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Performance Analysis of Recycled and Natural Aggregate Concrete Column with Varying Design Parameters

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Abstract

An analytical approach is made to show the performance of recycled aggregate concrete (RAC) columns with varying design parameters and to compare these with natural aggregate concrete (NAC) columns. The design parameters taken into consideration include concrete compressive strength, steel yield strength, longitudinal reinforcement ratio, and applied axial load. These factors were considered for two different aspect ratios which ensure flexural failure behaviour of column. A two-level factorial analysis was performed, and the columns were modelled and analysed using SeismoStruct, a finite element analysis software. The observed responses include: base shear capacity and displacement at first cracking; first yielding of steel; first crushing of concrete; and the ductility of the column. The pushover analysis was used to determine the performance of each column and statistical software R was used for the analysis of variance (ANOVA), which determines the percent contribution of each design parameter and their interactions on various performance criteria. The analysis shows that, RAC columns perform with improved ductility compared to NAC column.

Keywords: Recycled Aggregate Concrete; Recycled Concrete Column; Factorial Analysis; Pushover Analysis; R; Ductility.

1 Introduction

Concrete is the most widely used construction material around the world for building homes, high-rises, industrial projects, and many other types of significant structures. In recent years, the consideration of both environmental and economic factors has led to the development and use of green or sustainable concrete. One of the most promising forms of green concrete is recycled aggregate concrete (RAC), which utilizes a partial or complete replacement of coarse natural aggregate (NA) with recycled concrete aggregate (RCA). The use of RCA substantially reduces the demand of NA, which thereby decreases the cost and environmental impacts associated with the production and transportation of NA. It is estimated that 17% of landfill volumes worldwide is demolished or unused concrete [1]. As typical concrete mixture contains approximately 41% coarse aggregate by volume [2], recycling this component carries the potential to drastically reduce the volume of waste. In many countries, governments are imposing strict regulations on reducing greenhouse gas emissions in various sectors. For instance, Canada has a mandate to reduce more than 30% greenhouse gas emission by 2050 compared to what was in 2015. Besides, many countries provide incentives in various forms for utilizing/recycling industrial wastes. Contractors/Builders have advantageously started utilizing RAC in major projects particularly in developing countries where NA is too expensive or not readily available. However, RAC is only

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