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Seismic risk in town and planning seismic codes of Yugoslavia

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ABBSTRACT: The paper is concerned with the history of practical dealings with the seismic risk in the national town plannings from 1964 to 1990. Also a brief survey is given of the approaches that take into consideration the system of structure (manmade) and ground (natural) under erthquake conditions in the case examlpe of Ivanjica Town Plan, western Serbia.

INTRODUCTION

The first building codes and standards for seismically active regions of Yugolslavia was enacted following the 1964 Skoplje earthquake. The selection of the provisional calculation loading, the coefficient of seismicity, was related in the mentioned codes to the category of buildings and the type of ground. The design seismicity was set a degree higher than that of the area concerned and referred to the higher building categories. The seismicity of area applied to the massive housing projects. Building grounds were divided into three seismic categories: good, medium, and poor grounds. The revised codes of 1981 were enacted as the Building Codes and Stndards for Seismic Areas. Five categories of structures were introduced :

(1) fourth (IV) category buldings of weight coefficient K < 0,75;

(2) third (III) category buildings of weight coefficient K= 0.75;

(3) second (II) category buildings of K= 1.0;

(4) first (I) category buldings of coefficient K= 1.5 ; and

(5) buldings beyond any category of coefficient K> 1.5.

The coefficients of seismicity in the Codes were relative not to the ground categories, but to the earthquake degrees. The ground quality partly considered the coefficient of dynamicity, Kd, of 0.5 , 0.7 and 0.9 seconds, depending on the ground category, where 0.9 seconds referred to poor ground (third category).

Seismic maps that followed the Codes were of diferent types, showing seismicity in degrees on earthquake scale, taking or not taking into account the effect of ground. The effect of ground was considered in detail field surveysand was chiefly used in correcting earthquake degrees of the maps. A seismic degree was expressed by the value of respective dynamic ground vibration parameters or often by the probability degree for these parameters to reach the estimated level or exceed it.

The major difficulty in observing the mentioned Codes and Standards for various building project was the irrelation of a man-made structure and the ground as a natural structure. Usually, more consideration was given to the building than to the ground; the vulnerability of the latter was given inadequate consideration. This proved an unreasonable approach.

The base map for the Building Codes for Seizmic Areas of 1964 was the Seismic Map of Yugoslavia of 1950, that was based on the maximum earthquake intesity recors for Yugoslavia until that year, including the pre-record earthquakes.

A seismic was prepared in 1973 for Serbia that took into consideration the ground effect on the earthquake intensity. It substituted the 1950 Map of Maximum Earthquake Intesities. Seismic degree in the field and the selection of the coefficient of seismicity depended on the corrected earthquake degree from the map for local seismogeologic conditions established by field surveys.

For the new Codes of 1981, a new national seismic map of maximum intesities was prepared. This map did not take into consideration either the ground effect or the sesmicity effect on ground vulnerability. The earlier mentioned siesmic map of the 1981 Codes was replaced in 1990 by a new map of six oleates, each covering a respective period of 50, 100, 200, 500, 1000 and 10.000 years. The oleates showed areas of different earthquake intesities in MSK-1964 instead of the earlier MCS degrees. The probability of earthquake intesity occurrence on these maps was 63%.

The basic degree by definition is the expected earthquake intesity within a time interval on the ground defined by the seismic regionalization map, or the 'average ground', which is a fiction ground . Thus, this seismic map is a map of the relative hazard for the involved ground in the area defined by the map for +/- earthquqke degree. It is also a map of the relative hazard on a fictions grounds, because it gives earthquake intesities six nine degrees.

The noncosideration of the ground effect by the Codes makes them inadequate, especially where applied to the natural environmental effect for town plan purposes. Another problem is faced when seismicity is estimated of the grounds on which buildings of different categories are planned. The problem is which of the available seismic map oleates should be used and how.

SEISMIC MAPS AND GROUND

An effect of ground, particularly to a depth of 15 -25 metres below the surface, on the earthquake intensity has been well documented.

Local engineering-geological conditions (structure, hydrogeological properties, and physical-mechanical characters) are particularly important for their effects either in the domanis of elastic behaviour of ground or in seismodeformations where the ground vulnerability is concerned.

The behaviour of ground at respective earthquake degrees is treated on seismic maps within the elasticity domain, which is clearly unrealistic. For a solution of the problem, the effect on ground of dynamic loading cased by an earthquake ought to be valorized, or local geodynamic properties (ground vulnerability) taken into consideration.

GROUND VULNERABILITY

In earthquakes of high intesity, the ground behaviour is not elastic, but sudden movements dvelop plastic deformations, fractures and catastrophic dislocations of blocks and rock masses. Consequently, the ground is vulnerable and, unlike a structure or a building, our capacity to increase its seismoresistance is very limited.

Roughly, three types of ground (slope and plain) deformations are distinguished: seismotectonic, seismogravitational, and seismodynamic.

Seismotectonic deformations occur at earthquake foci on ground surface.

Seismogravitational deformations occur at scarps or slopes in the form of rockfalls or landslides caused by the seismic force and the gravity.

Seismodynamic deformations occur in plains, caused by the earthquake energy transmitted by seismic waves from the eartquake focus. These seismodeformations have the form of fractures, sand volcanos, or rock flows.

Dimensions of the latter two types of seismodeformations primarily depend on the eartquake intesity, and on the engineering-geological conditions(litthology, structural and mechanical charcteristics of rocks, and hy̌drogeological properties of rocks).

A procedure of taking into consideration the ground effect for reducing the seismic risk in the earthquake engineering and the town planning is proposed as applied on the case example of investigations for the geological-enegineering map of Ivanjica (western Serbia).

For the purpose of the town plan, firstly , the seismic map oleates were selected for time intervals of 100, 500 and 1000 years, because they covered virtyally types of buildings on this ground. The earthquake intesities involved were of VI, VII and VIII degrees on MSK-1964 scale.

The second step was the estimation of vulnerability for the entire town plan area, for each oleate or respective earthquake degree. The suitability for building was assessed using the 'quasi-set' method a higher objectivity.

The poor ground category included plots where all three seismodeformations were likely to occur. The category of unsuitable grou- nds included those where seismogravitational and seismodynamic deformations could occur. Conditionally suitable ground covered those where only seismodynamic deformations were possible. Optimum suitable grounds were considered those where seismic deformations not expected at the given earthquake intesities but an elastic behaviour of the ground.

For further analysis of ground vulnerability, the amounts of seismodeformataions on the surface were considered for each ground category. Geometric dimensions of seismodeformations were an additional criterion.

With the view acceptable vulnerability of building categories defined in the Codes, effects of seismodeformations on buildings were estimated for each category of ground.

Taking into consideration vulnerabilities of building defined by categories in the Codes, estimates were made of the acceptable ground vulnerability for each category of buildingsagainst ground vulnerability effect on the acceptable vulnerability defined by the Codes.

The Codes stipzlate the use of 500-year seismic map oleata for buildings of categories I and II on which the urbanization area in the 8th earthquake degree zone. Categorized ground of the town area analysed by the effect of eighth degree earthquake using the mentioned method. For the optimum suitable ground for building, structures of categories II and III were recommended by two degrees lower than those on the oleate. For the conditionally suitable grounds, buildings of the mentioned categories were of the same degree as on the oleate; within the category ereas, depending on the mentioned additonal factors, parts of the areas were separated of a degree higher or lower defined on the oleate. For grounds unusuitable for building, some sites were of one two degrees higher on the oleate.

CONCLUSION

The described method was used in an attempt to elucidate the earthquake at town plan level and correlate it with the significance of a building element within a category for its planning, in order to reduce the cost difference to a reasonable measure at the town plan and building levels. Moreover, the intention was to spatially correlate the building category (man- made medium) with the natural medium (ground) for a preventive reduction of material and human losses at the town plan level.

In so doing, the seismic risk will be reduced at the engineering desing level, because it will have been estimated at the town planning level.

REFERENCES

Sunarić, D., Nedeljković, S. Orlić, B., & Jevremović, D. Geotecnical ba(king for ... Ivanjica; Mining-geology University in Belgrade 1991.