Researchers use plant fibres to develop green options for transport industry

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University of Portsmouth researchers and teams from around the world are at the forefront of a drive to develop greener composite materials from agricultural waste to be used in the automotive, marine and aerospace industries.

A team from the University's School of Engineering is designing and developing lightweight materials from renewable resources including agriculture biomass – a process that could provide significant environmental benefits in the transportation sector.

The Advanced Materials and Manufacturing (AMM) Research Group, School of Engineering, is working to develop lightweight sustainable composites and address the key challenges of using natural fibre reinforced composites for structural and semi-structural applications.

Dr. Hom Nath Dhakal, who leads the research group, said: "The sustainable composite materials are produced from flax, hemp, jute and waste biomass date palm fibres to develop parts like car bumpers and door linings—mainly for non-structural components. The team is also working towards making them suitable for structural and semi-structural applications by using hybrid techniques."

He added: "Using natural plant fibres such as date palm biomass for composite manufacturing has the potential to provide farmers in high value products with extra income and reduce C02 emissions from the burning of waste at the same time, an example of valorisation of

materials.

"These lightweight alternatives could help to reduce the weight of vehicles, contributing to less fuel consumption and fewer CO2 emissions. The sustainable materials can be produced using less energy than glass and carbon fibres, and are biodegradable, therefore easier to recycle."

Despite their many attractive attributes such as high specific strength and stiffness, having a lower production cost than synthetic fibres, reduction of wear on the machinery used to process these fibres and reduced concerns with health and safety during processing, natural fibres have their inherent drawbacks. They are less compatible with polymer matrices, hydrophilic in nature (absorbing moisture) and their mechanical properties are sometimes difficult to attain for the structural property requirements.

Dr. Dhakal and his team have been working closely with industry to address these problems and test the strength and viability of parts made from the sustainable materials. These test results are compared to that of hybrids of the natural materials with more traditional glass and carbon fibres. The AMM Research Group has been working in collaboration with researchers from various institutions from around the world.

Dr. Dhakal said: "In the last 12 months, the AMM Research Group has been involved in this ongoing research effort and has published many high impact factor papers in prestigious journals including the Composites Science and Technology, Composites Part A and Composites Part B."

A recent collaborative study, published in the journal *Composite Part A: Applied Science and Manufacturing* explored the potential of waste leaf sheath date palm fibres and the results of this publication can be

beneficial to composites based industries.

Date palm is cultivated extensively in North Africa and the Middle East and the accumulated bio-waste of plant fibres is in the order of millions of tonnes per annum. While there are a number of traditional uses of this bio-waste (including ropes and baskets), a large amount of the residue is burnt or land-filled.

The study looked at the structure, physio-chemical and mechanical properties of date palm fibres to assess whether they had the potential as reinforcements for composite materials. Evidently, the date palm fibre reinforced composites are cost-effective and environmentally-friendly reinforcements for high energy absorption and improved acoustics functions. This investigation provided structure property relationships. In order to get optimum properties from natural fibre composites, the properties of fibres themselves are important. Components such as door linings, front and rear car bumpers and parcel shelves can be manufactured using these reinforcements.

One of the issues with materials created from natural fibres is the lower strength compared to carbon and glass fibre composites, as they are susceptible to increased moisture absorption. A study published in *Composites Science and Technology* (Almansour et al., 2018) tested the effect of water absorption on the mechanical properties of flax and basalt fibre hybridised composites and tested their modes I and II fracture toughness behaviours.

Developing sustainable composite materials with improved properties that can withstand high performance and lightweight demands, as well as needing to be able to withstand harsh environmental conditions, are challenging undertakings. Hybridisation of two or more fibres (combination of natural fibres with glass, basalt and carbon fibres for example) is one technique in which the benefits of each reinforcing

material can be combined to achieve composites that exhibit both improved mechanical performance and environmental impact, leading to sustainability.

From the AMM group's studies, it has been revealed that high mechanical strength as well as toughness was achieved by using basalt fibre hybridised with flax fibres. Dr. Dhakal said: "The way forward for natural fibre composites to be used in structural applications would be a combination of both materials (natural fibres and synthetic fibres) with a hybrid approach. Meeting these challenges requires further research and innovation between academic institutions and industry."

More information: Alain Bourmaud et al. Exploring the potential of waste leaf sheath date palm fibres for composite reinforcement through a structural and mechanical analysis, *Composites Part A: Applied Science and Manufacturing* (2017). DOI: 10.1016/j.compositesa.2017.10.017

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