EFFECTS OF SHREDDED WASTE PAPER AS AN ADDITIVE ON PROPERTIES OF CONCRETE AND STRUCTURAL BEHAVIOUR OF REINFORCED CONCRETE BEAM

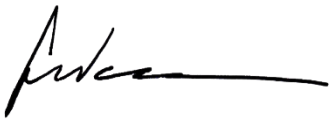
SOLAHUDDIN BIN AZUWA

MASTER OF SCIENCE

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.



(Supervisor's Signature)

Full Name : IR. DR. FADZIL BIN MAT YAHAYA

Position : SENIOR LECTURER

Date : 18TH JULY 2022

STUDENT'S DECLARATION

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.

(Student's Signature)

Full Name : SOLAHUDDIN BIN AZUWA

ID Number : MAH18002

Date : 18TH JULY 2022

EFFECTS OF SHREDDED WASTE PAPER AS AN ADDITIVE ON PROPERTIES OF CONCRETE AND STRUCTURAL BEHAVIOUR OF REINFORCED CONCRETE BEAM

SOLAHUDDIN BIN AZUWA

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Master of Science

FACULTY OF CIVIL ENGINEERING TECHNOLOGY
UNIVERSITI MALAYSIA PAHANG

JULY 2022

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my main supervisor Ir. Dr. Fadzil Bin Mat Yahaya for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He always impressed me with his outstanding professional conduct, strong conviction for science and belief that a Master program is only the start of a lifelong learning experience. I appreciate his consistent support from the first day. I applied to the graduate program to these concluding moments. I am truly grateful for his progressive vision about my science training, his tolerance of my naïve mistakes and his commitment to my future career. I also sincerely thank you for the time spent proofreading and correcting my many mistakes.

My sincere thanks go to all my lab mates and staffs of Civil Engineering, Universiti Malaysia Pahang (UMP), who helped me in many ways and made me stay at UMP pleasant and unforgettable. Many special thanks go to the member engine research group for their excellent cooperation, inspiration and supports during this study.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I acknowledge the sincerity of my parents, who consistently encouraged me to carry on my higher studies in Malaysia. I am also grateful to my family for their sacrifice, patience and understanding that were inevitable to make this work possible. I cannot find the appropriate words that could adequately describe my appreciation for their devotion, support and faith in attaining my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which are crucial for successfully completing this study.

ABSTRAK

Kitar semula Kertas Buangan (WP) berkesan merupakan salah satu pendekatan alternatif untuk mengurangkan peningkatan pelupusan WP dan mengehadkan tapak pelupusan sampah. Pelbagai teknik telah diperkenalkan untuk menggunakan semula WP, termasuk sebagai bahan tambahan dalam campuran konkrit untuk menghasilkan konkrit mesra alam untuk aplikasi pembinaan, seterusnya mengurangkan kos pembinaan dan memelihara hutan dan sumber asli yang semakin berkurangan. Kajian terdahulu telah menunjukkan bahawa konkrit dengan WP mempunyai kekuatan mampatan dan lenturan yang lebih besar berbanding dengan konkrit tanpa WP, yang berpotensi menggantikan simen Portland dalam pembuatan konkrit. Namun begitu, kepentingan SWP belum dinilai sepenuhnya dalam campuran konkrit dan perkembangan RCB. Oleh itu, penyelidikan ini mengkaji kesan dua jenis Kertas Buangan Dicincang (SWP) yang terdiri daripada Kertas Buangan Fotokopi Dicincang (SCPWP) dan Kertas Buangan Kadbod Dicincang (SCBWP) sebagai bahan tambahan terhadap sifat konkrit dan tingkah laku Rasuk Konkrit Bertetulang (RCB). Sebanyak tujuh bancuhan konkrit telah disediakan masing-masing dengan 0% (kawalan), 5%, 10%, dan 15% penambahan SCPWP dan SCBWP, manakala tiga bancuhan Rasuk Konkrit Bertetulang Kertas Buangan Dicincang (SWPRCB) disediakan dengan penambahan peratusan optimum SCPWP dan SCBWP berdasarkan kekuatan mampatan terbaik. Konkrit Gred 30 dengan nisbah 1:0.75:1.5 (simen:pasir:agregat) dan nisbah air-simen (W/C) 0.5 telah digunakan dalam kajian ini. Kebolehkerjaan konkrit segar, sifat mekanikal, seperti kekuatan mampatan, kekuatan lenturan, kekuatan tegangan membelah, dan penyerapan air, dianalisis selepas 7 dan 28 hari pengawetan air. Berdasarkan keputusan, kebolehkerjaan, kekuatan mampatan, lenturan dan tegangan membelah meningkat dengan penambahan 5% dan 10% SCPWP dan SCBWP. Penyerapan air juga tinggi disebabkan penambahan SCPWP dan SCBWP yang lebih tinggi. Sebaliknya, 15% penambahan SCPWP dan SCBWP mencatatkan kesan tertinggi dari segi penyerapan air konkrit serta kehilangan jisim. Semakin tinggi peratusan SCPWP dan SCBWP, semakin tinggi kadar penyerapan air. Konkrit dengan SCBWP menunjukkan kekuatan dan penyerapan air yang lebih baik berbanding SCPWP untuk semua peratusan penambahan. Penambahan SWP sebanyak 10% dianggap sebagai peratusan optimum untuk mencapai kekuatan mampatan tertinggi dan digunakan dalam penyediaan SWPRCB, yang terdiri daripada 0% C (kawalan tanpa SWP), 10% SCPWP, dan 10% SCBWP. Semua spesimen disubjekkan kepada pengawetan udara selama 28 hari dengan guni-guni basah menutupi permukaan atas SWPRCB. Penambahan 10% SCPWP dan 10% SCBWP dalam campuran konkrit meningkatkan kelakuan struktur, termasuk beban luluh (Py), beban muktamad (Pu), beban maksimum (Pmax), beban pada retak pertama (P1), dan penurunan pesongan luluh (δy), pesongan muktamad (δu), dan pesongan maksimum (δmax) dengan tetulang ricih penuh dan berkurang dengan Jarak Rakap (SS) = 100 mm, 150 mm, 200 mm daripada 0% C. Selain itu, regangan lentur dan ricih konkrit juga meningkat dengan penambahan 10% SCPWP dan 10% SCBWP untuk semua jenis tetulang ricih. Tambahan pula, SWPRCB dengan SS = 200 mm merekodkan terikan lentur dan ricih konkrit tertinggi. Manakala, 10% SCBWP mencapai δy, δu, dan δmax terendah berbanding 10% SCPWP dan 0% C. Kajian ini menunjukkan bahawa SCPWP dan SCBWP boleh digunakan sebagai bahan tambahan dalam konkrit pada kadar 5% dan 10% dan 10% untuk RCB dengan kekuatan dan penambahbaikan struktur yang ketara.

ABSTRACT

Effective Waste Paper (WP) recycling is an alternative approach to reduce the rising disposal of WP and limiting landfills area. Some of these approaches are incorporating an additive in concrete mixtures to produce eco-friendly concrete for construction applications, subsequently reducing the cost of construction and preserving the fast-depleting forest and natural resources. Previous studies showed concrete with WP has greater compressive and flexural strength compared to concrete without WP, which could potentially replace Portland cement in concrete manufacturing. Nevertheless, the significance of Shredded Waste Paper (SWP) has not been fully evaluated in concrete mixture and RCB development. Therefore, this research investigated the effect of two types of SWP comprising Shredded Copier Waste Paper (SCPWP) and Shredded Cardboard Waste Paper (SCBWP) as additives on the concrete properties and the behaviour of Reinforced Concrete Beam (RCB). A total of seven concrete mixes were prepared with 0% (control), 5%, 10% and 15% addition of SCPWP and SCBWP, respectively, while three Shredded Waste Paper Reinforced Concrete Beams (SWPRCB) mixes were prepared with the addition of the optimum percentage of SCPWP and SCBWP based on optimum compressive strength. The Grade 30 concrete with a designated mixture of 1:0.75:1.5 (cement:sand:aggregate) and a water-to-cement (W/C) ratio of 0.5 was used in this study. The workability of fresh concrete and mechanical properties, such as compressive strength, flexural strength, splitting tensile strength and water absorption, were analysed after 7 and 28 days of water curing. It was found that the workability, compressive, flexural and splitting tensile strengths increased with 5% and 10% addition of SCPWP and SCBWP. Additionally, the water absorption increased with the higher addition of SCPWP and SCBWP. Contrarily, 15% of SCPWP and SCBWP addition recorded the highest water absorption and mass loss. The higher the percentage of SCPWP and SCBWP, the higher the water absorption rate. The concrete with SCBWP showed better strength and water absorption than SCPWP counterparts of similar addition percentages. The 10% addition of SWP was considered as the optimum percentage to achieve the highest compressive strength and was applied in the preparation of SWPRCB, which consisted of 0% C (control with no SWP), 10% SCPWP and 10% SCBWP. All specimens were air recured for 28 days with wet gunny sacks covering the SWPRCB's top surface. The addition of 10% SCPWP and 10% SCBWP improves the structural behaviour, including the load at yield (P_y), ultimate load (Pu), maximum load (Pmax), load at first crack (P_1) and decreased the yield deflection (δ_y), ultimate deflection (δ_u) and maximum deflection (δmax) with full and reduced shear reinforcements with Stirrup Spacing (SS) = 100 mm, 150 mm, 200 mm than 0% C. Furthermore, the concrete bending and shear strains also increased with the addition of 10% SCPWP and 10% SCBWP for all shear reinforcements. As expected, the SWPRCB with SS = 200 mm recorded the highest concrete bending and shear strains. Nevertheless, 10% SCBWP achieved the lowest δ_y, δ_u and δmax compared to 10% SCPWP and 0% C. This study indicates that SCPWP and SCBWP gave optimum behaviour with 5% and 10% addition for concrete and 10% for RCB with significant strength and structural improvement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REFERENCES

Abalaka, A. E., & Okoli, O. G. (2013). Influence of curing regime on strength development of grade C60 concrete. *International Journal of Modern Engineering Research (IJMER), 3*, 709-714.

Aciu, C., Ilutiu-Varvara, D.A., Cobirzan, N. & Balog, A. (2014), "Recycling of paper waste in the composition of plastering mortars", Procedia Technology 12, 295-300.

Agamuthu, P., Fauziah, S. H., Khidzir, K. M., Aiza, Noorazamimah. (2007). Sustainable Waste Management-Asian Perspectives Proc. International Conferences on Sustainable Solid Waste Management, 5-7th Sep, 2007, Chennai, India. pp. 15-26.

Akinwumi, I. I. & Gbadamosi, Z. O. (2014), "Effects of curing condition and curing period on the compressive strength development of plain concrete", *International Journal of Civil and Environmental Research* **1**(2), 83-99.

Akinwumi, I. I., Olatunbosun, O. M., Olofinnade, O. M., & Awoyera, P. O. (2014). *Structural Evaluation of Lightweight Concrete Produced Using Waste Newspaper and Office Paper*. *6*(7).

Asha, P., Dipti, S., Rupali, P., & Prerana, P. P. (2017). Effect of Paper Waste on Concrete Properties : Sustainability Approach. *Journal, International Engineering, O F Approach, Sustainability*, *6*(4), 440–444.

Ashish Kumar Shakya1, & Gautam Bhadoriya, Utilization of Paper Waste and Fly Ash in Cement Concrete-A Review, International Research Journal of Engineering and Technology (IRJET), 6 (7), 1956-1959, 2019.

ASTM C1609 / C1609M19, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete Using Beam With Four-Point Loading.

ASTM C496 / C496M-17, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens, ASTM International, West Conshohocken, PA, 2017.

Azevedo, A. R. G., Alexandre, J., Xavier, G. de C., & Pedroti, L. G. (2018). Recycling paper industry effluent sludge for use in mortars: A sustainability perspective. *Journal of Cleaner Production*, *192*(May), 335–346. https://doi.org/10.1016/j.jclepro.2018.05.011

Bai, J., Chaipanich, A., Kinuthia, J. M., O'Farrell, M., Sabir, B. B., Wild, S., & Lewis, M. H. (2003). Compressive strength and hydration of wastepaper sludge ash-ground granulated blastfurnace slag blended pastes. *Cement and Concrete Research*, *33*(8), 1189–1202. https://doi.org/10.1016/S0008-8846(03)00042-5

Balwaik, S. A., & Raut, S. P. (2011). Utilization of Waste Paper Pulp by Partial Replacement of Cement in Concrete. *International Journal of Engineering Research and Applications*, *1*(2), 300–309.

Borysiuk, P., Nicewicz, D., Pawlicki, J., & Klimczewski, M. (2007). The influence of the type and preparation of ligno-cellulose fibres on the properties of MDF. *Wood Research*, *52*(4), 79–88.

Bozkurt, N., & Yazicioglu, S. (2010). Strength and capillary water absorption of lightweight concrete under different curing conditions. *Indian Journal of Engineering and Material Sciences, 17,* 145-151.

British Standard. (2007). Steel for the Reinforcement of Concrete - Weldable Reinforcing Steel - Bar, Coil and Decoiled Product - Specification BS 4449: 2005.

British Standard. (2009). *Testing Concrete. Method for Determination of Flexural Strength.* London: BS EN 12390: Part 5.

British Standard Institution 2011. Testing concrete. Method for determination of water absorption. London, BS 1881: Part 122.

British Standard Institution. 1983. Testing concrete. Method for making test cubes from fresh concrete. London, BS 1881: Part 108.

British Standard Institution 2013. Testing concrete. Methods for mixing and sampling fresh concrete in the laboratory. London, BS 1881: Part 125.

British Standard. (2000). *Testing Fresh Concrete: Slump Test.* London: BS EN 12350: Part 2.

British Standard. (2009). *Testing Hardened Concrete. Compressive Strength of Test Specimens.* London: BS EN 12390: Part 3.

British Standards Institution. 1992. Specification for Aggregates from natural sources for concrete: BS 882.

Carmen Martinez, Teresa Cotes and Francisco A. Corpas, Recovering wastes from the paper industry: Development of ceramic materials, *J. of Fuel Processing Technology, No. 103*, 2012, pp. 117-124.

Castro, J., Bentz, D. and Weiss, J. 2011. Effect of sample conditioning on the water absorption of concrete. *Cement and Concrete Composites.* **33**: 805-813.

Celpa, Industria Papeleira Portuguesa. Boletim Estatistico, Ed., Associaçao da Industria Papeleira, Lisboa, 2008.

Chakraborty, S. (2014). *ID : SEM 007. February 2016.* https://doi.org/10.13140/RG.2.1.1750.7601.

Chen, H., Jiang, W., Yang, Y., Yang, Y., & Man, X. (2017). State of the art on food waste research: a bibliometrics study from 1997 to 2014. *Journal of Cleaner Production, 140*, 840–846. https://doi.org/10.1016/j.jclepro.2015.11.085.

Chin, T.L., et al. (1998). A Novel Method to Reuse Paper Sludge and Co-Generation Ashes from Paper Mill. Journal of Hazardous Materials, Volume 58, Issues 1-3, February 1998, Pages 93-102.

Chun, Y., Naik, T., & Kraus, R. (2007). Pulp and paper mill fibrous residuals in excavatable flowable fill. *Presented at the International Conference on Sustainable Construction Materials and Technologies.*

Chung, J. H., Kim, B. H., Choi, H. K., & Choi, C. S. (2015). Development of Concrete due to Paper mixing ratio. *Hanyang University, Seoul, Korea*, 1–4.

Chung M. T., Yamin, S. A. (2008). Recuperative Energy Potential from a Typical Landfill in Malaysia. Paper Presented on International Conference on Environmental 2008 (ICENV, 2008).

Civil Blog. 2016. Common types of cracks in hardened concrete. http://civilblog.org/2016/02/12/2-common-types-of-cracks-in-hardened-concrete/#.

Colomer F. J., Gallardo A., Robles F., Bovea D. and Herrera L., Opciones de valorización de lodos de distintas estaciones depuradoras de aguas residuals , *J. of Ingeniería, vol. 14*, 2010, pp. 177–190, 2010.

Davis M.L., Cornweel D.A., Introduction to Environmental Engineering, third ed. McGraw-Hill, WCB 2013.

Demir, M.S. Baspinar and M. Orhan, Utilization of kraft pulp production residues in clay brick production, *J. of Building and Environmental*, *Vol. 40*, 2005, pp. 1533–1537.

EN, B.1992. 1-1: 2004 Eurocode-2: Design of concrete structures. General rules and rules for buildings.

Full, F. B., Associated, B., Almeida, N., Pais, R., Pais, R., Pais, R., & Pais, R. (2005). *REINFORCED CONCRETE BEAMS WITH RECYCLED AGGREGATES Demolition of Stadium*. *2005*(September), 27–29. https://doi.org/10.13140/RG.2.1.4061.5128.

Fuwape, J. A., Fabiyi, J. S., & Osuntuyi, E. O. (2007). Technical assessment of three layered cement-bonded boards produced from wastepaper and sawdust. *Waste Management*, *27*(11), 1611–1616. https://doi.org/10.1016/j.wasman.2006.09.005.

Gallardo, R. S., & Adajar, M. A. Q. (2006). Structural Performance of Concrete With Paper Sludge As Fine Aggregates Partial. *International Symposium on Environmental Engineering and 5th Regional Symposium on Infrastructure Development*, *May*, 1–8.

Gambhir. (2004). *Concrete technology*. New Delhi: Tata McGraw-Hill.

Gao, J., & Fourie, A. (2015). Using the flume test for yield stress measurement of thickened tailings. *Minerals Engineering*, *81*(August 2017), 116–127. https://doi.org/10.1016/j.mineng.2015.07.013.

Ghani, A. N. A., & Mohammad Shukeri, R. (2008). Concrete Mix with Wastepaper. *2nd International Conference on Built Environment in Developing Countries (ICBEDC), Penang, Malaysia, University Sains Malaysia (USM)*, *Icbedc*, 567–575. http://eprints.usm.my/34459/1/HBP15.pdf

Gunarto A, Satyarno I, Tjokrodimuljo K. *Newsprint Paper Waste Exploiting for Concrete Panel*. Institute of Research Center, Gadjah Mada University. 2008.

Hassani A., Ganjidoust H. and Maghanaki A. A., Use of plastic waste (polyethylene terephthalate) in asphalt concrete mixture as aggregate replacement., *J. of Waste Management and Research*, *vol. 23*, 2005, pp. 322-327.

Honnold V. (2009). Developments in the Sourcing of Raw Materials for the Production of Paper, United States International Trade Commission. Journal of International Commerce and Economics.

https://shredderwizard.com/, Everything you need to know before buying a paper shredder.

Ilakkiya R., Dhanalakshmi G., (2018). *Experimental Investigation on Concrete Using Waste Paper Monisha T*. *4*(4), 102–106.

Jiang, P. H. 2003. Tension stiffening and cracking of steel fiber-reinforced concrete. *Journal of materials in civil engineering*. 15(2):174-182.

Jung, H. S., Choi, H. K., & Choi, C. S. (2015). An experimental study on development of construction concrete products using wastepaper. *Journal of Ceramic Processing Research*, *16*, 104–109.

Kelly Hart, Natural Building Blog, Thriving Sustainably with Earthbag Building and Other Practical Solutions, (2018).

Kachlakev, D., PhD. Miller, T, PhD, P Yim, S, PhD, PE; Chansawat, K. and Potisuk, T., (2001) "Finite Element Modeling of Reinforced Concrete Structures Strengthened with FRP Laminates", Oregon Department of Transportation, Research Group. *Canadian Journal of Civil Engineering*, 646-54.

Kalapad, J. D., Mansute, M., Swami, V., Sulbhewar, V., & Khandale, T. M. (2019). A Study on Partial Replacement of Cement By Waste Paper Pulp In Concrete. *International Journal of Innovations in Engineering and Science*, *4*(4), 2456–3463. www.ijies.net.

Kantro, D. L. (2008). "Influence of water-reducing admixtures on properties of cement paste-a miniature slump test," *Cement, Concrete and Aggregates*, 2, 95-102.

Khan, A. S., & Zhang, H. 2000. Mechanically alloyed nanocrystalline iron and copper mixture: behavior and constitutive modeling over a wide range of strain rates, *International journal of Plasticity*, 16(12): 1477-1492.

Khan Academy (2016), https://www.khanacademy.org/humanities/ap-art-history/later-europe-and-americas/modernity-ap/a/frank-lloyd-wright-fallingwater.

Khandelwal S., Prajapat K. L., Kumar M., Bhantia L., Sharma A., Sharma V., 2015. Int. J. of C. R. & D. 4, 668.

Kraus, R. N. et al. (2003). Concrete Containing Recycled Fibers from Pulp and Paper Mills. Sixth CANMET/ ACI International Conference June 2003, Recent Advances in Concrete Technology. Bucharest, Romania.

Latifah, A.M, Mohd, A.A.S, Nur, I.M.Z. (2009). Municipal Solid Waste Management in Malaysia: Practices and Challenges. Journal of Waste Management, 29: 2902-2906.

Li, A. E., Alkhairi, F. M., & Hammoud, H. 2013. *Fiber Reinforced Concrete*. *ACI Journal.* 59: 351-374.

Liaw, C. T., Chang, H. L., Hsu, W. C., & Huang, C. R. (1998). A novel method to reuse paper sludge and co-generation ashes from paper mill. *Journal of Hazardous Materials*, *58*(1–3), 93–102. https://doi.org/10.1016/S0304-3894(97)00123-4.

Magnaghi, G. (2006). The Evaluation of the Recovered Paper Market: Comparing 2006 with 2005. www.bir.org/pdf/7 Dec07 MagnaghiReport2.pdf.

Malaysian News Print Industries, (2007). Paper Recycling report. http://www.newsprint.com.my.

Malik, M. I. (2013). Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine Aggregates. *IOSR Journal of Engineering*, *3*(7), 08–13. https://doi.org/10.9790/3021-03760813.

Malthy R, Jegatheeswaran D. Comparative study on concrete bricks with conventional bricks. *ICI Journal*. January-March 2011.

Martin, A. M. 2008. Fibre reinforced cement-based (FRC) composites after over 40 years of development in building and civil engineering. *Composite structures*, 86(1): 3-9.

Ministry of Housing and Local Government, (2008). National Solid Waste Management Policy. http://www.kpkt.gov.my/jspn/main.php%20(8>October 2008).

Modolo R., Benta A., Machado L., Labrincha J.A. and Ferreira V.M., Solutions development for pulp and paper process solid wastes from laboratory bench to industrial scale, *J. of Inovaçao na Construçao Sustentavel, vol. 1*, Plataforma para a Construçao Sustentavel, 2008, pp. 11–22, ISBN: 978-989-95978-0-8.

Mohamed, O. S., Mohd , N. H., M, Abdul.Mujeebu. (2009). Assessment of Municipal Solid Waste Generation and Recyclable Materials Potential in Kuala Lumpur, Malaysia. Journal of Waste Management and Research. 29(7): 2209-2213.

Monte M.C., Fuente E., Blanco A. and Negro C., Waste management from pulp and paper production in the European Union, *J. of Waste Management and Research, vol. 29*, 2009, pp. 293–308.

MS 522: Part 1: 2003, Ms 522 Part 12003 Portland Cement (Ordinary and Rapid-hardening) Part 1 Specification (Second Revision)-709539.

Naik, T. R., Friberg, T. S., & Chun, Y. M. (2004). Use of pulp and paper mill residual solids in production of cellucrete. *Cement and Concrete Research*, *34*(7), 1229–1234. https://doi.org/10.1016/j.cemconres.2003.12.013.

Neville, A.M. 2011. *Properties of Concrete.* (5th Edition). Malaysia: Longman, Malaysia.

Nitereka, C. and Neale, K.W. (2013). Analysis of Reinforced Concrete Beams Strengthened in Flexure with Composite Laminates.

Ngoc, U. N., & Schnitzer, H. (2009). Sustainable solutions for solid waste management in Southeast Asian countries. *Waste Management*, *29*(6), 1982–1995. https://doi.org/10.1016/j.wasman.2008.08.031.

Okino, E. Y. A., Santana, M. A. E., & De Souza, M. R. (2000). Utilization of wastepaper to manufacture low density boards. *Bioresource Technology*, *73*(1), 77–79. https://doi.org/10.1016/S0960-8524(99)00146-7.

Patil, P. R. P., Patil, V. P., Aravind, M., Patil, R., Patil, A. A., & Pawar, J. J. (2019). *Concrete concrete*. *07*(04), 493–506.

Poopak, S., & Agamuthu, P. (2011). Life cycle impact assessment (LCIA) of paper making process in Iran. *African Journal of Biotechnology*, *10*(24), 4860–4870. https://doi.org/10.4314/ajb.v10i24.

Portland Cement Association, 2016, Aggregate. America's Cement Manufacturers. http://www.cement.org/cement-concrete-basics/concrete-materials/aggregates (23 July 2016).

Prasad G. V. S., Reddy P. P., Swathi M., Kumar P. D. V., Praveenraja T., Naveen M., 2015. In. J.of Eng. R. 3.

Raghuwanshi, S., Singh, V. V, & Mishra, P. (2018). A Review on use of Waste Paper Pulp by Partial Replacement of Cement in Concrete. *IJSRD-International Journal for Scientific Research & Development|*, *5*(12), 2321–0613. www.ijsrd.com.

Ramachandrudu, K., & Natarajan, C. (2018). Mechanical Properties and Flexural behavior of Concrete Concrete. *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN*, *15*(4), 31–36. https://doi.org/10.9790/1684-1504033136.

Ramesh, G. B. R., & Chandu, U. G. (2018). *Concrete – a Sustainable Building Material*. *119*(17), 87–93.

Ravindra Singh, L., Saleem, A., & Geeta, B. (2015). Application of Paper Waste in Cement Concrete. *Journal of Engineering Research and Applications Www.Ijera.Com*, *5*(4), 95–98.

Rocha J.C., John M.W., Utilizaçao de residuos na construçao habitacional., *J.of Coletânea Habitare, vol. 2*, 2003.

Saifullah M.A. Hossain Experimental and Analytical Investigation of Flexural Behavior of Reinforced Concrete Beam, 2015.

Salem, R. M., & Al-Salami, A. E. (2016). Preparation of Waste Paper Fibrous Cement and Studying of Some Physical Properties. *Civil and Environmental Research*, *8*(3), 42–54. https://www.semanticscholar.org/paper/Preparation-of-Waste-Paper-Fibrous-Cement-and-of-Salem-Al-Salami/b12a5bcad54da1654e3f3f5ab2383d741b21020d%0Ahttps://www.iiste.org/Journals/index.php/CER/article/view/29376.

Sangrutsamee, V., Srichandr, P., & Poolthong, N. (2012). Re-pulped waste paper-based composite building materials with low thermal conductivity. *Journal of Asian Architecture and Building Engineering*, *11*(1), 147–151. https://doi.org/10.3130/jaabe.11.147.

Santamaria, J., Fuller, B., & Fafitis, A. (2007). Structural properties of a new material made of waste paper. *WIT Transactions on Modelling and Simulation*, *46*, 557–567. https://doi.org/10.2495/CMEM070561.

Science Buddies (2015). Folded or Flat Paper Towel: Which One Absorbs More Water ? Bring Science Home.

Selvakumar T., Sathiya R., Jayalakshmi B., (2018). *Experimental Study of Concrete Concrete and Bricks*. 67–77.

Selvaraj, R., Priyanka, R., Amirthavarshini, M., & Prabavathy, S. (2015). *EVALUATION OF CONCRETE: An Innovative Building Material*. *6*, 52–56.

Selvarasan T., Bharathidasan K., Journal, I. (2017). *Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre 1*. *4*(5), 254–263.

Seyyedalipour, S. F., Yousefi Kebria, D., Malidarreh, N. R., & Norouznejad, G. (2014). Study of Utilization of Pulp and Paper Industry Wastes in Production of Concrete. *Journal of Engineering Research and Applications Www.Ijera.Com*, *4*(1), 115–122. www.ijera.com.

Sin, L. H., Huan, W. T., Islam, M. R. and Mansur, M. A. 2011. Reinforced lightweight concrete beams in flexure. *ACI Structural Journal*. 108(1): 3-12.

Srinivasan R., Sathiya K. and Palanisamy M., Experimental investigation in developing low cost concrete from paper industry waste, *The Bulletin of the Polytechnic Institute of Jassy, Construction. Architecture Section (Romania)*, 2010.

Subramani, T., & Shanmugam, G. (2015). Experimental Investigation Of Using Concrete And Recycled Aggregate As A Coarse Aggregate. *International Journal of Application or Innovation in Engineering & Management (IJAIEM)*, *4*(5), 323–332. http://www.ijaiem.org/Volume4Issue5/IJAIEM-2015-05-26-74.pdf.

Suri, R. S. (2018). Study of Implementation of Waste Paper in Cement Concrete. *International Journal for Research in Applied Science and Engineering Technology*, *6*(1), 1506–1507. https://doi.org/10.22214/ijraset.2018.1231.

Syed Mohsin, S.M. 2012. Behaviour of fibre-reinforced concrete structures under seismic loading. P.h.D thesis, Imperial College London, UK.

Tantray, M. A. (2019). Quality Tests on Light Weight Concrete Concrete. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, *8*, 2278–3075.

Tarun R. Naik, Yoon-moon Chun and R. N. K. (2003). *Enhancing Strength and Durability of Ready-Mixed*.

Thiswaran, Y. D. (2018). *Paper Crete : A lightweight concrete Concrete : A Lightweight Concrete*. *March 2018*.

Thiswaran, M. Y. D., & Varma, D. M. B. (2017). Properties of Concrete Concrete: Building Material. *IOSR Journal of Mechanical and Civil Engineering*, *14*(02), 27–32. https://doi.org/10.9790/1684-1402072732.

Titzman, L. C. (2006). *Analysis of Low-Cost Building Material for the Mixalco Process Analysis of Low-Cost Building Material for the Mixalco Process*. *December*.

Turk, K., Caliskan, S., & Yazicioglu, S. (2007). Capillary water absorption of self-compacting concrete under different curing condition. *Indian Journal of Engineering & Materials Sciences, 14*(5), 365-372.

Urvashi, D. (2006). Sustainable Solid Waste Management: Issues, Policies and Structures. Published by Academic Foundation, New Delhi, India. pp. 70-75.

Van Beers D., Bossilkov A., Lund C., Development of large scale reuses of inorganic by-products in Australia: the case study of Kwinana, Western Australia, *J. of Resources Conservation and Recycling, vol. 53*, 2009, pp. 365–378.

Wagih, A. M., El-Karmoty, H. Z., Ebid, M., & Okba, S. H. (2013). Recycled construction and demolition concrete waste as aggregate for structural concrete. *HBRC Journal*, *9*(3), 193–200. https://doi.org/10.1016/j.hbrcj.2013.08.007.

Wikipedia, The Free Encyclopedia, https://en.wikipedia.org/wiki/Concrete.

Yun, H., Jung, H., & Choi, C. (2011). Mechanical properties of concrete containing waste paper. *ICCM International Conferences on Composite Materials*, 1–4.

YTL Cement. 2015. Orang Kuat, YTL Cement (online). https://www.ytlcement.com/bags_orang kuat.asp (30 November 2015).

Zaki, H., Gorgis, I., & Salih, S. (2018). Mechanical properties of concrete. *MATEC Web of Conferences*, *162*(January). https://doi.org/10.1051/matecconf/201816202016.