National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Surface deformation, Seismicity modulation, and Geodynamic implications of the Delhi-Haridwar Ridge
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Venue	: ER-303
Date and Time	: 07 May 2025 (10:00 am)
Abstract	: Globally, regions undergoing active tectonic processes are often associated with significant seismic hazards, particularly where tectonic plate boundaries converge. The Himalayas, formed by the ongoing collision between the Indian and Eurasian plates, constitute one of the most seismically active zones on Earth. This collision not only drives large-scale crustal deformation along the orogenic belt but also influences intraplate regions such as the Indo-Gangetic Plain (IGP), where the interaction between tectonic and non-tectonic processes plays a crucial role in shaping the landscape and modulating seismic activity. In recent decades, the growing impact of anthropogenic activities&mdashsuch as groundwater extraction, rapid urbanization, and land-use changes&mdashhas introduced new complexities in understanding seismicity and crustal deformation. These activities can alter subsurface stress regimes, potentially triggering earthquakes or amplifying existing seismic hazards, particularly in densely populated and rapidly urbanizing areas. This study focuses on the Delhi-Haridwar Ridge (DHR), a prominent geological structure within the IGP that marks the transition between the stable Indian Shield and the tectonically active Himalayan front. The DHR is characterized by a complex fault network, including the Mahendragarh-Dehradun and Sohna faults, which play a pivotal role in stress accumulation and release. Additionally, the region is under intense anthropogenic pressure, making it an ideal natural laboratory to investigate the interplay between tectonic dynamics and human-induced processes. Adopting a multidisciplinary approach that integrates geodetic observations, hydrological modelling, and seismic analysis, this research investigates the mechanisms governing seismicity and crustal deformation in the DHR region. Specifically, it quantifies the effects of groundwater withdrawal, seasonal hydrological loading, and urban development on subsurface stress conditions and fault behaviour. The results reveal that excessive groundwater extraction induces significant land subsidence and alters pore pressure, leading to stress redistribution along active fault systems. Seasonal hydrological cycles, especially monsoonal recharge and groundwater fluctuations, further modulate crustal stress and contribute to spatiotemporal variations in surface deformation. Moreover, rapid urbanization&mdashmarked by large-scale infrastructure development and land-use changes&mdashamplifies subsurface stress changes and elevates seismic hazards in vulnerable urban centers. The DHR also acts as a structural conduit for stress transmission between the Indian Shield and the Himalayan orogen, reinforcing its significance in regional geodynamics. Overall, this study underscores the critical influence of anthropogenic activities on crustal stress regimes and seismic hazard potential. The findings emphasize the need for integrated geophysical monitoring, sustainable groundwater management, and seismic risk-informed urban planning. By bridging the gap between tectonic and anthropogenic influences, this research contributes to a more comprehensive understanding of Earth&rsquos crustal behavior and offers a framework for improved hazard mitigation in seismically vulnerable, rapidly urbanizing regions.