

Earthimalayan Wood, Cane & Bamboo: Door to Earthquake Resistant Technologies – K. R. Y. Simha, Indian Institute of Science, Bengaluru - 560 012 (E: simha@iisc.ac.in)

Nestled along the line joining 1897 and 1950 earthquakes and trapped between hills knuckling around the northeastern syntaxis (NEST), Brahmaputra valley (BRV) has survived dangerously. Archaeological evidence of human habitats, cane and bamboo houses, bridges, boats and furniture are a testimony to the spectacular skills of local artisans, architects and sculptors for surviving on rugged terrain ravaged by floods, cyclones and earthquakes. Himalayas and NEST representing the largest natural river management system divide, divert and guide myriad rivers hydrating well over a million square kilometres before debouching to distant oceans.

While steering the Brahmaputra down and inward along BRV, periproximal rivers like Irrawaddy, Salween and Mekong have also been shifted and squeezed by NEST over the past 2 million years. Distal rivers like Yangtze, Yalung, Tatu and Min flowing east also reveal the joint impact of NEST and global tectonics. Exploration of BRV hydrology by Dalrymple aided Oldham's authoritative 1897 earthquake GSI memoir. Ironically, the 1950 catastrophe complicated by NEST continues befuddling seismologists. Led by Coudurieur-Curveur a 2020 update consolidating the work of groups led by Gupta, Ben-Menahem, Rajendran, Tapponnier and others compliments the hydroseismological impact assessment on shearing and streamlines contraction of Salween, Mekon and Yangtze curling around NEST by Hallet and Molnar in 2001.

Presently, BRV is staggering with a dozen or more earthquakes of $M > 2.7$ each week including an $M 6.4$ on April 28, 2021. Over a hundred shallow quakes (focal depths between 3 and 40 kilometres with the main shock at 37 kilometres) have released about 100 trillion joules in six weeks. While this may augur well in reducing $M 8$ probability circa 1897 and 1950, an $M 7$ during floods can be equally devastating. Transverse-BRV faults like Kopili seem busy swarming a 40 km radius centred 92.5E on the Brahmaputra. The interaction of the BRV network of transverse and parallel faults with larger Himalayan thrusts orchestrated by NEST is the main cause for seismic swarms. While swarms higher up in the piedmont region away from BRV are not new, their migration towards Guwahati is a disquieting development.

Earthquake and flood-resistant shelters for rapid fabrication and repair *in situ* using local resources are urgently needed to prepare BRV for facing the 2021 monsoon. It is in this context that wood, cane and bamboo abundant and ubiquitous to BRV offer opportunities for carpenters, architects and engineers for designing frames and furniture. The pentad of geology, hydrology, seismology, earthquake and wood technology includes the exciting field of hydroseismology for addressing liquefaction vividly portrayed in Oldham's memoir. The history of civilization is replete with structures and frames of wood, cane and bamboo for castles, bridges, shelters, artistic sculptures and furniture. Their resilience to earthquakes, floods and fires forms the saga of the historic Old Faithful Inn over the past century. These heritage structures serve as benchmarks for formulating earthquake, fire, flood and emergency management codes like FEMA 232/P749 for homebuilders.

Presently, there is a need for creating a dynamic database of rivers, forests, geoponic terraces, hills and valleys of BRV using satellite

images. It is possible to prepare updated GPS-compatible seismic microzonation maps for disaster management and damage mitigation. For illustrating this concept, a 0.66° wide strip originating at 26N laid out along BRV between 91.5E and 93E can be covered with 3 km side square panels. This means 1369 square panels like pixels providing coverage of 12321 square km along 180 km of BRV spread evenly across both banks of Brahmaputra. These 1MP equivalent GPS panels can be imaged and analyzed to yield a severity index of microzone (SIM). Quantifying SIM can be based on prevailing faults, floods, rock and soil type, liquefaction susceptibility, erosion, slope stability, forest cover and earthquake periods. This can be further supplemented with techno-socioeconomic data regarding structures and residents for actuarial purposes. A quantitative metric like SIM updatable by GPS technology can become the driving mission for a new BRV Authority for Seismic Technology Initiative (BRVASTI) for disaster forecasting & management.

Geological Survey of India established in 1851 has inspired and aided the Geological Society of India and the Indian Society of Earthquake Technology (ISET) founded in 1958 and 1962, respectively. Inaugurating the ISET journal, founder president Jai Krishna titled the first paper simply *The problem of earthquakes!* This issue also featured structural dynamics research at IISc Bangalore led by Iyengar (KTS). Over 40,000 papers and memoirs issued by these two societies have furnished vital data for planning and executing major bridges, tunnels, dams, mines, power plants, railways and airports built with billions of tons of steel, brick, stone and concrete along with a modest share of wood and timber. Safety and stability which are given paramount importance in public projects are often, unfortunately, often uprooted by style and stigma in private construction.

Unplanned smaller scale buildings and shelters violating codes sabotage entire communities living in seismic zones like BRV. Emergency and disaster management for protecting life and property had not been a formal part of technical training and education. It is therefore gratifying that CDMR-a dedicated centre for disaster management and research newly set up at IIT Guwahati offering MS & PhD programs from July 2021 can greatly supplement and streamline earlier initiatives. Following the 28 April 6.4M earthquake, IIT Guwahati Director and present ISET President Sitharam reiterated microzonation, liquefaction; however, more interestingly in the BRV context, recommended admirable Assam-type of *wooden* houses. Endowed with elastic resilience and magnificent fatigue endurance wood along with cane and bamboo offer exotic yet spartan options for homebuilders.

Changing the mindset of builders and town planners to adopt wood, cane and bamboo warrants providing both training and incentives. Fortunately, century-old institutes of forest research, wood science and technology set up all over India are well equipped to aid and amplify the scope of CDMR for designing and rigorous testing of non-conventional shelters like houseboats, awnings, furniture and plywood boards. Indeed, BRV beckons engineers and entrepreneurs alike for reinventing the magic of wood, cane and bamboo rejoicing 1958 Williams lyrics on the bamboo door and bamboo roof technology!