IMPROVING THE PERFORMANCE OF RC BEAM WITH CIRCULAR OPENING USING HYBRID FIBRES

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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Penyelidikan ini membentangkan kajian mengatasi kehilangan kekuatan dalam rasuk konkrit yang mempunyai pembukaan dengan menggunakan gentian hibrid. Untuk mengatasi kehilangan kekuatan di dalam rasuk konkrit dengan pembukaan, gentian kenaf dan gentian keluli (gentian hibrid) telah ditambah semasa dalam proses membancuhan konkrit. Kajian ini merangkumi empat sampel rasuk iaitu tiga rasuk konkrit dengan pembukaan bulat di pusat yang ditambah 1% gentian hibrid dan 2% gentian hibrid, sementara dua rasuk konkrit yang lain bercampur tanpa gentian hibrid dengan salah satu rasuk konkrit termasuk pembukaan bulat untuk digunakan sebagai rasuk kawalan rujukan. Selain itu, ujian yang terlibat adalah ujian penurunan, ujian kiub, dan ujian lenturan. Ujian ini dijalankan untuk mendapatkan nilai sebenar beban maksimum yang dapat diatasi oleh sampel ujian. Perbandingan antara sampel ujian dibuat dengan semua data yang dikumpulkan. Hasil yang diharapkan dari kajian ini adalah peningkatan dalam prestasi keseluruhan yang meliputi kekuatan dan daya tahan dalam rasuk dengan pembukaan yang ditambahkan gentian hibrid. Hasil kajian di akhir experimen yang diperoleh menunjukkan bahawa Vf = 1% dan Vf = 2% berjaya meningkatkan kekuatan dan mengubah mod kegagalan dari lenturan ke ricih.

ABSTRACT

The research presents the study of overcoming the loss of strength inside RC beams with opening by the use of hybrid fibre. In order to overcome the loss of strength inside the RC beam with opening, mixture of kenaf fibre and steel fibre (hybrid fibre) was added during the concrete mix design. This study includes four beam sample which is three RC beams with circular opening at the centre that were added 1% hybrid fibre and 2% hybrid fibre, while the other two RC beams are mix without hybrid fibre with one of the RC beam includes circular opening to be used as reference control beam. Apart from that, the testing involved are the slump test, cube test, and flexural test. This test was conducted to obtain the exact value of the maximum load that the test sample can withstand. Comparison among the test sample are to be made with all the data collected. The expected outcome of this research is the increase in performance that includes strength and durability in beams with opening that were added hybrid fibre. The result obtained in the end of the experiment showed that Vf=1% and Vf=2% managed to increase the strength and changed the failure mode from bending to shear.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

kN	Kilo Newton
mm	Milli Metres
μ	Ductility
MPa	Mega Pascal
Py	Load at Yield
Pu	Ultimate Load Failure
Pmax	Maximum Load
δy	Deflection at Yield
Vf	Volume of Fraction
NaOH	Sodium Hydrioxide
%	Percentage

LIST OF ABBREVIATIONS

RC	Reinforced Concrete
Rebar	Reinforcement Bar
FRC	Fibre Reinforced Concrete
HFRC	Hybrid Fibre Reinforced Concrete
Lab	Laboratory
OMC	Optimum Moisture Content
Max	Maximum
Vs	Versus
UMP	Universiti Malaysia Pahang
BS	British Standard
Vf	Volume Fraction

CHAPTER 1

INTRODUCTION

1.1 Background of Research

Reinforced concrete (RC) nowadays have become the norm of the construction world (Yakut, 2008). Due to the provided reinforcement, RC can also withstand a good amount tensile stress and with a fair behaviour for fire and weather resistance of RC (Marten, 2011). Today, RC is the best choice for building material in the usage of the buildings main support like column, beams, and slab (Reza, 2016). As for today's construction of modern buildings, utilities like pipes, duct, wires have become absolutely necessary to accommodate crucial role in providing services such as air-conditioning, electricity, telephone, water supply, and sewage. The height of the empty space varies to the amount and types of connecting channels that needed to be stored and as a consequence, it lessens to the floor height in buildings. Figure 1.1 shows the examples of mainstream false ceiling in today's world.

Figure 1.1 Example of fake ceiling

Source: Coreybryant.org. "Drop Ceiling"

For some buildings, in order to maintain the building's function, the design of these types of buildings will have the column to be located far away from each other resulting a much larger beam needed to withstand the load. The large beam in some cases can block the building's utilities path resulting to the beam needed to be add an opening so that the main utilities like electricity, piping for fire sprinkler and air duct can be arrange to the whole building in order to ensure the building's facilities functioning as proposed (Saeed, 2014).

Beam with opening will obviously lessen the strength of the beam internally and externally and negligence of safety factor may end with a catastrophic outcome like the failure of the beam and even the whole building collapsing (Jabbara, Hejazib, Mahmod, 2016). Among the method to strengthen the beam are by adding steel rod to the opening's peripheral in order to strengthen it internally. Some other method is the usage of additional substances during the concrete mix design like fibres and polymer.

Fibres are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, and shatter-resistance in concrete. Thus, the considerable improvement in the post-cracking behaviour of concrete containing fibres due to both plastic shrinkage and drying shrinkage are among the primary factors fibres are being used in Fibre Reinforced Concrete (FRC) (Sonasath, 2014). Among the common types of fibres are steel fibres, glass fibres, carbon fibres. Other types of fibres include the natural fibres such as kenaf fibres and coir while synthetic fibres such as polypropylene fibres and nylon fibres. In addition, the character of FRC changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. With the positive impacts of fibres are widely known (Kilbride, 2013), some two of the different types of fibres can give a greater outcome when mixed together otherwise known as Hybrid Fibre creating much more stronger and stiffer bond between the fibres. Hybrid fibres can provide a system in which one type of fibre, this is stronger and stiffer, improves the first cracks stress and ultimate strength, and the second types of fibre, which is more flexible, and ductile leads to improved toughness and stain in the past cracking zone (Mohankar, Pidurkar,

Thakre, Pakhare, 2016). This study comprises the mixture of steel fibre which acts as the strong and stiff component while kenaf fibre as the flexible component. In theory, this combination would increase the strength of the concrete.

1.2 Problem Statement

In this research, the investigation is about to add the mixture of steel fibre and kenaf fibre (hybrid fibre) in the concrete mix design used in the construction. The addition of openings for concrete beam will causes it to behave differently than a simple concrete beam without an opening (Hart, 2006). This is due to the facts that the changes in cross-sectional dimension of the beam and not to mention are subjected to high stress concentration that may lead to wide cracking that is unacceptable from aesthetic and durability viewpoints and may lead to the collapse of the beam or even the whole building. The reduced stiffness of the beam with opening may also give rise to excessive deflection under service load and result in a considerable redistribution of internal forces and moments in continuous beam. This may lead to an after-effect of the building to be marked unsafe by the authorities as the building could collapse if the main beams aren't capable of transferring load to the column without failing. Even so, if those unacceptable failures are discovered during the contract period, the contractor will be responsible for repairing or even redesign the beam until it is considered safe all at his expense. Regardless of the outcome, further delay to the roadway, in which the beam is constructed. (El-Karim, 2015). Therefore, there is a need in a better solution that can prevent or at least minimize the number of cracks for beams with opening. Unless special reinforcement is provided in sufficient quantity, the strength of such beam may be reduced to a critical degree.

Generally, the solution when including an opening for the usage of small pipes on condition that additional reinforcement is added around the periphery of the opening and some other initiative like adding the Fibre-reinforced polymer (FRP). As time goes by, there's a few challenges emerge in as the usage of FRP as the monomers of polymer can be volatile, combustible and toxic. Initiators, which are used as catalysts, are combustible and harmful to human skin. The promoters and accelerators are also dangerous (Azwani Sofia, 2015). Among other approaches is by adding carbon fibre inside the concrete mix design called Carbon Fibre-reinforced concrete (CFRC).

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