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Cracks in circular reinforced concrete columns occurring during the construction process

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Abstract

In the paper, the origins of cracks in reinforced concrete columns occurring during the construction process are discussed. The development of the cracks was analyzed using equations of deformations and stresses for long cylinders proposed by S. Timoshenko. Collocation of the reinforcement in circular cross sections was discussed.

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Keywords: reinforced concrete column; cracks in columns; stresses due to temperature in circular columns; shrinkage deformations

1. Introduction

Cracks in reinforced concrete structures can occur in the early stage of the concrete maturing process [5]. They may originate from temperature differences between the internal and external layers of the concrete element as well as the shrinkage process. Shrinkage deformation increases in time and depends on many factors, for example: the preparation process, placing of the concrete, compacting, curing of the concrete mix, and the shape of the cross section which is defined as the ratio of the area of the cross section to the perimeter. The appearance of cracks raises concern about the durability and safety of the structure, especially when their origin remains unknown [1]. In the

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code PN-EN 1992-1-1:2008 [C1] p. 7.3.1 it is stated: “Cracking is normal in reinforced concrete structures subject to bending, shear, torsion or tension resulting from either direct loading or restraint of imposed deformation.”. However, this statement does not relate to reinforced concrete columns, where cracks may have diverse morphology. In this paper, behavior of circular concrete columns in the early maturing stage was analyzed based on an office building in Warsaw. Temperature influence in the concrete hardening process was solved using equations of deformation and stresses equation for cylinders proposed by S. Thimoshenko [10].

2. Brief description of the building

The office building is 56.67 m tall. Its cross section is a circular segment, with a chord of 85.60 m and sagitta of 29.20 m at the terrain level. The building has two elevations: surface close to plain set by chords of the circles and a convex surface set on arches of the circular segments (Fig. 1). In the central part of the circular segment, there is a dilatation, which splits the building into two parts. In the building, there are sixteen floors above the ground level and two underground floors. The first floor height is 5.50 m, while the other floors are 3.6 m tall. Above the sixth floor above ground level the convex elevation is recoiled in relation to the lower part of the building.

The structure has slabs and columns with two internal rigid cores located close to each other in the internal part of the building, close to the dilatation.

Axes of the columns are not located in the nodes forming an irregular modular net. In the longitudinal direction (perpendicular to the chord) the net is mostly spaced every 7.50 m. In the other direction there are two modular nets designed. Distances between columns vary between 2.70 m and 10.30 m. Square columns were designed in the nodes of the rectangular modular net. Circular columns were designed at the cross section of the modular net perpendicular to the chord and arched modular nets. Slabs were designed as 25 cm thick, concrete class C30. At the dilatation and the bays the cantilever slabs are strengthened with beams, which are connected with the reinforced concrete core of the building. Layout of the typical cross section between the second and sixth floor is presented in Figure 1. The view of the designed open space is presented in Figure 2.

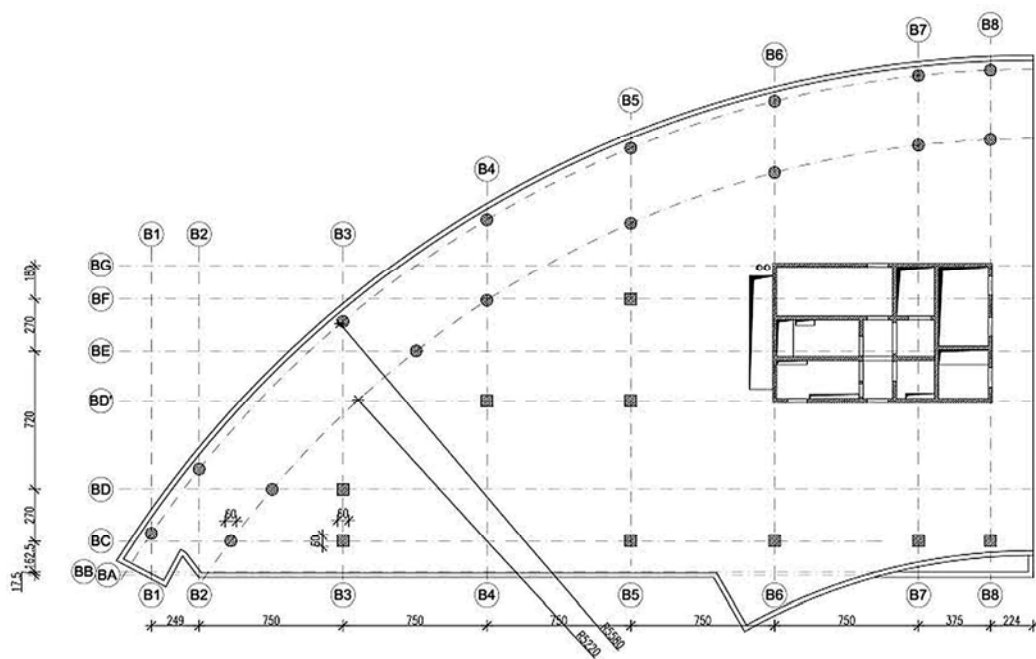


Fig. 1. Layout of the typical cross section between second and sixth floor

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