This report comments on the seismic performance of a Reinforced Concrete Frame building with masonry infill walls situated near the IIT Kanpur main campus entrance gate.

Building description: It's a two storey RC building with masonry infill used for commercial purposes. It's situated near a railway line.

Seismic performance of the building

Conceptual design and planning consideration:

Building shape and lay out was almost symmetric so it will offer smooth and direct load paths for earthquake loads.

Masonry was provided as infill which may not be very good for seismic performance of the building. For the good earthquake performance masonry infill walls are supposed to be isolated from the frame which was not the case here.
Short columns can be seen in the building. Short columns perform very badly during earthquakes due to induced high shear forces in them. Captive columns (partially restrained by the wall) can also be seen which is expected to perform very badly during earthquakes.

Figure 1(i)RC frame bulding with masonry infill (ii) short columns in the first floor

Possibility of vertical additions of storey was evident from the reinforcement bars left exposed on the roof however it is not sure whether the columns were designed for vertical additions or not.

As can be seen from the building it follows the "weak column-strong beam". During earthquakes forces are transferred from beams to columns, so column should be designed to be stronger in bending than the beams, in this way beam will fail first rather than columns, so the complete collapse can be avoided.

Figure 2 weak column and strong beam design

Detailing Considerations

It could not be deduced just looking the structure whether "ductile detailing" of the structure has been followed or not. However some general observations shows that 135° hooks has not been provided and they have a bent angle of 90° also some exposed portion of the reinforcement showed that stirrups are not according to the norms provided in IS code. So overall it can be inferred that ductile designed has not been followed. Extended bars can be seen at the top of building columns. Extended bar for future construction become excessively corroded and thus should be avoided.

Figure 3. 90 degree hooks

Beam columns joints were very poor at many places not properly connected and with poor reinforcement detailing. At some places mixed connections were used like reinforced concrete beams resting on masonry columns which can be detrimental to the structure under earthquake loads.

Non structural elements basically included masonry infill, holdings etc. One surprising thing was reinforcements through masonry columns.

Figure 4 Poor beam column connections

Diagonal slabs and beams were used in staircase. These elements attract large earthquake forces and can damage the parent structure by pounding and crushing effects.

Construction Considerations:

Poor construction practices were followed. Exposed reinforcements, pipe installation through the load walls and beams could be seen in the structure.

Figure 3. Pipe installation through beams and walls

Figure 4 Exposed reinforcement