Can Lucknow monuments survive quake?

Abhinav Malhotra | TNN

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Manoj Chhabra

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IIT-Kanpur Study Paints Gloomy Picture For Rumi Darwaza And Imambara

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The Lucknow monuments built using thin 'lakhauri' (burnt-clay bricks) and lime-crushed brick 'surkhi' (aggregate) mortars were "seismically evaluated" by Prof Durgesh C Rai of the Department of Civil Engineering, IIT-Kanpur, over a period of three years. His research has also found place on the cover of 'Current Science' (January 25 edition), a fortnightly journal of scientific research.

According to Prof Rai, the damage to the Lucknow monuments is likely in the event of an earthquake causing a shaking intensity of 7 or above on Ritcher scale in Lucknow region as it comes in Zone 3 of the Indian Seismic Code-IS 1893.

Talking to TOI, Prof Rai said: "We collected brick, mortar and plaster samples from various Lucknow monuments, including renovation plaster sample from Rumi Darwaza, Dilkhusha and Naubatkhana. Test methods like microwave acid digestion, thermo-gravimetric analysis (TGA), scanning electron microscope associated with energy dispersive spectroscopy (SEM–EDS) and X-ray diffraction (XRD) were used to find the chemical and mineralogical composition of the material. The brick samples were also examined visually for their surface texture, colour, particle shape and size."

"Studies were carried out to characterize engineering properties of old masonry materials and new mortar being used for renovation work. The mechanical properties of reclaimed 'Lakhauri' bricks were found comparable to good-quality contemporary bricks of neighbouring regions," he added.

Further, the research found that mineralogical composition of the material was not too different, except for a few minerals. The lime-surkhi mortar used in old masonry work was found to be lime rich with binder to aggregate ratio of about 1:2 to 3 by volume that is similar to those used in Byzantine structures of Western and Central Asia.

"As the renovation mortar has poor hydraulic property compared to old mortar, the bricks used then are no different from modern day bricks," he added.

"The arch and half-dome structure of Rumi Darwaza was analyzed for its seismic resistance using laboratory determined properties of Lakhauri masonry. The pushover and response spectrum analysis estimated lower seismic capacity in comparison to demand for design-level ground motions, implying likelihood of damage in future earthquakes," said Prof Rai.

The half-dome drum structure, Rumi Darwaza, was studied for seismic resistance since its shape and the materials used for its construction contribute to its uniqueness.

"Work at Rumi Darwaza was taken up by the Archaeological Survey of India (ASI), Lucknow, to repair the damage in the structure caused by ageing, climatic conditions and vibration due to traffic movement through the gate. Though major cracks were found in the structure, no significant retrofitting or intervention work was carried out," said the IIT-Kanpur scientist. According to the latest edition of Current Science, material characterization of historical masonry materials and structural analysis of historical monuments were important aspects of any renovation or retrofitting. "The most important aspect considered in the renovation works of historical buildings is that the intervention material should be compatible with the original material in the sense that it will not cause any damage in the long term. This requires knowledge about the physical properties, mineralogical and chemical composition of original masonry materials as well as various problems arising out of continued deterioration, which our study has pointed out," Prof Rai said.

Asked whether use of wrong materials in restoration of historical buildings leads to rapid deterioration in the whole structure and its constituent elements, Prof Rai said: "They may lose their historical, documental and aesthetical value. The materials used in restoration are usually selected without carrying out detailed research and without determining what problems they may cause, leading to undesirable effect on the structure in short and long-term."

"It is important that suitable criteria should be adopted for the selection of repair mortars considering the requirements of resistance to the environmental conditions as well as of compatibility to old materials," he added.

Prof Rai said IIT-Kanpur is ready to provide scientific support to ASI for doing renovation of these important monuments so as to fortify them against earthquake and other environmental factors such as rain.

However, Superintending Archaeologist (Lucknow Region) Archeaology Survey of India (ASI) Praveen Kumar Mishra, said: "Rumi Darwaza and other masonry monuments in Lucknow have withstood climatic changes in the past 300 years and have passed the test of time. Nothing has happened to the historical buildings in Lucknow so far and keeping in mind our expertise in conserving heritage sites, there seems to be no threat to the Lucknow monuments."

He said that he would like to analyze the magnitude of earthquake which can actually damage Rumi Darwaza and other historical monuments.

"I am not aware about the research work done by the IIT-Kanpur scientist and neither read the paper published in the recent edition of 'Current Science' journal but a proper conservation of the Lucknow monuments is being done. I will study the research work done by Prof Rai," Mishra added. When questioned whether ASI was ready to take scientific input from IIT-Kanpur for better conservation of historical Lucknow monuments, Mishra said: "I welcome the technological know-how from IIT-Kanpur. If it is provided to us, we are ready to use it for better preservation of our monuments."

The study primarily aims at:

- Characterization of materials used in Lucknow monuments, such as Lakhauri bricks, lime-surkhi mortar and plaster and masonry assemblages recreated in laboratory using Lakhauri bricks and lime-surkhi mortars
- Seismic evaluation of the half-dome structure of Rumi Darwaza by comparing its present day seismic load carrying capacity with the expected seismic demand using suitable analytical and numerical modeling. For the purpose of material modeling in numerical analyses, masonry properties were obtained from masonry assemblages constructed with reclaimed Lakhauri bricks and simulated lime-surkhi mortars