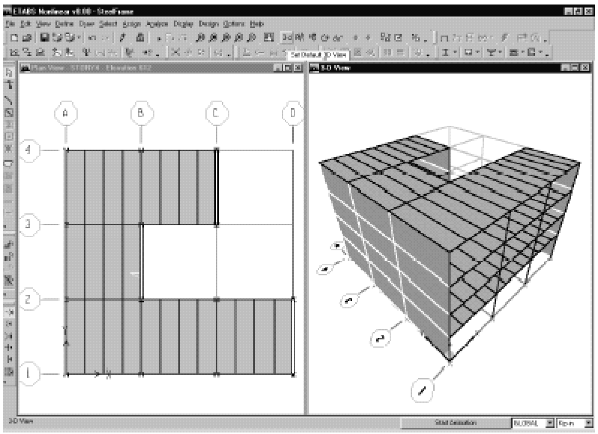

Fig. 2. Model after all dummy wall-type objects have been added in ETABS programme.

The elements used for presentation by ETABS programme are: 3D graphic displays; static deformation and own shape of vibrating; loads; stress diagrams for bars, walls and disc; results selection with screen displaying; table showing of the entry and exit data; graphic definition "section cut" type for stresses; "open gl viewer"; displacements and stresses showing in the "time-history" analyse; "avi" file type for "time-history"; spectral response curves for "time-history" analyse; force – displacement diagram in the nonlinear response domain; graphic representation of the plastic articulations. The elements used for calculus in the ETABS programme are as follows: metallic frame calculus for various designing cods; armed concrete frame calculus for various designing cods; composite grinds calculus corresponding to the American, English and Canadian cods; armed concrete walls calculus for American, English and Canadian cods; statically and dynamical loads calculus; "section designer" mode for non-regular shape sections description. The obtained data (rapports given by ETABS) are going to be entrance data in order to create a seismically risk concentrators map. The image of the structure modelled by ETABS programme is given in Fig. 2. The static loads used in this example consist of the dead, live, earthquake and wind loads acting on the building. For this example building assume that the dead load consists of the self weight of the building structure, plus additional dead load applied to the floors and additional dead load applied to the beams around the perimeter of the building.

The additional dead load applied to the floors accounts for items such as partitions, ceiling, mechanical ductwork, electrical items, plumbing, and so forth. The additional dead load around the perimeter accounts for the cladding. The live load is taken to be the same at each story level.

This live load is reducible for steel frame and composite beam design. Note that realistically those loads would probably vary at some of the different floor levels. However, for the purposes of this example, we have chosen to apply the same load to each story level.

4. CONCLUSIONS

We have taken into account that in order to design in dynamical concept of an earthquake resistant structure we must optimally associate the next fundamental properties which define the components and the structural units: resistance, rigidity capacity, energy dissipation and ductility capacity, ability to guaranty a seismically insurance level to a construction, in the established limits. In the same time it is necessary to give a special attention to the local placement conditions, taking into consideration the decisive influence that this can have in the designing process.

Using the reports generated by the ETABS programme we were able to create o digital map with seismically risk concentrators.

The informational models for the flow concentrators' map can be discharged in a united multi-expert type computer field system that allows data centralization from more that one build structures and evacuation flows simulation for the hole build assembly, neighbourhood, sector, etc.

We consider that a special interest should be given to the researches regarded the build structures behaviour modelling with the purpose of industrial activities running.

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