

Research Article

An Investigation on Engineering Properties of Composite Beam

Sayed Javid Azimi, Sharifah Maszura Binti Syed Mohsin, Fadzil Bin Yahaya and Abdoullah Namdar
Department of Civil Engineering and Earth Resources, Universiti Malaysia Pahang, Malaysia

Abstract: There is several agriculture waste materials have continuously been producing. The oil palm shell has been used to produce Oil Palm Shell Concrete (OPSC). And by use of 1% Kenaf-Oil Palm Shell mixture, a natural composite concrete (OPS-kenaf concrete) has been made. The time to failure, stroke and flexural strength of concrete beams have been studied. The concrete cubes have also been tested to identify time to failure and compressive strength of proposed concretes. The results have been indicated that 1% kenaf-OPS mixture enhances flexural strength of beam. And also the stroke and time to failure have not considerably been changed. The significant effect has not been observed on morphology of crack. The compressive strength of (OPS-1% kenaf mixture) has been improved. This new proposed composite concrete beam has acceptable effect on minimizing environment pollution.

Keywords: Crack, flexural of strength, kenaf, OPS, time to failure

INTRODUCTION

The possible improvement of the Oil Palm Shell Concrete (OPSC) using natural fibers, such as kenaf fiber is an interesting issue in construction materials and structural engineering.

The oil palm shell reinforced concrete has lower bond between oil palm shell and matrix due to concave and convex smooth surface (Mannan and Ganapathy, 2004). The OPS has been recommended as a coarse aggregate for the production of low-cost and lightweight concrete (Teo *et al.*, 2006). The natural fibre enhances toughness, crack morphology, durability, fatigue and resistance of concrete (Jumaat *et al.*, 2009; Cook *et al.*, 1978; Viswanathan and Gothandapani, 1999) and it has been used in construction of tiles, corrugated roofing sheets, pipes, gas tanks, water tanks and silos (Elsaid *et al.*, 2011). The kenaf fibre has the potential to be used as reinforcement (Elsaid *et al.*, 2011). The natural fibres is a cost effective materials (Udoeyo and Adetifa, 2012). The Oil Palm Shell Reinforced Concrete Beams (OPS_RCB) exhibited higher ductile behavior compared to the beams made of NWC (Shafigh *et al.*, 2011b; Mannan *et al.*, 2002). Lightweight Aggregate Concrete (LWAC) such as Oil Palm Shell Reinforced Concrete (OPSRC) allows designer to design an economical section (Domagala, 2011; Ke *et al.*, 2009). The method and duration of curing have significant influence on the engineering properties for OPS concretes (Mannan *et al.*, 2002). The shear strength of OPS concrete beam is slightly higher than normal concrete beams (Jumaat *et al.*,

2009). OPS concrete in existence of super plasticizer has a good workability (Shafigh *et al.*, 2011a).

The main objective of this research study is to investigate on flexural and compressive strength of composite concrete beam, to apply waste agriculture materials in construction industry and introduce a safe lightweight structure element with acceptable flexibility.

EXPERIMENTAL SET-UP AND MATERIALS PREPARATION

The Ordinary Portland Cement (OPC) with specific gravity of 3.14 (g/cm³) has been used and 1% of cement weight, the Superplasticizer (SP) with EN 934-2 grade, product of Sika visocrete has been mixed to the concrete, for achieve better workability. According to the (Shafigh *et al.*, 2011a) the Superplasticizer (SP) enhances the workability of OPS concrete.

The potable water has been used for all mix design. The Oil Palm Shell (OPS) has been collected from a palm oil factory, washed in laboratory with tap water, dried in oven with subject to 100°C heats, sieved with exact size of 10 mm and finally replaced as coarse aggregate in concrete mix design.

The second material in this composite concrete beam is long kenaf, it has been cleaned from non-fibrous debris, cut to size of 3 cm and used in concrete mix design with quantity of 1% weight of concrete. The beam has been made with 100×100×500 mm dimensions. Ordinary Portland Cement (OPC), sand, oil palm shell as aggregate and water have been used for

Corresponding Author: Abdoullah Namdar, Department of Civil Engineering and Earth Resources, Universiti Malaysia Pahang, Malaysia

This work is licensed under a Creative Commons Attribution 4.0 International License (URL: <http://creativecommons.org/licenses/by/4.0/>).



Fig. 1: Palm oil shell in natural form, factory and laboratory

Table 1: Proportion of materials for OPS concrete grade 20

Ingredients	Amount (kg/m ³)
W/C ratio	0.42
Water	209.10
Cement (portland)	510
Fine aggregate (sand)	800
Coarse aggregate (OPS)	350
Superplasticizer	5.10

casting composite concrete (Fig. 1 and Table 1). After 28 days of curing, the flexural strength of Oil Palm Shell Concrete (OPSC) beams and compressive strength of OPSC cubes have been measured. The OPSC and composite concrete of (OPS-kenaf concrete) have been produced by using conventional method. The W/C ratio has been selected according to Table 1. To produce OPS concrete, the cement paste has been made in first phase and subsequently fine and coarse aggregate have been added. Addition of 1% kenaf to OPS concrete, produce a composite concrete. The kenaf has to be uniformly mixed in concrete, to improve flexural strength of composite beam. The concretes have been poured into mould and vibrated by vibration table. The specimens have been covered by using wet sack for 24 h and demoulded. The sack has been remained on beams and saturated 3 times/day to complete curing of 28 days. The specimens have been marked then placed in the machine under right angle to the rollers for testing. The strain gauges have been installed on one third of end at each side of the beams and for cube in the center of cube face. The maximum linear applied force, stroke and time to failure have been recorded by using strain gauges.

RESULTS AND DISCUSSION

The mechanical properties of the composite concrete and OPSC have been investigated. The time to failure, stroke and flexural strength of concrete beams have been studied. The concrete cubes have also been tested to identify compressive strength and time to failure of concretes. The composite concrete exhibits acceptable flexural strength compare to the OPSC (Fig. 2 and 3). The stroke and time to failure have not considerably been changed in both beams (Fig. 2 to 5). It is occurs due to weak bonding between Kenaf and OPS. The compressive strength of composite beam (OPS-1% kenaf mixture) has been improved. The kenaf improves compressive strength of concrete (Fig. 6 and 7). The morphology of crack in both cases is shear

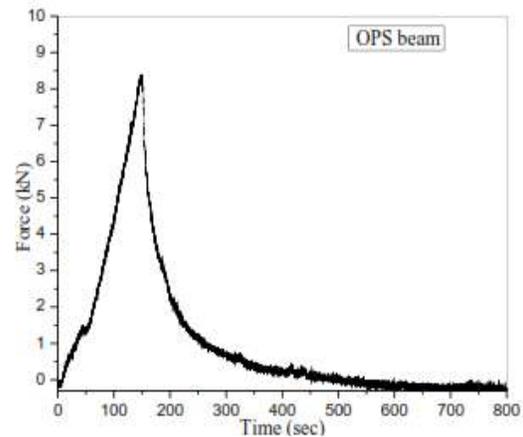


Fig. 2: Force vs. time to failure for OPSC beam

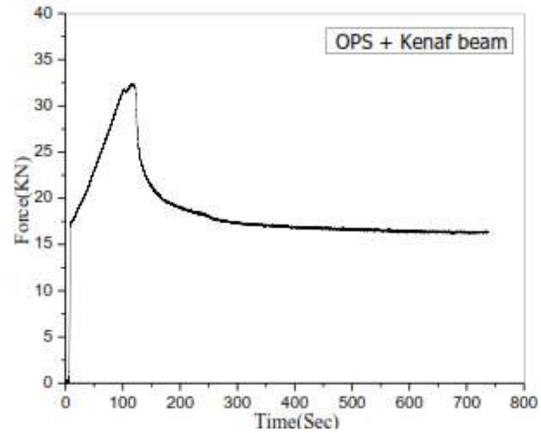


Fig. 3: Force vs. time to failure for OPS+1% kenaf concrete beam

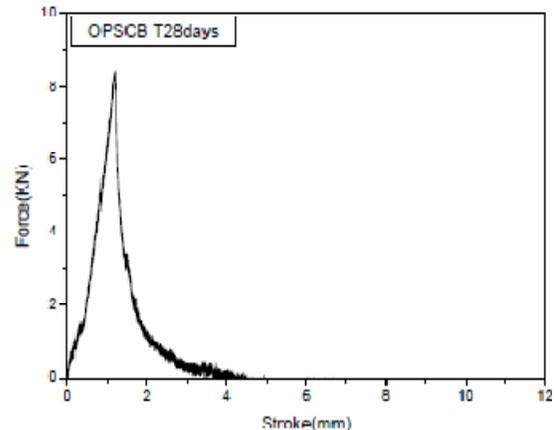


Fig. 4: Force vs. stroke for OPSC beam

crack (Fig. 8). The time to failure has direct relationship with crack morphology. According to the result of research work has been reported by Namdar *et al.* (2013), a beam subjects to flexural force, the shear crack converts to flexural crack, due to increase of time to failure.

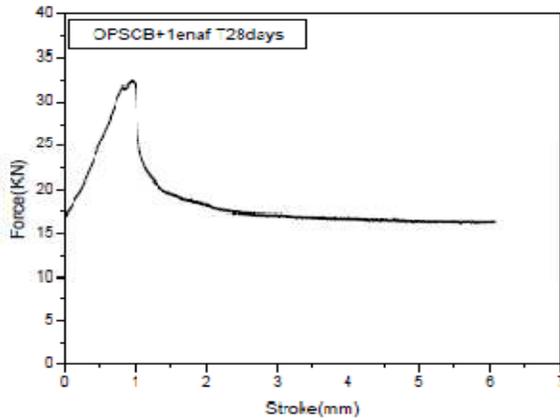


Fig. 5: Force vs. stroke for OPS+1% kenaf concrete beam

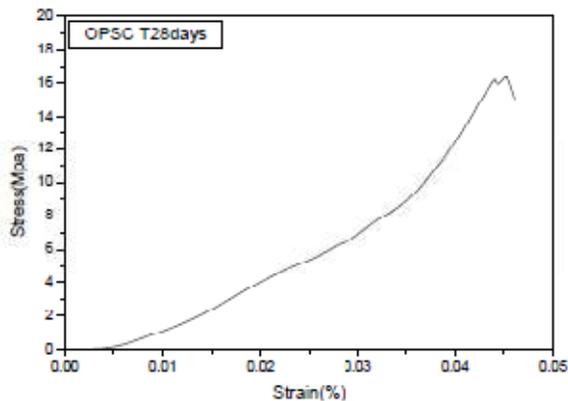


Fig. 6: Stress vs. strain for OPSC cube

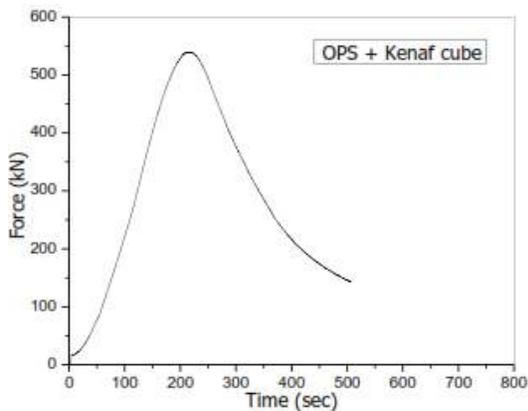


Fig. 7: Force vs. time to failure for OPS+1% kenaf concrete beam



Fig. 8: Failure mode for OPS+kenaf concrete beam

CONCLUSION

The composite concrete of (OPS-1% kenaf mixture) exhibits acceptable flexural strength compare to the OPS Concrete of (OPSC). The stroke and time to failure have not considerably been changed in both beams. The compressive strength of composite beam (OPS-1% kenaf mixture) has been improved. The morphology of crack in both cases is shear crack. The time to failure has direct relationship with crack morphology. According to the results of research study has been reported by Namdar *et al.* (2013), the shear crack converts to flexural crack on a beam, due to increase time to failure.

REFERENCES

- Cook, D.J., R.P. Pama and H. Weerasingle, 1978. Coir fibre reinforced cement as a low cost roofing material. *Build. Environ.*, 13(3): 193-198.
- Domagala, L., 2011. Modification of properties of structural lightweight concrete with steel fibres. *J. Civ. Eng. Manag.*, 17(1): 36-44.
- Elsaid, A., M. Dawood, R. Seracino and C. Bobko, 2011. Mechanical properties of kenaf fiber reinforced concrete. *Constr. Build. Mater.*, 25(4): 1991-2001.
- Jumaat, M.Z., U. Johnson Alengaram and H. Mahmud, 2009. Shear strength of oil palm shell foamed concrete beams. *Mater. Design*, 30(6): 2227-2236.
- Ke, Y., A.L. Beaucour, S. Ortola, H. Dumontet and R. Cabrilac, 2009. Influence of volume fraction and characteristics of lightweight aggregates on the mechanical properties of concrete. *Constr. Build. Mater.*, 23(8): 2821-2828.
- Mannan, M.A. and C. Ganapathy, 2004. Concrete from an agricultural waste-Oil Palm Shell (OPS). *Build. Environ.*, 39(4): 441-448.
- Mannan, M.A., H.B. Basri, M.F.M. Zain and M.N. Islam, 2002. Effect of curing conditions on the properties of OPS-concrete. *Build. Environ.*, 37(11): 1167-1171.
- Namdar, A., I.B. Zakaria, A.B. Hazeli, S.J. Azimi, A.S.B. Abd. Razak and G.S. Gopalakrishna, 2013. An experimental study on flexural strength enhancement of concrete by means of small steel fibers. *Fract. Struct. Int.*, 26(2013): 22-30.
- Shafiq, P., M.Z. Jumaat and H. Mahmud, 2011a. Oil palm shell as a lightweight aggregate for production high strength lightweight concrete. *Constr. Build. Mater.*, 25(4): 1848-1853.
- Shafiq, P., H. Mahmud and M.Z. Jumaat, 2011b. Effect of steel fiber on the mechanical properties of oil palm shell lightweight concrete. *Mater. Design*, 32(7): 3926-3932.

- Teo, D.C.L., M.A. Mannan and V.J. Kurian, 2006. Structural concrete using Oil Palm Shell (OPS) as lightweight aggregate. *Turk. J. Eng. Environ. Sci.*, 30(4): 251-257.
- Udoeyo, F.F. and A. Adetifa, 2012. Characteristics of kenaf fiber-reinforced mortar composites. *Int. J. Res. Rev. Appl. Sci.*, 12(1): 18.
- Viswanathan, R. and L. Gothandapani, 1999. Mechanical properties of coir pith particle board. *Bioresource Technol.*, 67(1): 93-95.