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Review of Natural Fibre Reinforced Polymer Composite and Textile Fibre Composite for Sustainable Construction

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Abstract: In today's world, natural fibre reinforced polymer composites (NFRPC) are becoming increasingly popular because to their eco-friendliness, lightweight superiority in life cycles, biodegradability, low cost and good mechanical quality. In a number of engineering applications NFRPCs are widely used and research in that field is progressing quickly. Due to natural fibres, researchers face various challenges during NFPRC construction and deployment (NFs).

Among the challenges are fibre quality, thermal stability, water absorption and incompatibility with polymer matrices. Steel strengthening is continuously required to fulfil the tensile strength and ductility requirements of concrete buildings, because the most often used building medium on the globe is concrete.

Furthermore, corrosion of steel reinforcement is one of the most severe issues facing civil engineers today; hence promoting sustainable concrete as well as structures to reduce their negative influence on the environment is vital.

The development of new environmental materials to replace the bars of steel as a reinforcement of the concrete structure is a key step towards assuring the long-term durability of the cement and construction. According to this evaluation document, strengthened concrete constructions create a wide range of environmental concerns including significant CO2 and other greenhouse gas emissions.

Keywords: Environmentally friendly materials, Natural fibre reinforced polymer composite, textile fibre composite, Sustainability, composite materials

I. INTRODUCTION

A composite is a substance composed of at least two components. The concept would all be incorporated in bricks, concrete, wood, bone, synthetic composite material such as fibre enhanced plastics (FRP). Due to their great strength, rigidity, and combination of low weight, FRPs are being used to fabricate a variety of structures. Epoxy resin and synthetic fibres are commonly used. High-performance composite materials are the name given to these materials.

They have a number of advantages, including the ability to replace many synthetic fibres. These NFs have also been used to create bio-composites, demonstrating composite material improvements. (NFRPCs) provide a variety of benefits, including low weight, biodegradability, low cost, and great mechanical qualities.

These characteristics made NFRPCs stand out as a unique material for a variety of transportation applications, including aviation, automobiles, building, and railways. Steel, cement and wood are the most crucial elements of the building's physical foundations, resulting in significant development expenses.

Oil-based fibre reinforced polymer composites have emerged as a more appealing development material in recent years The world's two most important and active sectors are construction and building design. They account for 28.1 percent of industrial workers and 7.5 percent of European economic workforce correspondingly.

The worldwide construction and construction industries are growing quickly. China is expected to construct about 40 billion cubic metres of mixed commercial and residential areas over the next 10 years, comparable to one in New York every two years or Switzerland as a whole.

It is the most widely used human-made substance on the globe since it is a vital element of the building and construction industries. Baton was used in 2002 over 2.7 billion cubic metres, with the production dispersed over more than 150 countries. This corresponds to almost 0.4 cubic m3 of concrete consumed per person each year.

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Table 1: Country Names with the percentage rate of workforce.

COUNTRY	PERCENTAGE
China	59.30 %
Japan	1.50%
India	6.60%
Asia (Excl. China, Japan, India)	11.90%
Africa	4.50%
USA	2.00 %
America (Excl. USA)	5.10%
Oceania	0.20%
CIS	2.10%
Gem bureau	6.30%

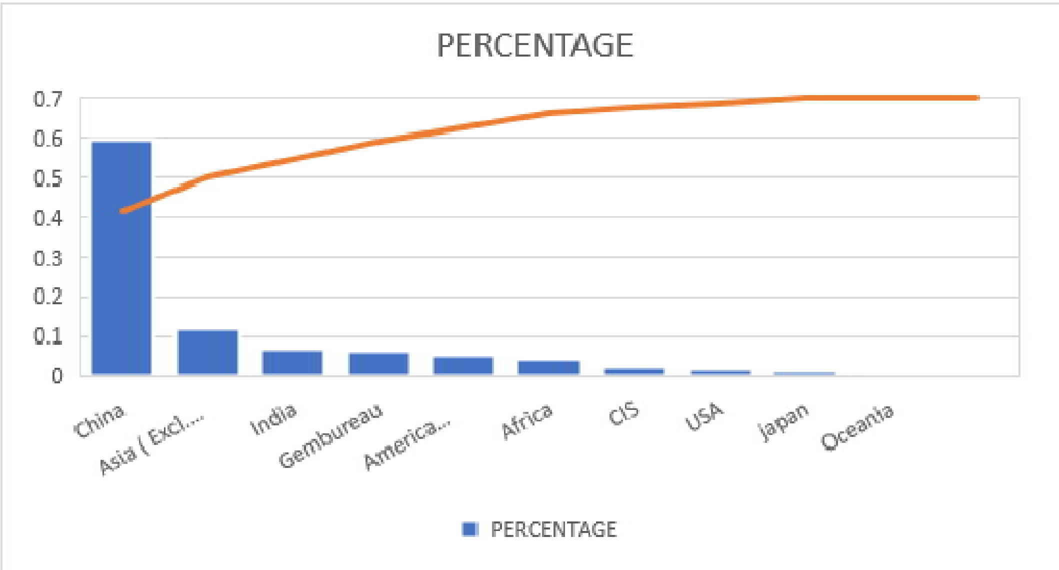


Figure 1 World Cement Production

II. STRUCTURE OF SUSTAINABLE CONCRETE

As per United Nations "able to fulfill current demands without jeopardising future generations' capacity to achieve their own requirements" is the concept of sustainability. It causes environmental, economic, and aspects of sustainability, "the three pillars" from some Picture 2. The concrete industry's long-term profitability is essential to our planet's and humanity's progress. This sector is focused on building higher-quality structures both for individuals and businesses that will improve quality of life and working conditions while minimizing environmental impact.

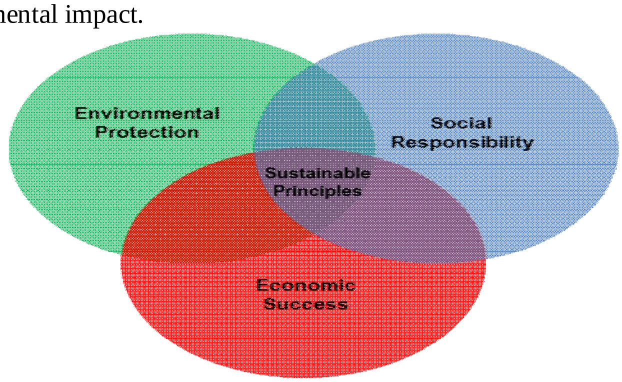


Figure 2 Triple Bottom Line of Sustainability

A. Principles

Sustainable construction was identified by the International Council of Buildings (CIB) in 1994 as "responsible for developing and maintaining" a healthy built environment based on resource efficiency and project design based on ecological principles. Using by-products or renewable materials has a number of benefits, including the capacity to generate new uses for by-products while conserving natural resources and preserving traditional construction processes. Another wonderful move towards this industry is the development and use of alternative materials, technology and building methods. Resources and energy consumption in this situation may be significantly decreased and high energy efficiency can be achieved without jeopardising damaging ecosystems. The abilities to generate new opportunities for by products while conserving natural resources and maintaining existing constructive methods is one of the benefits of the use of by-products and renewable materials an additional great step in the development of structures utilising alternative materials, technology and construction methods is the creation of sustainable construction. This can substantially lower the resource and energy consumption and lead to high energy efficiency without jeopardising human health or having a detrimental influence on the ecosystems. According to the study, "resources," "reusing," "recycling," "nature," "economics" and "quality" are the main words used in the design of sustainable building. In reality, all these motto-words help build long-lasting cement and structures. The development of sustainable concrete and structures hence is crucial for sustainable building since it is almost impossible to imagine a construction industry which without concrete or concrete structures.

B. Jute Fibre

Jute is a versatile fibre that can be found in sacking, burlap, and twine, as well as tufted carpet backing. It's a long, bright, brilliant fibre tweaked to rough, robust strands. One of the cheapest natural fibres. It consists mainly of cellulose, lignin and pectin, all of which are plant components. Jute is a word used to designate both the plant and the fibre. It is a lightweight fabric consisting of natural fibre, which serves to manage soil erosion, preserve seeds, suppress weeds and a range of other applications for farming and landscape development. Jute is therefore the most environmentally friendly fibre from seed to expired fibre, as expired fibre may be regenerated more than on other fibres.

C. Properties

Ute fibres are totally biodegradable and recyclable, which makes them environmentally beneficial. Jute is a natural fibre, commonly referred to as The Golden Fibre, with a smooth and golden shine. Jute is a cheap vegetable fibre, derived from the plant's vast or skin stem. It is the second most significant vegetable fibre after the cotton in terms of use, global consumption, manufacturing and availability. It has a high tensile strength, low resistance and makes it simpler for textiles to respire. As a consequence, jute is best suited to packing large agricultural products. It supports high-quality manufacturing of industrial thread, fabric, net and bags.

It is one of the most polyvalent natural fibres, with uses in packaging, textiles, non-textiles, construction and farming. When the yarn is mixed, the breakage tenacity and the extensibility are lower when coupled in a ternary combination.

D. Factors Affecting Properties

1) *Length of Staples:* For synthetic staple fibres, like nylon, longer staple cotton provides you with greater strength. With the longest fibre, low twisting factors provide burly yarn.
2) *Fineness of Fibre:* Fine fibres, compared to coarse fibres spun into the same yarn count, generate strong yarn. This is due to the greater number of threads in the yarn cross section and the greater friction in the inner part, as the number of fibres in the cross section increases. As a consequence, the desired yarn strength is achieved.
3) *Strength of Fibre:* In general, fine fibres provide strong yarn. In the case of cotton fibre, fibres will have a long-lasting length, which will enable the production in the same cross-section of a higher number of tiny filaments and the strength of individual fibres. The strength of the yarn is thus the force.

E. Twist

With a single spun yarn, the torsion increases to a point where each twist beyond that produces a decreased strength. The amount of torsion required by exceptional strength is governed by the twist Angle and is consistent across a range of yarns with the torsion Angle necessary for maximum strength for each fibre.

1) *Finishing with Fibre:* To affect the processing character of man-made fibres, particularly synthetic fibres, many chemicals are used. The kind and quantity of chemicals employed will have a considerable influence both on yarn strength and on staple fibre preparation characteristics.

III.GENERAL FACTORS

The strength of the yarn is influenced by several different elements. Chemical therapies, such as size, used for spinning yarn improve or diminish the yarn strength. Some chemicals have a negative impact on the material, which reduces strength. Besides the tensile property of spun yarn is impacted, apart from this chemical procedure, by the arrangement of the individual fibres in the unique yarn, as a result of drawing and twisting, the building of spun yarn. The curve has a dynamic characteristic. The yarn can maintain its curvature only if the dynamic balance regulates also the tensile property. Many aspects impact the characteristics including fibre geometry, shape and surface qualities, matrix characteristics, design of mixes, procedures of mixing and placing, casting and cure. The mechanical, thermal and acoustic characteristics and durability of Jute are mostly influenced by the length, volume and look ratio of the fibres, fibre activity and material combination, as well as by the casting pressures. The manufacturing method and quality management significantly enhance jute performance. Jute fibres act as crack-arresters such as normal reinforced concrete fibres, which prevent flaws in the cement matrix. The uniform distribution of fibres in the fragile matrix benefits from several composite engineering characteristics such as fracture, tensile and flexural strength, hardness, fatigue and impact resistance.

A. Long-Lasting Concrete Structure

Concrete is formed from of cement, gross aggregate, fine aggregates (sand), water and / or admixtures (gravel or crashed stone). Recycled concrete aggregates can be utilised to replace the main sustainable concrete components. The addition of the fly ash, slag, fumes of silica can be formed of, among other resources, rice husk ash, waste ceramics, wastes of tungsten, and re-claimed glass. The use of substitutes such as fly ash and slag cement in Portland cement, in a combination which typically would end up in a landfill, offers advantages. Reports indicate that substituting fly ash and slag cement for Portland cements from 15% to 40% can result in improved strength and reduced permeability of concrete and hence increase the lifetime of concrete structures. Pozzolans, such as calcined clays or industrial wastes, can be natural or human-made. Natural pozzolans formed from a silicon-rich magma that crystallised quickly but remained amorphous. In the case of artificial pozzolans, clays calcined below the dihydroxylation temperature become structurally unstable due to the loss of hydroxyl groups during the calcination process. Furthermore, reducing the amount of water used in concrete improves its strength and longevity. All of this is made possible by the use of admixtures, which improve the durability of concrete by improving its properties. It is more difficult to manufacture extremely sustainable concrete without admixtures such as super plasticizers. It has a very high strength but have a low tensile strength which makes it brittle. Steel reinforcement, on the other hand, is still very expensive today because it is made from a non-renewable resource that requires a lot of energy to produce. For each cubic metre of concrete building, approximately 200kg of steel reinforcing will be required. The most challenging task to overcome is steel corrosion in concrete structures. Maintenance, repair, and strengthening of about 84,000 reinforced and pre-stressed concrete bridges in the EU costs £215 million per year, not including traffic management expenditures.

B. Coir Fibre and it's Mechanical Properties

Coir fibre is one of the natural concrete fibres most frequently utilised. It consists of the exterior coconut shell. In 2009, over 500 000 tonnes of coir fibres were produced every year, primarily in India and Sri Lanka. Mothproof, fungus and red resistance, good temperature insulation and acoustic insulation, flammable, moisture- and moisture-resistant, strong and durable, resistant, resistant to form springs even after repeated application are some advantages of the fibre coir.

C. Coir Fibre Reinforced Concrete's Compressive Properties

The CFRC compressive characteristics were derived from the compression of these cylinders utilising compression testing equipment (static modulus of elasticity, compressive strength, corresponding strain and compressive strength). The compression check is followed by ASTM C39 (Standard test method for compressive strength of cylindrical concrete specimens). During the elastic response phase, the static elastic module was computed by utilising the incline of the stress strain curve. Figure 6 illustrates the PC and CFRC compressive stress stretch curves. (With a 5 percent fibre composition and a 50 mm fibre length) Figure 7 shows the impact of fibre number and fibre length on the static elasticity module. They possessed a more static, 25mm fibre-like elasticity modulus compared to PC. When compared with the PC, the introduction of coir fibres, depending on the fibre quantity and length, enhanced the static elasticity module or decreased.

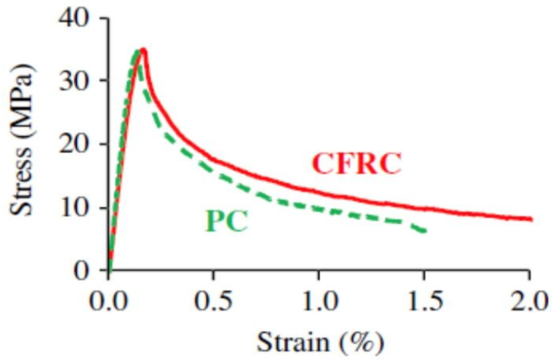


Figure 6: Compressive stress-strain curves of PC and CFRC [32].

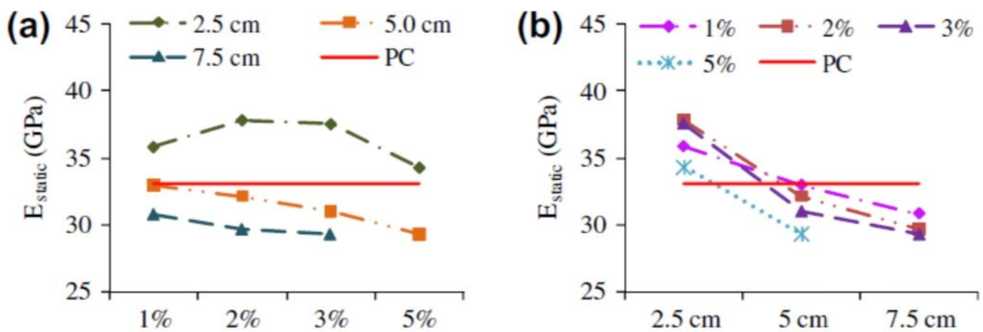
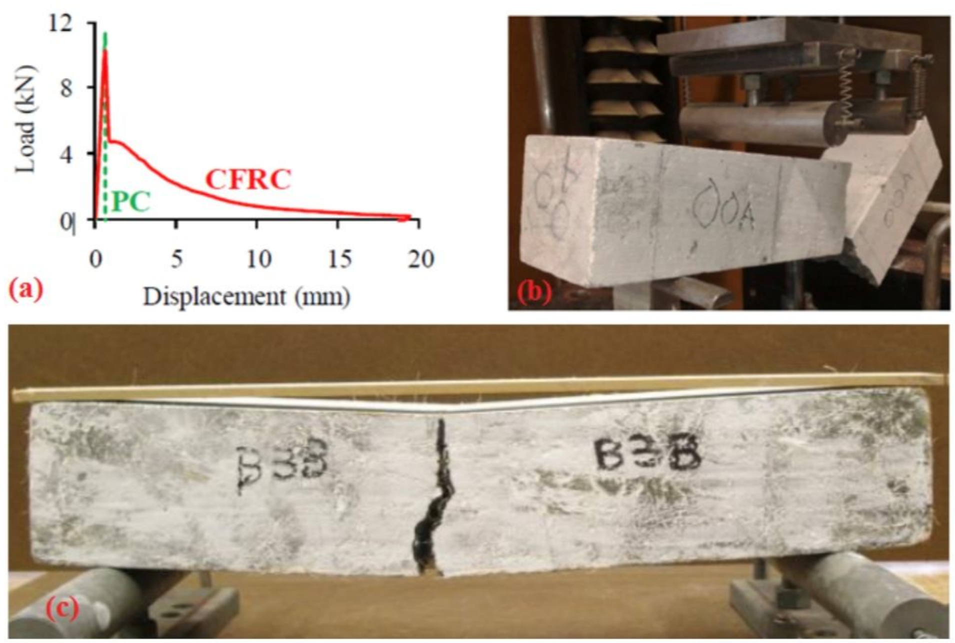


Figure 7: Static modulus of elasticity of CFRCs with various fibre content and lengths.

D. Coir Fibre Reinforced Concrete's Flexural Properties

Four-point bending tests in accordance with ASTM C78 were used to assess the CFRCs' flexural behaviour. As it shows in picture 11. The CFRC, on the other side has a large break running through the middle of the beam. The crack's neighbouring surface was bridged with coir fibres. Figure 12 depicts the cracked surface with beam's failure behaviour. The CFRC beam's fracture opening after failure was improved by using coir fibre bridging.



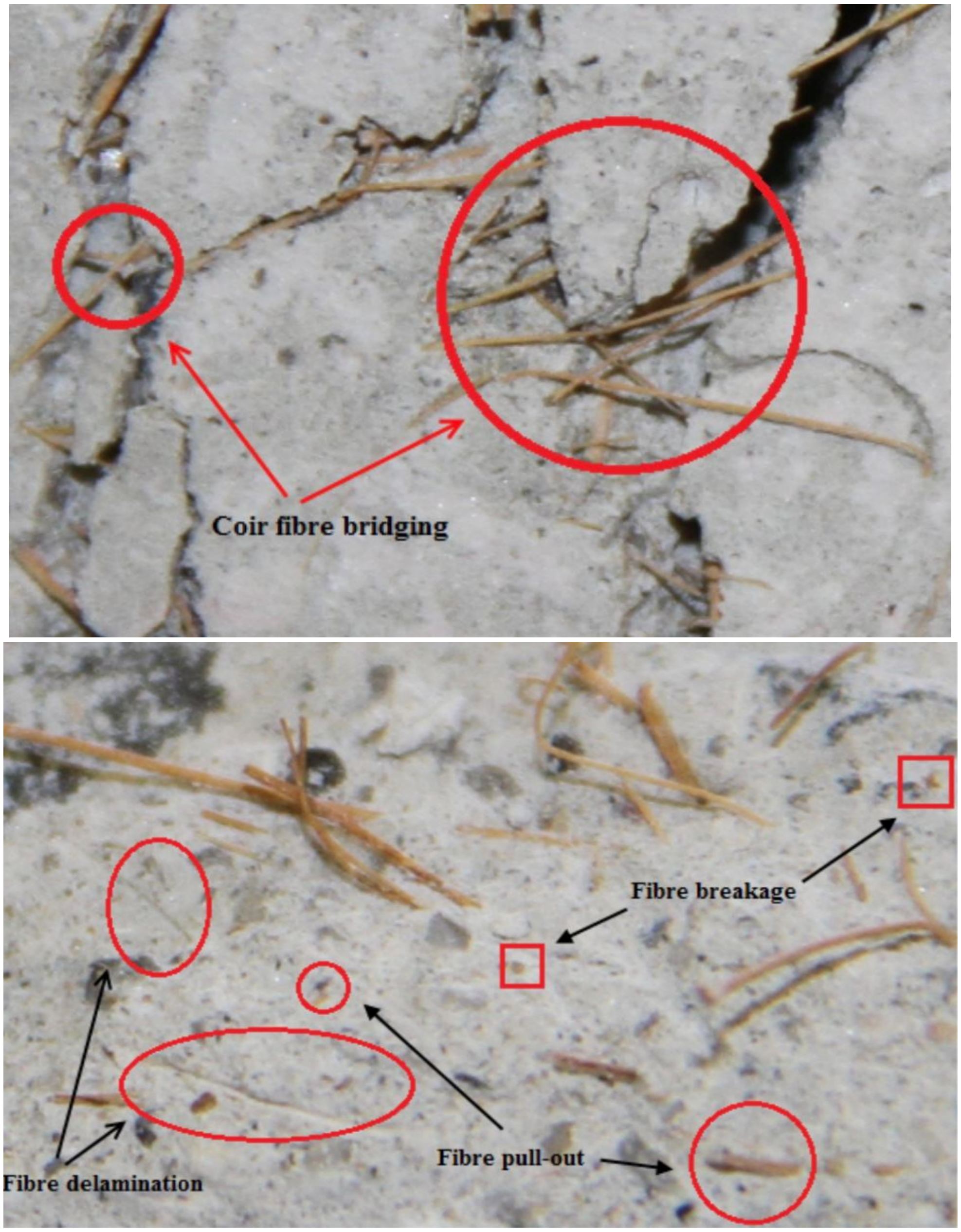


Figure 12: Bridging of coir fibres

E. Durability of Coir Fibre Reinforced Concrete and Flax Fibre Reinforced Polymer Composites

NFRC and polymer composites offer a lot of potential for usage in long-term concrete structures, there's no doubting it. However, in order to promote natural fibre composites, a number of challenges must be solved. It is main issue which must be resolve before they can be successfully commercialised. The lifespan of natural fibre reinforced concrete is associated with the capacity to resist both external and internal damage. Natural fibres submerged in cement of Portland will degrade due to the dissolution of the basic elements of fibres such as lignin and hemicellulose in the high alkaline environment, therefore weakening the natural flips. Some studies proposed that sustainability be improved Water-resistant chemical products containing sodium silicate, sodium sulphite can benefit from natural fibre concrete. Natural fibres with coatings water-resistant and alkaline-free can have a longer lifetime. Durability refers to the degradation resistance generated by external and internal forces in flax fibre enhanced polymers composites. A key issue that must be solved before the general adoption is the paucity of data on the durability of natural-fibre reinforced composites. Having a long-lasting flax fibre reinforced composite, lignocellulose materials must be modified to improve their environmental and dimensional stability.

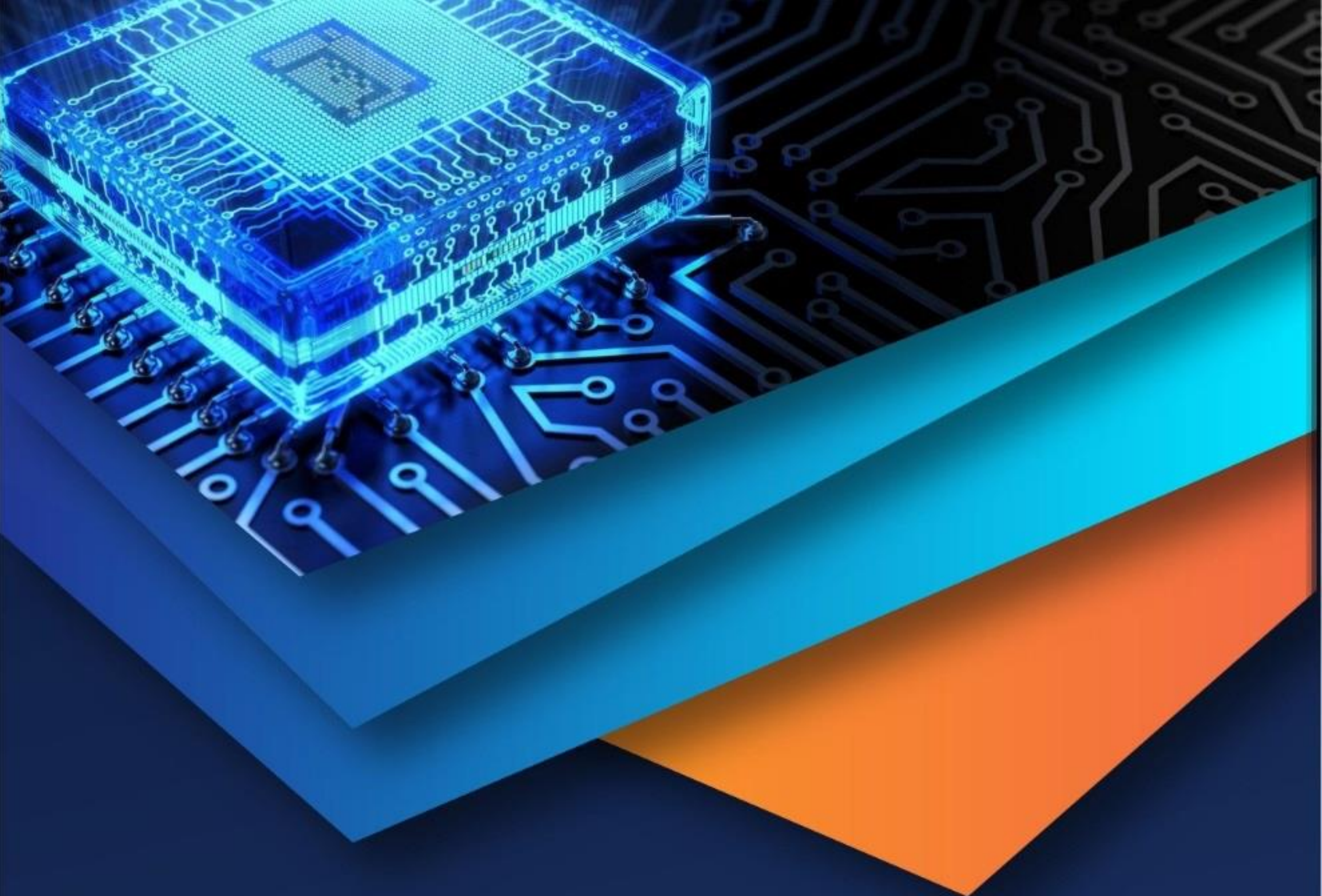
IV. CONCLUSIONS

Sustainable buildings in concrete should utilize less energy and raw materials during construction, reduce greenhouse gas emissions into the environment and reduce the cost of creating and maintaining them over time. In this work, CFRC mortar-free buildings (columns or walls) and FFRP tube enveloped CFRC composite columns were integrated in sustainable concrete structures. According to studies on these two sustainable concrete projects, natural fibers may be used as reinforcement in concrete and/or concrete buildings with excellent eco-efficiency. Both of them contain structures that might be used in concrete structures that remains for a longer period of time. Fiber bridging result of coir fiber, other hand, changes the failure mode of concrete, making it ductile. As a result, the coir fiber insertion enhances ductility, and the FFRP tube leads to a remarkable load-bearing volume enhancement in the composite structure. However, in order to stimulate the use of these sustainable concrete structures, for a continuing the durability of coir fiber and polymer composites should be enhanced."

REFERENCES

[1] Pacheco-Torgal F, Jalali S (2011) Cementitious building materials reinforced with vegetable fibres: A review. Constr Build Mater 25: 575-581.
[2] Dobbs R (2013) Prime numbers: megacities, FP's guide to the coming urban age. Foreign Policy.
[3] ISO, ISO/TC 71 (2005) Business Plan, Concrete, Reinforced concrete and pre-stressed concrete.
[4] Nail Tarun R (2008) Sustainability of concrete construction. Practice Periodical on Structural Design and Construction 13(2): 98-103.
[5] IMF, World Economic and Financial Surveys (2013) World Economic Outlook 2013, International Monetary Fund.
[6] Humphreys K, Mahasenan M (2002) Climate change. In: Towards a sustainable cement industry. Battelle – World Business Council for Sustainable Development.
[7] Worell E, Price L, Martin N, Hendriks C, Meida LO (2001) Carbon dioxide emissions from the global cement industry. Annu Rev Energy Environ 26: 303-329.
[8] Colinart T, Glouannec P, Chauvelon P (2012) Infleunce of the setting process and the formulation on the drying of hemp concrete. Constr Build Mater 30(9): 373-380.
[9] UNFCCC COP9 Report (2004) Delivering the Kyoto baby. Refocus, International Renewable Energy Magazine, 52-53.
[10] European Commission (2007) Accelerating the development of the sustainable construction market in Europe, report of the taskforce on sustainable construction composed in preparation of the communication. A Lead Market Initiative for Europe, COM 1-860.
[11] Kibert C (1994) Establishing the principles and model for sustainable construction. In Proceedings of the 1st international conference of CIB TG 16: 1–9, Tampa.
[12] Kibert C (2008) Sustainable construction: green building design and delivery. 2nd edn. Wiley, Hoboken.
[13] Yan LB, Chouw N (2013) Experimental study of flax FRP tube encased coir fibre reinforced concrete composite column. Constr Build Mater 40: 1118-1127.
[14] Glass J, Dainty ARJ, Gibb AGF (2008) New build: materials, techniques, skills and innovation. Energy Policy 36(12): 4534–4538.
[15] Yan LB, Chouw N, Jayaraman K (2014) Effect of triggering and polyurethane foam-filler on axial crushing and natural flax/epoxy composite tubes. Mater & Des 56: 528-541.
[16] European Concrete Platform ASBL (2009) Sustainable benefits of concrete structures, Brussels, Belgium, 1-40.
[17] Nasvik J (2013) Sustainable concrete structures – How to use concrete for sustainable purposes. Concrete Construction.
[18] Pacheco-Torgal F, Jalali S (2011) Eco-efficient construction and building materials. Springer-Verlag London Limited, London, 75-79.
[19] Al-Rawas A, Hago AW, Corcoran TC, Khalid M Al-Ghafri (1998) Properties of Omani artificial pozzolana. Appl Clay Sci 13: 275–292.
[20] Menezes R, Ferreira H, Neves A, Ferreira H (2003) Characterization of ball clays from the coastal region of Paraiba state. Ceramic 49: 120–127.
[21] Ambroise J, Murat M, Pera J (1985) Hydration reaction and hardening of calcined clays and related minerals. Cem Concr Res 15: 261–268.
[22] Coelho A, de Brito J (2013) Environmental analysis of a construction and demolition waste recycling plant in Portugal – part I: Energy consumption and CO2 emissions. Waste Management 33(5): 1258-1267.
[23] Lopez V, Llamas B, Juan A, Moran JM, Guerra I (2007) Eco-efficient concrete: impact of the use of white ceramic powder on the mechanical properties of concrete. Biosystems Engineering 96(4): 559-564.
[24] Yan LB, Chouw N (2013) Behaviour and analytical modelling of natural flax fibre reinforced polymer tube confined plain concrete and coir fibre reinforced concrete. J Compos Mater 47(17): 2133-2148.
[25] Yan LB, Chouw N (2013) Crashworthiness characteristics of flax fibre reinforced epoxy tubes for energy absorption application. Mater & Des 51: 629-640.
[26] Yan LB (2012) Effect of alkali treatment on vibration characteristics and mechanical properties of natural fabric reinforced composites. J Reinf Plast Compos 31(13): 887-896.
[27] Yan LB, Chouw N, Yuan XW (2012) Improving the mechanical properties of natural fibre fabric reinforced epoxy composites by alkali treatment. J Reinf Plast Comp 36(6): 435-437.
[28] Yan LB, Chouw N, Jayaraman K (2014) Flax fibre and its composites: A review. Composites Part B 56: 296-317.
[29] Dittenber DB, GangaRao HVS (2012) Critical review of recent publications on use of natural composites in infrastructure. Composites Part A 43(8): 1419-1429.
[30] Assarar M, Scida D, El Mahi A, Poilâne C, Ayad R (2011) Influence of water ageing on mechanical properties and damage events of two reinforced composite materials: Flax–fibres and glass–fibres. Mater & Des 32(2): 788-795.
[31] Balaguru PN, Shah SP (1992) Fibre-reinforced cement composites. McGraw-Hill.
[32] Ali M, Liu A, Sou H, Chouw N (2012) Mechanical and dynamic properties of coconut fibre reinforced concrete. Constr and Build Mater 30: 814-825.
[33] Li Z, Wang L, Wang X (2006) Flexural characteristics of coir fibre reinforced cementitious comp
[34] Composites. Fibres Polym 7(3): 286–294.
[35] Reis J (2006) Fracture and flexural characterization of natural fibre-reinforced polymer concrete. Constr Build Mater 20(9): 673–678

[36] Islam SM, Hussain RR, Morshed MAZ (2012) Fibre-reinforced concrete incorporating locally available natural fibres in normal- and high-strength concrete and a performance analysis with steel fibre-reinforced composite concrete. J Compos Material 46(1): 111-122.
[37] Hasan NMS, Sobuz HR, Sayed MS, Islam SM (2012) The use of coconut fibre in the production of structural lightweight concrete. J App Sci 12(9): 831-839.
[38] Asasutjarit C, Hirunlabh J, Khedari J, Charoenvai S, Zeghmati B, et al. (2007) Development of coconut coir-based lightweight cement board. Constr Build Mater 21(2): 277-288.
[39] Ramakrishna G, Sundararajan T (2005) Studies on the durability of natural fibres and the effect of corroded fibres on the strength of mortar. Cem Concr Compos 27(5): 575-582.
[40] International Year of Natural Fibres (2009). 40. Munawar SS, Umemura K, Kawai S (2007) Characterization of the morphological, physical, and mechanical properties of seven non-wood plant fibre bundles. J Wood Sci 53(2): 108-113.
[41] Ali M (2013) Utilization of coconut fibres and ropes as concrete reinforcement in mortat-free construction with novel interlocking blocks. PhD thesis, Department of Civil and Environmental Engineering, The University of Auckland, Auckland, New Zealand 1-237.
[42] Yan LB, Chouw N (2013) Compressive and flexural behaviour and theoretical analysis of flax FRP tube encased coir fibre reinforced concrete composite beams. Mater & Des 52: 801-811. 43. Yan LB, Chouw N (2013) Dynamic and static properties of flax fiber reinforced polymer tube confined coir fibre reinforced concrete. J Compos Mater.
[43] Li ZJ, Wang LJ, Wang XG (2007) Cement composites reinforced with surface modified coir fibres. J Compos Mater 41: 1445-1457.
[44] Ali M, Gultom RJ, Chouw N (2012) Capacity of innovative interlocking blocks under monotonic loading. Constr Build Mater 37: 812-821.
[45] Ali M, Briet R, Chouw N (2013) Dynamic response of mortar-free interlocking structures. Constr Build Mater 42: 168-189.
[46] Ali M, Chouw N (2013) Experimental investigation on coconut-fibre rope tensile strength and pull-out from coconut fibre reinforced concrete. Constr Build Mater 41: 681-690.
[47] Cook DJ, Pama RP, Weerasingle HLSD (1978) Coir fibre reinforced cement as a low cost roofing material. Build Environm 13: 193-198.
[48] Luisito JP, Neil JM, Rolendio N (2013) Coconut fibre (coir)-cement board production and application.
[49] Charlet K, Eve S, Jernot JP, Gomina M, Breard J (2009) Tensile deformation of a flax fibre. Procedia Engineering 1(1): 233-236.
[50] Yan LB, Chouw N (2013) A comparative study of steel reinforced concrete and flax fibre reinforced polymer tube confined coconut fibre reinforced concrete beams. J Reinf Plast Compos 32(16):1-10.
[51] Yan LB, Duchez A, Chouw N (2013) Effect of bond on compressive behaviour of flax fibre reinforced polymer tube-confined coir fibre reinforced concrete. J Reinf Plast Compos 32(4):273-285.
[52] De Lorenzis L, Tepfers R (2003) Comparative study of models on confinement of concrete cylinders with fibre reinforced polymer composites. J Compos Constr 7(3): 219-237.
[53] Gram H (1983) Durability of natural fibres in concrete. Swedish Cement and Concrete Research Institute, Stockholm.
[54] Filho R, Scrivener K, England G, Ghavami K (2000) Durability of alkali-sensitive sisal and coconuts fibres in cement mortar composites. Cem Concr Compos 22: 127–143.
[55] John VM, Cincotto C, Agopyan V, Oliveira CTA (2005) Durability of slag mortar reinforced with coconut fibre. Cem Concr Compos 27(5): 565- 574. 5
[56] Sivaraja MK, Velmani N, Pillai MS (2010) Study on durability of natural fibre concrete composites using mechanical strength and microstructural properties. Bulletin Material Science December issue 33(6): 719–729.
[57] Agopyan V, Savastano H, John V, Cincotto M (2005) Developments on vegetable fibre-cement based materials in São Paulo, Brazil: an overview. Cem Concr Compos 27: 527–536.
[58] Savastano H, Warden P, Coutts R (2005) Microstructure and mechanical properties of waste fibre-cement composites. Constr Build Mater 27: 583–592.
[59] Mohr B, Biernacki J, Kurtis K (2007) Supplementary cementitious materials for mitigating degradation of kraft pulp fibre cement-composites. Cem Concr Res 37: 1531–1543.
[60] Ghavami K (1995) Ultimate load behaviour of bamboo-reinforced lightweight concrete beams. Cem Concr Compos 17: 281–288.
[61] Bilba K, Arsene M (2008) Silane treatment of bagasse fibre for reinforcement of cementitious composites. Composites Part A 39: 1488–1495.
[62] Stamboulis A, Baillie CA, Garkhail SK, Van Melick HGH, Peijs T (2000) Environmental durability of flax fibres and their composites based on polypropylene matrix. Appl Compos Mater 7: 273–294.
[63] Le Duigou A, Davies P, Baley C (2010) Interfacial bonding of flax fibre/poly(l-lactide) bio-composites. Comp Sci Technol 70(2): 231-239.
[64] Singh B, Gupta M, Verma A (2000) The durability of jute fibre-reinforced phenolic composites. Compos Sci Technol 60: 581–589.
[65] Arbelaiz A, Fernandez B, Ramos JA, Retegi A, Llano-Ponte R, et al. (2005) Mechanical properties of short flax fibre bundle/polypropylene composites: Influence of matrix/fibre modification, fibre content, water uptake and recycling. Comp Sci Technol 65: 1582–1592.
[66] Guduri BBR, Khoathane C, Anandjiwala RD, De Veries A, Sadiku ER, et al. (2007) Effect of water absorption on mechanical properties of flax fibre reinforced composites. In: 6th International Conference on Composite Science and Technology. Durban, South Africa. 22-24 Jan, pp 1-10.
[67] Joffe R, Andersons J, Wallstrom L (2003) Strength and adhesion characteristics of elementary flax fibres with different surface treatments. Composites Part A 34: 603–612.
[68] La Mantia FP, Morreale M (2011) Green Composites: A brief review. Composites Part A 42(6): 579-588.
[69] MANSUR, M.A. and AZIZ, M.A., A Study of Jute Fibre Reinforced Cement Composites. International Journal of Cement Composites and Lightweight Concrete, England, Vol. 4, No. 2, pp. 75-85, 1982.
[70] AZIZ, M.A., PARAMASIVAM, P. and LEE, S.L., Chapter on "Concrete with Natural Fibres" in the book entitled New Reinforced Concretes, edited by R.N. Swamy, Int. Textbook Co., Glasgow, pp. 106- 140, 1984.



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