



Numerical Analysis of Pre-fabricated Reinforced Concrete Beams with Longitudinal Cavities

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Abstract

Pre-fabricated reinforced concrete beams are widely used within the construction industry, due to the method of construction being rational, time-saving and economical. However, the beams become very large and heavy when the span length exceeds 9m. The weight of the beam is a much more important factor for the pre-fabricated structural elements than that in in-situ casted, due to challenges in transportation and assembly. In addition, the weight reduction intuitively lowers the load on the structure itself. However, the weight reduction measures tend to reduce the structural capacity, so it is important to thoroughly study the structural performance of the modified design. Therefore, to reduce the weight of reinforced concrete beams with cross-shaped cross-sections, the possibility of introducing longitudinal circular cavities along the beams is studied. An existing beam with a cross-shaped cross-section was modified by the proposed longitudinal cavities, achieving 9% weight reduction. The cavities were proposed at a distance of the effective depth of the beam from the face of the supports, to maintain the required shear capacity of the cross-section. A numerical analysis of both the initial and the modified designs was then carried out, using non-linear finite element software (i.e. ATENA), to study the structural performance of the new modified design and compare it with the original design.

Keywords: Pre-fabricated concrete beams, weight reduction, numerical analysis

1 Introduction

Precast concrete elements are becoming more and more popular in the construction industry. The precast elements are cast into many different shapes and sizes, including walls, beams, columns, slabs and more. In general, structural systems are composed of precast concrete elements that are joined together in a mechanical way, for example using bolts, welds, reinforcing steel, and grout and concrete in the joints[1]. Moreover, it is vital to ensure the structural integrity of the whole structure during design, construction and

maintenance. The beam-column system is one of the precast concrete structural systems used in building frames, which can be used for building many storeys. The precast beams in a beam-column system can be made up of pre-stressed or reinforced concrete. When a span length becomes long then pre-stressed beams are more economical than reinforced concrete beams. It is vital to consider the height, width, length and weight limitations of the precast concrete members, in relation to lifting and transportation. During the raising of beams for transportation or assembly, they should be supported only at the designated