GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENCE AND TECHNOLOGY
LOK SABHA
UNSTARRED QUESTION NO. 2793
ANSWERED ON 06/08/2025

EARTHQUAKES-GPR TECHNOLOGY

2793. SHRI SURESH KUMAR SHETKAR:

Will the Minister of SCIENCE AND TECHNOLOGY be pleased to state:

(a) whether the Government has any mechanisms or plans have in place to ensure the timely deployment and operational readiness of GPR and related geophysical equipment immediately following the occurrence of an earthquake, if so, the details thereof;

(b) the details of the coordination framework between Central and State disaster management authorities, particularly for sharing and optimal utilization of scarce technical resources such as GPR equipment and trained operators;

(c) the details of the documented examples or case studies where the identification of voids using GPR directly contributed to the successful rescue of trapped individuals during earthquake disasters in India;

(d) manner in which the Government intend to address the inherent limitations of GPR technology, such as reduced penetration depth in certain building materials and challenges posed by debris clutter in collapsed urban environments; and

(e) whether the Government is exploring the integration of GPR with other emerging technologies, such as drone surveillance, artificial intelligence and remote sensing, to enhance the overall efficiency and effectiveness of earthquake search and rescue operations, if so, the details thereof?

ANSWER
MINISTER OF STATE (INDEPENDENT CHARGE) OF THE MINISTRY OF SCIENCE AND TECHNOLOGY AND EARTH SCIENCES
(DR. JITENDRA SINGH)
विज्ञान और प्रौद्योगिकी तथा पृथ्वी विज्ञान मंत्रालय के राज्य मंत्री (स्वतंत्र प्रभार)
(डॉ. जितेंद्र सिंह)

(a) The Government is continuously working on enhancing its operational readiness and timely deployment of Ground Penetrating Radar (GPR) and related geophysical equipment for search and rescue

purposes, detecting voids & buried objects, assessing structural damage, and understanding the earthquake's impact on the subsurface following the occurrence of an earthquake. In a recent landslide rescue operation in Lachen, Sikkim, the Indian Army utilized Drone mounted GPR to locate potential victims buried under debris indicating Government's readiness to ensure the timely deployment and operational readiness of GPR and related geophysical equipment in event of disasters. The Drone mounted GPR helped identifying two sub-surface anomalies at depths of 0.76 metres and 0.015 metres to support rescue operations.

(b) The primary responsibility of disaster management rests with the State Government concerned. The Central Government, wherever required, supplements the efforts of the State Governments by providing logistic and financial support in cases of natural disasters of severe nature. National Disaster Response Force (NDRF), constituted under section 44 of the Disaster Management Act, 2005 is equipped with state of art equipment like GPR and other geophysical tools to provide specialist response to a threatening disaster situation or disaster. At present, NDRF has 16 Battalions, which are located as per vulnerability profile of the country to provide immediate response during disasters. As per the National Policy on Disaster Management, raising of State Disaster Response Force (SDRF) and equipping them is with the State/UT Governments concerned. The Central Government regularly follows up with the State/UT Governments to raise SDRF and equip them with adequate disaster response capabilities. To facilitate the State Governments, the Central Government has also shared the list of disaster response equipment with them, with the request to equip their SDRF in line with NDRF. Training programs and workshops are being conducted to enhance the skills of engineers and other professionals in using GPR and other relevant technologies.

(c) Documented examples or case studies pertaining to identification of voids and successful rescues during Indian earthquake disasters are not readily available due to several reason like (i) the complexities of earthquake debris makes it challenging for GPR to accurately identify voids and distinguish them from other subsurface anomalies and (ii) GPR is often used in conjunction with other technologies like acoustic sensors and micro-seismic monitoring, making it difficult to isolate

GPR's specific contribution to a successful rescue. Thus, the focus was more on conventional search and immediate rescue of trapped individuals. However, after the 2001 Bhuj earthquake, GPR was used to investigate sand blow craters formed due to liquefaction in the Banni plain and Great Rann of Kachchh. The high-resolution GPR successfully imaged the stratigraphy and deformation up to 6.5 meters deep, helping to understand the mechanism of sediment venting. The Sikkim earthquake 2011 resulted in various types of failures, including slope failures, settlement, and structural failures. GPR was used to examine distressed pavements and depth of cracks in buildings.

(d) The Government is addressing the limitations of Ground Penetrating Radar (GPR) technology through ongoing research, development of improved interpretation techniques, and the integration of GPR with other technologies. Government Agencies and Educational Institutions like Indian Space Research Organisation (ISRO), National Geophysical Research Institute (NGRI), National Building Research Institute (NBRI), Indian Institute of Technology Roorkee (IIT Roorkee) are extensively working on GPR's limitations. Low Frequency Antennas and Dual-Polarized & 3D GPR Systems are being deployed for addressing reduced penetration depths whereas advanced Signal Processing techniques using Deep learning models are being developed and used to specifically eliminate clutter in reinforced concrete, improving the detection of voids and other subsurface anomalies.

(e) Yes, various research organisations like ISRO, NGRI, NBRI etc. are actively involved in developing and refining GPR techniques, including polarimetric GPR for fracture detection and time-domain full-waveform inversion for quantitative analysis of subsurface properties. The use of GPR in conjunction with other technologies, such as 3D software modelling, to create detailed subsurface visualizations are also being explored. GPR data is being combined with geospatial data (like topographic data) to create more accurate subsurface maps, particularly in uneven terrains. These techniques will help enhancing the overall efficiency and effectiveness of earthquake search and rescue operations.

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