



XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP) (TFoCE 2014)

Numerical Simulations of a Wedge Splitting Test for High-Strength Concrete

Marta Sitek^{a*}, Grzegorz Adamczewski^b, Marcin Szyszko^b, Bartłomiej Migacz^b,
Paweł Tutka^b, Maja Natorff^b

^aDepartment of Structural Mechanics and Computer Aided Engineering, Faculty of Civil Engineering, Warsaw University of Technology, al. Armii Ludowej 16,00-637 Warsaw, Poland

^bDepartment of Building Materials Engineering, Faculty of Civil Engineering, Warsaw University of Technology, al. Armii Ludowej 16,00-637 Warsaw, Poland

Abstract

The paper presents results of wedge splitting tests (WST) for high-strength concrete performed in a laboratory and an attempt to develop a numerical model of the test. Characteristics of high-strength concretes as well as the experimental setup of WST are presented. The numerical simulation is performed in Simulia Abaqus software and the outcomes are compared to experimental values.

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Peer-review under responsibility of organizing committee of the XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP)

Keywords: wedge splitting test; high-strength concrete; Finite Element; Abaqus; concrete cracking;

1. Introduction

The main goal of this paper is to compare results from experimental and numerical analysis of a wedge splitting test for high-strength concrete. The experimental part of the research was performed by the Students Scientific Association of Building Materials Engineering within a Rector's grant "A study on technical characteristics of advanced cement concretes" [1]. The numerical simulations were developed by the members of the Students Association of Numerical Modeling in a general purpose software Simulia Abaqus 6.11.

* Corresponding author. Tel.: +48-22-234-65-05; fax: +48-22-825-65-32.
E-mail address: m.sitek@il.pw.edu.pl

2. High-strength concrete

According to the EN-206-1 standard, a high-strength concrete is a concrete of compressive strength class minimum C50/C60 for normal concrete or dense concrete and higher than LC50/55 for light concrete [2].

High-strength properties of the concrete mixture are obtained by modifying the composition with appropriate additives and reduction of the water - cement ratio. Micro-fillers, such as fly ash and silica fume, are added to obtain a denser structure and a greater contact surface between aggregates and cement paste. Water - cement ratio in this type of concrete should be less than 0.4, usually in the range of 0.21÷0.38. Those values can be achieved due to usage of various kinds of plasticizers and super plasticizers. Selecting a proper type of aggregates is also critical. Their strength, size and shape should be considered. Crushed-stone aggregates obtained from high-strength rocks (>150MPa), such as granite, syenite or basalt, have the highest quality. The shape should be close to cubic and the surface should have an appropriate roughness.

The high-strength concrete composition is presented in table 1.

Table 1. High-strength concrete composition.

Ingredient	content [kg/m ³]
cement CEM I 42.5R	450
water	144
microsilica	31.5
sand 0/2	924
granite 2/4	459
granite 4/8	498
superplasticizer	9

3. Wedge splitting test

Wedge splitting test is a test method useful especially for testing fracture properties of brittle materials such as concrete, due to the well-controlled crack width development [3,4]. WST is widely used in testing various types of concretes [5, 6, 7]. It is a suitable method for establishing splitting tensile strength, which is related to tensile strength and fracture energy. Although concrete is not expected to withstand tension, establishing this value is necessary to determine critical load causing cracking.

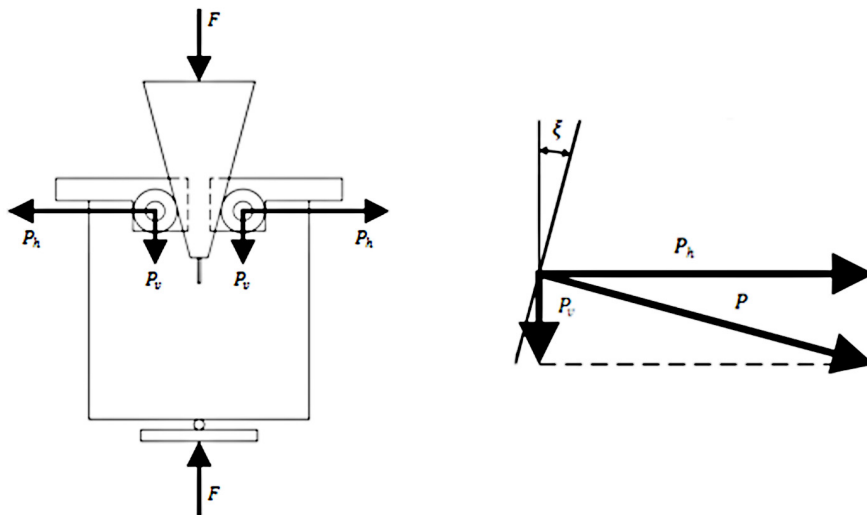


Fig. 1. Geometry and loading of a WST specimen.

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