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The influence of configuration on to the seismic resistance of a building

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Abstract

Configuration of a building, achieved by coordinating the demands of an urban project and designer's style, and conditioned by the building's function (interior design) and the choice of a structural system, has an effect on the building behaviour under earthquake. The need for greater freedom in design results in solutions that present a serious influence onto the seismic performances of a building. Consequences that can lead all the way to collapse demand for overall analyses and structural measures to achieve the set reliability degree of a building. Building configuration is defined in the initial design phases, when it is possible to evaluate the regularity of a structure and observe the influence of the proposed design solution onto the structural treatment (structure analysis, dimensioning, and modelling). It implies the design of regular structures (configuration) when it is necessary to provide the most economic design, building, and maximum predictability of the demanded seismic performances. Designing irregular structures, on the other hand, demands for a structural designer to be included from the initial stage of a conceptual design, the ability of an architect to accept necessary structural measures for seismic resistance and their integration into the design in order to reduce the consequences of irregularity and achieve the demanded aesthetic qualities without endangering the building integrity.

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1. Introduction

Configuration (arrangement, establisment of contours, exterior shape) of a building defines a shape, size and relations of building dimensions. The terms “building concept” or “conceptual design” are often just freely used terms by architects to identify the configuration, referring to architectural (functional) characteristics, such as interior planning and surface organization in a building. Strictly speaking, building configuration refers to the indicators of shape and dimensions of a building as a unity, resulting from the project solution and related to the geometric proportion of the building contours [1]. In a wider sense, the configuration includes the type, dimensions and position of structural elements, also emphasizing the significance of structural properties of a building.

Urban design and design plans for every settlement can influence the exterior of a building. In this context, urban planning demands sometimes dictate the maximum building heights, street profile (especially in densely populated urban surroundings), main building contours, need for an open first floor, vertical plane dimensions or other characteristics of architectural form. Regardless the fact that geometric parameters of a construction plot and the urban surrounding demands have an impact on the solution for a building’s foundations, the detailed design of the final building contours is based on the demands for the interior space design. The concept of an interior design includes the organization of adequate areas, by dimensions and shape, and the analysis of the surfaces for main contents of architectural space. Diverse solution variations for the interior space design in a building, in accordance with its function, can be linked to adequate possible solutions for the planned surfaces intended for human and material movements, communication zones (corridors, halls, staircases, elevators); they are based on a selection of one alternative or the combination of several alternatives. Quality of the space primarily depends on the properly set relations between individual functional zones in a facility. Wrong zoning or inadequate grouping of functional zones can destroy the overall functionality of a structure in general, resulting in a functional chaos in a building, unnecessary movement and wandering by building users. The functioning of the main (working) zones in a structure depends on the well organized movement scheme, as well as the safety of the building users and their in-time evacuation in the case of an accident or a fire.

Designing architectural structures implies to find the most satisfactory disposition, building foundation and appropriate height (number of floors) in order to satisfy the conditions defined in a project brief, yet also the selection of optimal and safe bearing structure to provide a rational solution and economic building of a structure [3].

2. Configuration of the seismically resistant buildings

With the selection of a configuration of a structure (building shape and dimensions), the architect directly influences the selection of the system of bearing elements in a structure, i.e. the structural system. The type, position and dimensions of main structural elements (columns, walls, floors, staircases), as well as the non-bearing walls and openings in the horizontal structural elements or exterior facade surface elements, have an impact on the behaviour of a structure under earthquakes.

Planning the interior space in a building is conditioned by the demand for a greater freedom in designing, coordination of the urban project demands, and the designer’s style, and often it results in solutions such as: soft story; discontinuity of shear walls; a variation in the bearing capacity and stiffness of elements along the building circumference; and the irregularity of shape that has a serious influence on the seismic performances of a building. The consequences that can lead all the way to collapse demand for overall analyses and structural measures to achieve the demanded degree of the structure reliability. The observations of these types of design solutions and the possible structural measures are presented in tables: soft story (Table 1), discontinuity of shear walls (Table 2), variations in perimeter strength and stiffness (Table 3), and irregularity building forms in the plan (Table 4).