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BEHAVIOUR OF REINFORCED CONCRETE BEAMS WITH KENAF AND STEEL HYBRID FIBRE

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ABSTRACT

This paper presents the effect of kenaf fibre and steel fibre mixed and added into reinforced concrete beams. In investigating the structural behaviour of the beams, four-point bending tests were conducted on six beams by considering two distinct parameters; (i) shear reinforcement arrangement (ii) volume of fraction of kenaf fibre and steel fibre. The experimental work consists of six beams, three beams with full shear reinforcement added with fibres by a volume fraction of V_f = 0%, Vf = 1% and V_f = 2%, respectively. Whilst, the other three beams tested with a reduced amount of shear reinforcement added with fibres with a volume fraction of, V_f = 0, V_f = 1% and V_f = 2% were examined. The beam with V_f = 0% kenaf and steel fibre in full shear reinforcement was taken as the control beam. The experimental result suggests promising enhancement of the load carrying capacity (up to 29%) and ductility (up to 22%) as well as controlled crack propagation for the beams with V_f = 1%. Additionally, it was observed that addition of fibres changes the mode of failure of the beam from brittle to a more ductile manner.

Keywords: Kenaf fibres, ductility, load carrying capacity, mode of failure, hybrid fibre, reinforced concrete beam, steel fibre.

INTRODUCTION

Fibre reinforced concrete has been given due attention by researchers over the past few decades (Swamy and Lankard, 1974), (Sharma, 1986), (El-Niema *et al.*, 1991), (Syed Mohsin, 2012). This is essentially due to its capability of enhancing the load carrying capacity and ductility of the concrete structures. It also changes the mode of failure, control cracking propagation as well as increasing energy absorption. Furthermore, recent findings suggest that that fibres also have the potential to serve as part of shear reinforcement in reinforced concrete structures (Syed Mohsin, 2012), (Azimi *et al.*, 2014), (Abbas *et al.*, 2014).

Steel fibres have also demonstrated its capability in improving the structural behaviour of reinforced concrete beams (Mansur and Ong, 1991), (Kwak *et al.*, 2002), (Syed Mohsin *et al.*, 2012), (Abbas *et al.*, 2014). Recent studies also suggest that the addition of fibres to reinforced concrete beams with reduced shear reinforcement restores the strength and ductility of the beam (Abbas *et al.*, 2014), (Syed Mohsin *et al.*, 2014). Based on the literature, the study of hybrid fibres (steel and kenaf) to improve the structural behaviour of the reinforced concrete beams and simultaneously serve as part of shear reinforcement in beams has yet been explored. This study attempts at investigating the aforementioned structural properties of a novel hybrid kenaf-steel fibre reinforced concrete.

METHODOLOGY

Preparation of cubes and reinforced concrete beams for testing

Table-1 lists three sets of concrete mixture proportions used in the present research. Kenaf fibres included in the mixtures were 30 mm of length with a diameter that ranges between 0.1 mm to 2 mm as shown in Figure-1. The hooked end type steel fibres with a length of 60 mm and a diameter of 0.75 mm were added into the mixtures as depicted in Figure-2.

Table-1. Concrete mixture.

MATERIALS	Mix 1 (V_f= 0%)	Mix 2 (V_f= 1%)	Mix 3 (V_f = 2%)
Cement (kg/m^3)	510	510	510
Aggregates (kg/m^3)	308	308	308
Sand (kg/m^3)	848	848	848
Water(L/m^3)	204	204	204
W/C ratio	0.4	0.4	0.4
Superplasticizer (L/m^3)	5	5	5
Kenaf fibre(m^3)	0	8.44×10^{-5}	1.688×10^{-4}
Steel fibre (m^3)	0	2.53×10^{-4}	5.06×10^{-4}

Figure-1. Kenaf fibre.