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FAILURE OF BUILDINGS ON MOUND - A CASE STUDY

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ABSTRACT

The century old buildings situated on mound at Jais town, Rae Bareli (Uttar Pradesh), India, failed after heavy rainfall. The paper presents the convincing evidence of the failure of buildings through photographs. The prime cause of failures and suggestions are also reported.

KEYWORDS

Mound (Tcela), century old, heavy rainfall, failure, Lakheri Bricks, geotechnical investigation. differential settlement, monitor, progressive tilt.

INTRODUCTION

Jais town the birth place of famous poet Malik Mohamud Jaisi is situated on century old manmade mound in the district of Rac Barchi (Uttar Pradesh), India. The buildings constructed over it. were also reported to be more than 80 to 100 years old.

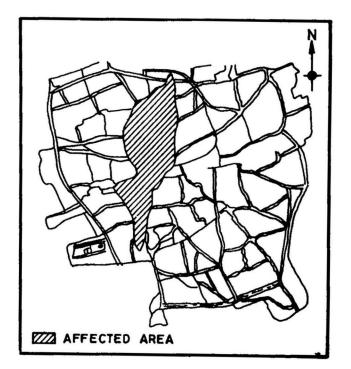
Due to heavy rainfall in the month of September 1986 the nrea was inundated with flood and not found approachable without boat. Major distress developed after the rain stopped and the flood water started receding. It was apprehended that there might be any seismic activity in the area, but having the problem in the localised larea on the mound, the failure of buildings due to seismic activity was ruled out.

Having the problem of societal nature, the distict authority entrusted it to Central Building Research Institute, Roorkee (India) for undertaking the study on failure of buildings on age old mound. The author undertook the programme as a case study of special nature.

TYPE OF CONSTRUCTION AND EXTENT OF DISTRESS

A large number of residential buildings were supported on

mound (Teela) and reported to be about 80-100 years old. On inspection, the major failure in buildings were found in a localised area (Fig. 1) showing mostly in north south direction. The construction of buildings on mound



having rick walls with small size bricks of size 17 cm x 10 cm x 4 cm thickness approximately found laid in mud mortar. The bricks were locally known as Lakheri Bricks. The thickness of walls varied from 45 cm to 75 cm showing most often without proper bonds. The foundation of buildings was of shallow type without getting any proper detail except wider base of mostly spread type. This type of buildings showed higher degree of failure than the newly constructed buildings having properly bonded brick wall in mud mortar cement-sand plaster on walls and RCC or RBC roofings. As reported, the spread type shallow foundation was provided of burnt clay brick work laid in cement-sand mortar upto plinth level. Thereafter, the superstructure was laid in mud mortar of 23 cm thick brick work. The town was covered by a network of footpath made of flat brick soling with drains on both sides following natural contour of the mound.



Fig. 2 Collapsing Wall

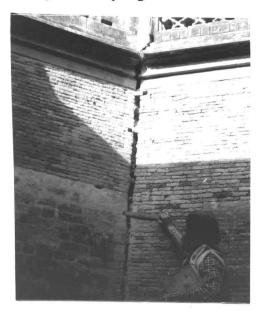


Fig. 3 Separation of Walls at Corner



Fig. 4 Severe Cracking near Lintel

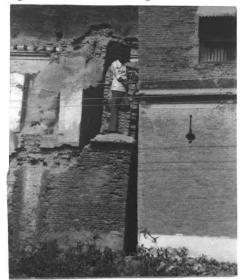


Fig. 5 Tilt in building due to settlement and tilt measurement

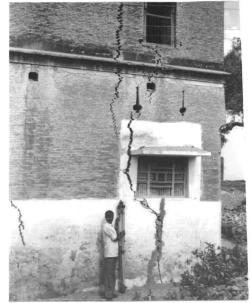


Fig. 6 Cracking in Wall and tilt measurement

The extent of distress in buildings were of interesting nature and it was decided to take large number of photographs to examine the failure patern for convincing the district authority. Few are shown in Figs. 2 through 10 providing fair idea of failure in buildings. The EDM (Elecronic Distance Meter) was used to assess tilt in buildings due to differential settlement.

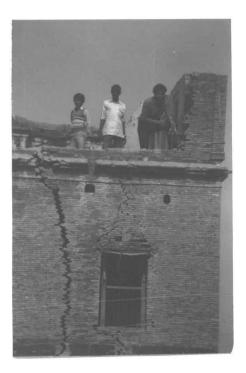


Fig. 7 Wide Crack in wall and tilt measurement



Fig. 8 Cracks in newly constructed building showing scepage in wall



Fig. 9 Capilary rise and dampness in walls

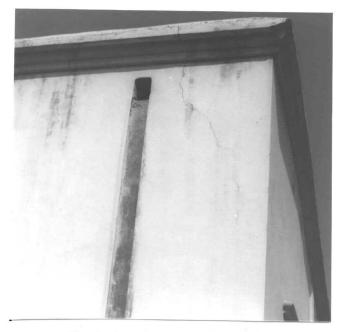


Fig. 10 Repaired cracks in building

GEOTECHNICAL INFORMATION

Due to urgent requirement of report on distressed buildings. the geotechnical investigation carried out for the proposed overhead water tank on the same mound (Teela) n the month of January 1986 was collected from the district authority to study the subsoil condition. The bore log of two locations are shown in Fig.s11(a-b). No fresh geotechnical investigation was carried out after getting geotechnical information from their record.

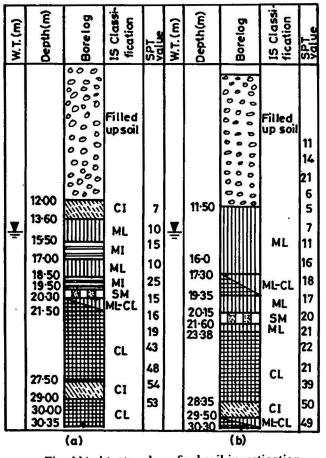


Fig. 11(a-b) Borc log of subsoil investigation

DISCUSSION ON FAILURES

On the basis of study the prime cause of distress was due to the unprecedented rainfall. The age old buildings showing enough sign of deterioration stared failing due to heavy rainfall and flooding resulting in the saturation of subsoil and found tilted towards sides where there was chance to accumulate and percolate water under the foundation. The buckling, bulging vertical cracks, separation of wall at corner and floor from walls indicated uneven settlement of foundation soil on mound. The heavy and thick wall of buildings and protected interior walls continued to carry loads. The catastropic failure was not observed even having severe distress. Minor cracks in walls were found in case of newly constructed buildigs. However, seepage in walls due to capilary rise was observed. The stagnant water pool between the buildings might had created differential settlement of the foundation due to moisture ingress into the subsoil and induced tensile stress in the walls caused severe cracking, dislocation of walls at corner. failurc/distortion of arches on doors and tilting of walls. The tilt measured with the help of EDM indicated its magnitude between 1 in 50 and 1 in 100 at different height of buildings. Any tilt above 1 in 300 in brick wall is not considered desirable. Therefore, tilt above 1 in 100 for the building was taken as unsafe.

The bore log of two locations revealed subsoil condition carried out on mound upto around 30.3 m depth indicating filled up soil layer upto around 12 m depth having low SPT value (N = 5 - 14) underlained by soil layers of CI, ML, MI, ML-CL, CL, CI and CL groups. The subsoil of fill (Teela) having clay silt of medium plasticity with water table at 14-15 m below ground level. The N-values between 5 and 53 were observed from 12 m to 30.3 m depth with certain variation in results. Heavy rainfall and inundatioin of mound for more than fortnight saturated the top filled up layer of soil having N-value in order of 5-14 in dry condition reduced the strength behaviour significantly and increased the settlement characteristics in higher order resulted in collapsible condition and finally produced higher degree of differential settlement and failure in outlived buildings in localised area.

Hence, from the above discussion it was inferred that the cause of distresses in buildings experienced unprecedented rainfall during the period, poor drainage of the mound (Teela) and the consequent weakening of mud based old constructions leading to differential settlement of the foundation and tilting of buildings.

SUGGESTION

Considering the extent of damages and distresses in outlived buildings the restoration was not found economical and suggested to rebuild after proper geotechnical investigation on mound. The newly constructed buildings showing lower degree of distress were suggested to watch osely. Tell-tale markers were placed at all critical locations for periodical observation to record propagation of cracks. Sealing of cracks and strengthening measure were also suggested. No such progress in propagation of cracks was reported.

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REFERENCE

CBRI (1987) "Report on Distressed Buildings at Jais Town. Rac Barcli" (unpublished) pp 2-28.