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PROBLEMS AND TRENDS  
IN PREFABRICATION OF HOUSES IN SEISMIC ZONES<sup>1/</sup>

by

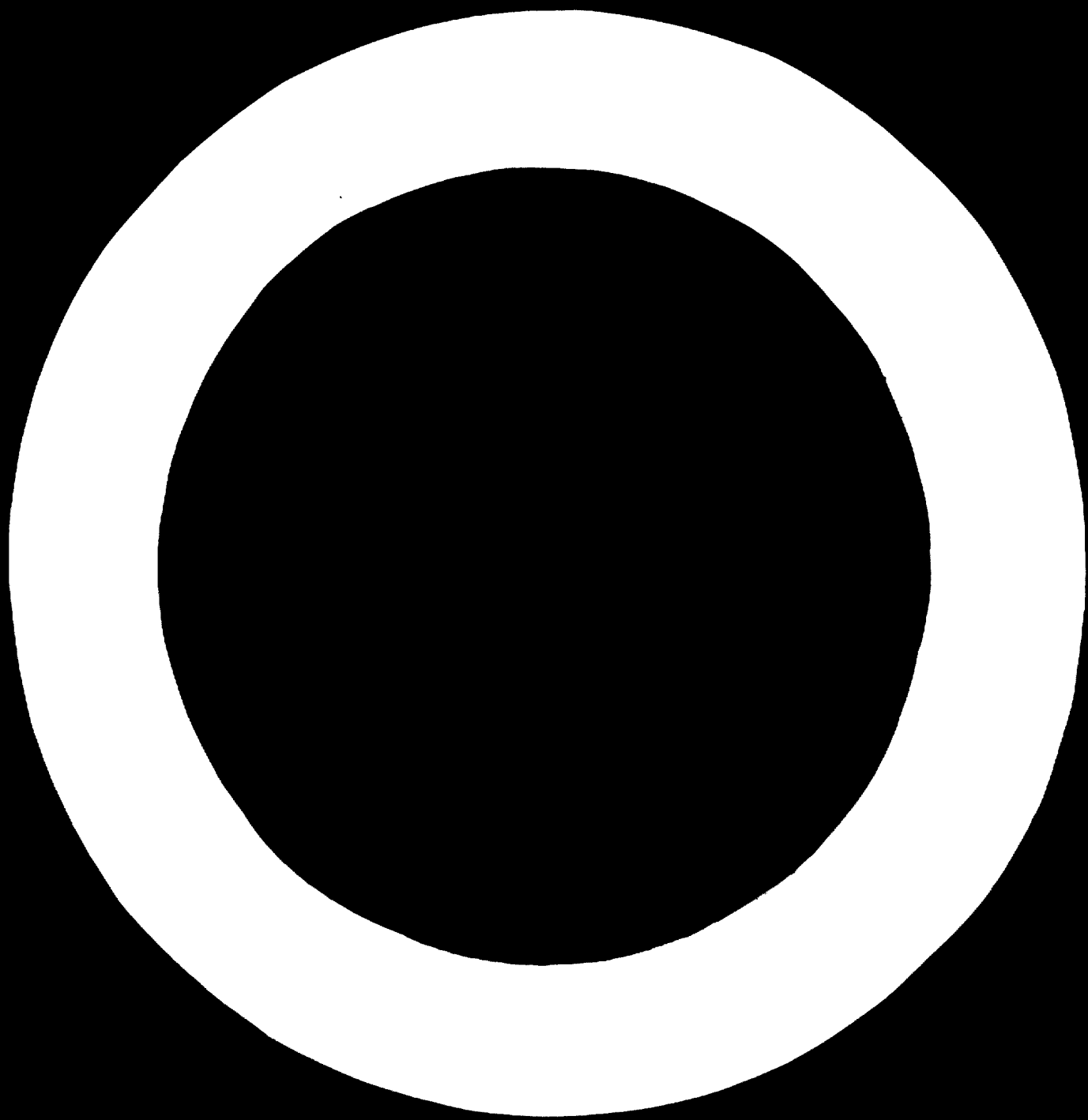
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PROBLEMS AND TRENDS IN DWELLING PREFABRICATION  
SEISMIC ZONES

1/. The Middle-Orient countries in the northern and western region, the northern one and along the eastern coast and those in Central Africa are subjected to the earthquake action. Consequently it is necessary that in these countries some adequate protection measures should be taken for the buildings against the earthquakes.

2/. The studies effected on the building behaviour during the earthquakes permitted the following conclusions to be drawn :

- the reinforced concrete and steel structures can have a high ductility and a high energy absorption capacity so that generally those ones can resist to strong earthquakes ;
- masonry buildings are as a rule very vulnerable
- weak material buildings (made in clay, stone masonry without mortar) have a very reduced strength fact which explains the seismic disasters recorded on the occasion of the earthquakes at Agadir, Turkey, Iran, Sicily and from other zones of the globe.

Concerning the prefabricated building behaviour during the earthquakes we have a very reduced experience because in the zones the earthquakes occurred there were built few prefabricated buildings.

The collapse of the prefabricated floor buildings

8 storied "Consulaire" and 4 storied "Saade Hotel" during the Agadir earthquake in 1960 was due to the complete lack of strength to horizontal forces and to the lack of continuity between the different structural elements.

The experience of the "natural laboratories" shows that the collapse of a building or the degree of damage are on one hand the effects of the earthquake intensity and on the other effects of the defects in conception in the choice of the materials, of the structure type, the structural element layout in the designing details of the joints and connections and of the plastic hinge zones, in the analyzing methods and of the construction defects.

The buildings that were well-conceived and well-built could resist to the strongest earthquakes.

3. Considerable progresses were recorded in the earthquake-engineering field beginning with 1952.

The principles, the concepts, the analyzing, designing and experimental methods enable the realization of a safe protection of the buildings against the earthquake action.

In accordance with the energy theory the fundamental resistance principle of the structures against the earthquakes can be formulated as follows :

- A structure can be safe against earthquakes if it possesses a high energy absorption capacity which will enable the seismic energy absorption with which it is fed during the seismic vibration and also if this energy absorption capacity is not damaged (deteriorated) as a consequence of alternative repetition of the displacements in the postelastic range.

This means that the structures must possess enough strength and a high capacity of postelastic deformation.

- For the safety estimation against the collapse the admissible elasto-plastic displacement criterium is used.

Practically the admissible elasto-plastic displace-

ment and the safety against the collapse are established on the base of the maximum elasto-plastic displacement concept, of the ductility factor (the ratio between the maximum elasto-plastic displacement and the yield displacement) of the plastic excursion (the sum of all plastic displacements).

- The use of the computers and of the accelerograms recorded from different earthquakes enables the dynamic response analyse that is the calculation of the characteristics on which the structure safety depends.

- The test effecting in laboratories on the structure elements, on some building parts or on a whole building gives the possibility of knowing the force-displacement diagram, that is of the energy absorption capacity and of the admissible elasto-plastic displacement. That is the way in which the real structural characteristics may be introduced in the calculations for the structural safety estimation.

4). Taking into account the experience in Japan, Romania and other countries, the conclusions that may be drawn concerning the principal problems and trends in the dwelling prefabrication in seismic zones as well as the general recommendations for their designing are as follows:

a) There exists the possibility to build in all safety prefabricated dwellings even in the highest degree of seismicity zones without limiting the number of storeys.

There exists the tendency of using the most advanced analysing, designing and testing methods.

b) For the structural elements, resistant and ductile (with a high deformation ability in postelastic range) must be chosen: reinforced concrete, prestressed concrete, steel and steel reinforced concrete. Nonductile and weak resistance materials must be avoided.

c) For the structural system, simple shaped structu-

ral elements having enough strength and a high ductility must be chosen. There may be used load bearing shear walls and frames as well. The structural system must be limited only to the minimum number of structural elements because the layout of the structural elements must be simple, clear and uniform. One must avoid the elements with complicated shapes, unsymmetrical and nonuniform layout. It is better that the interior partitions to be nonstructural. It is very advantageous to use energy absorber elements that have the role of absorbing the seismic energy.

d) We draw the attention concerning the tendency in using light materials for all elements and nonstructural parts (interior partitions, doors, windows, floors, ceilings etc.).

The world tendency of a continual production and consumption in plastic material growth is also remarked.

The estimates show that in the year 2000 the plastic materials will reach about 78 per cent from the total production and consumption of the construction materials.

e) Test effecting is necessary for the knowledge of the strength and ductility properties of structural elements of the connections and even of the structures as a whole.

Tests should be done for one way static loading, alternative loading and dynamic loading.

- The fact that the prefabricated dwellings are realised in typical series comprising from several thousand flats to several hundred-thousand flats offers the possibility of making expenses for a deeper study of the protection measures against the earthquakes by using the most advanced analyzing and experimental methods.

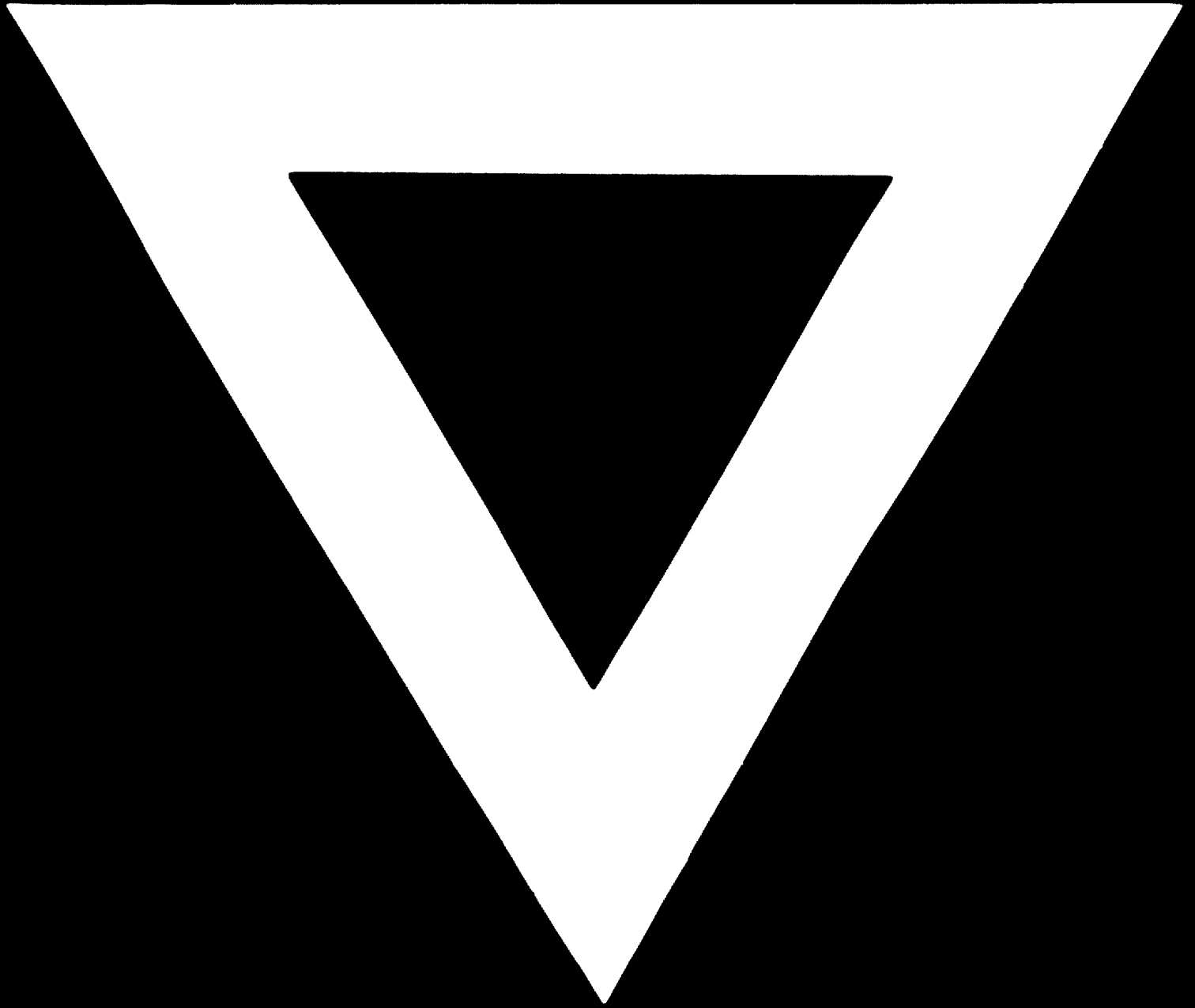
Thus there exists the possibility for buildings to have a higher safety as against the nontypized buildings.



- For the study of the most adequate solutions for the structural systems and for the study of the possibility of using the local materials it is advisable that in the realization of the research programmes the inter-regional cooperation between the countries concerned in the problem to be used.

f) For the designing of the prefabricated dwellings the elaboration of codes based on the most advanced tendencies in the earthquake engineering field is advisable.





**30. 11. 73**