SRM to Quake Proof Buildings

*Dr P Anbazhagan, Assistant Professor in the Department of Civil Engineering, at the Bangalore-based Indian Institute of Science has conducted experimental investigations to select the optimum size of tyre crumbs from ELTs to develop sand-rubber mixture (SRM) to make low to medium rise building earthquake-resistant. In this interview to **Tyre Asia**, he elaborates on his work on waste tyre as isolation material that is cost-effective and useful*

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Death toll figures following earthquakes are alarming. The powerful temblors that devastated Nepal two years ago killed more than 8,500 and destroyed half a million homes. It could still ignite similar havoc in the Himalayan region. In the past century, such seismic terror had killed an average of 20,000 people a year throughout the world, with over 80 per cent of fatalities in developing countries. It is imperative that technologies should be developed to construct buildings that are seismic resistant. What Dr P Anbazhagan did was to research ways to utilise discarded tyres that would minimise building collapses in times of earthquakes.

The Assistant Professor in the Department of Civil Engineering at the Bangalore-based Indian Institute of Science has been doing extensive studies on seismology and geology, ground motion prediction equations, and rupture based seismic hazard analysis. He has come up with elaborate investigation into waste tyre uses to mitigate and make building structures earthquake-proof.

He has found that scrap tyres provide numerous advantages from the viewpoint of civil engineering practices. "By using seismic isolation devices derived from ELTs, you have the twin advantage of addressing disposal problems and finding practical use in civil engineering as geo-materials," says Dr Anbazhagan in an interview. He notes that the use of waste tyres to reduce seismic impact would be an ideal solution to environment-friendly disposal of ELTs. Proper disposal of waste tyres is a challenge. "We have to ensure that they do not pose any threat to human health and the environment. In many developed countries people have to pay disposal charges for used tyres. Improper disposal results in fire and health hazards," he said.

In this context it is necessary to find cost-effective way to utilise ELTs. He started studying utilisation of ELTs in seismic isolation as the current resources and technology for this purpose are very expensive and not affordable to the vast majority of people living in developing countries. "" Our proposed scheme is definitely environment-friendly and low cost as raw materials are derived from waste materials," Dr Anbazhagan said.

He vows that earthquake vibrations can be minimised by applying seismic isolation techniques where low-cost isolation materials could be used by developing sand-rubber mixtures (SRM) where appropriate-sized crumb rubber derived from waste tyres could be used. In his study he used seven different rubber sizes, including six sizes of granulated rubber.

He classified them as A, B, C, D, E, F and G for developing SRM. Under A he used crumb passing 2 mm sieve – and retained on 1 mm sieve), B (4.75 mm – 2 mm), C (4.75 mm – 5.6 mm), D (5.6 mm – 8mm), E (8 mm – 9.5 mm), F (12.5 mm – 9.5 mm), and one size of tyre chips G (20 mm – 12.5 mm).

When granulated rubber size in the range of 9.5 mm to 12.5 mm was mixed with sand, it demonstrated improved shear strength properties up to 30 per cent mix by volume but thereafter it got reduced. Analysing the engineering properties of SRM with higher rubber content of 50 per cent and 75 per cent, it was found that the shear strength characteristics of these were almost same or lower than that of sand with higher compressibility. Dr Anbazhagan also examined the various performance parameters, including width and thickness of SRM around foundation of the structure. He also conducted laboratory model tests on unreinforced and reinforced SRM.

Damping characters

His numerical studies showed that the percentage of rubber in SRM, thickness

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and width of SRM around the footing and frequency variation of the input motion are the main factors, which control the damping characteristics of earthquake motion. For 75 per cent SRM, the horizontal accelerations could be reduced by 40-50 per cent for the selected thickness and width of SRM around the footing. Using 75 per cent SRM caused excessive settlement and it was felt that there was a need to improve the static properties without affecting the damping.

Dr Anbazhagan, who is credited with developing Rupture Based Seismic Hazard Analysis, a new method to predict earthquakes hazard values, says three types of geo-synthetics – geogrid, geonets and geotextile – were used for reinforcing SRM in layered form, with varying number of geosynthetic layers (1 to 4 layers), geosynthetic arrangement and confining pressure (for different depth). His study showed that many layers of equally-spaced geotextile for 50 per cent SRM and geonet for 75 per cent SRM showed better strength when compared to other combinations.

For his research Dr Anbazhagan has set up sophisticated equipments worth more than Rs20 million from sponsored research schemes for experimental investigation of his research studies. He has measured dynamic properties of unreinforced and reinforced SRM, and developed dynamic models useful for numerical analysis.

In his experimental investigation he selected seven crumb sizes that are based on shear strength, energy absorption capacity and stiffness, it was noted that the percentage of rubber in RSM, thickness and width around the footing and frequency variation controls the damping characteristics of earthquake motion.

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As sand becomes costly and not available easily, Dr Anbazhagan also focused on using of Manufactured sand, local soil and crushed construction waste from buildings demolition as an alternate for sand to make SRM. He feels that lab scale results need to be validated and confirmed by large-scale shake table tests, which requires extensive industrial support. He is also looking at the possibilities of minimising the soil liquefaction during earthquake using these composite materials.

"Depending on building load and earthquake force, we need to design the proposed isolation scheme such as thickness of SRM and number of reinforcement layers that can be used for construction.

Dr Anbazhagan's research team at IISc, which included his PhD student Manohar DR, has now opened a way to build quake-free buildings and at the same time address the environmental hazards posed by mounting tyre scraps.