

Some Failures & Remedies



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Some major causes of current Failures

Following one or composite are the main causes of current failures

- **Differential settlement due to Soil condition**
- Differential settlement due to Lack of Foundation Design
- **Poor quality of construction material**
- Poor quality of Detailings
 - **Lack of infill wall connection**
 - Spacing of lateral ties
 - **Hook of lateral ties**
 - Adjacent building joint consideration (pounding effect)
- **Lack of Structural design**
 - **Soft storey effect**
 - Short column effect
 - **Size of member (rare)**
 - Reinforcement bar (rare)

H/W=?



Differential settlement due to Soil condition



Building Structure at the same location (Macchapokhari, Balaju)



Failure near by Balkhu River



Failure near by Dhungedhara, Thamel



Tower erected building

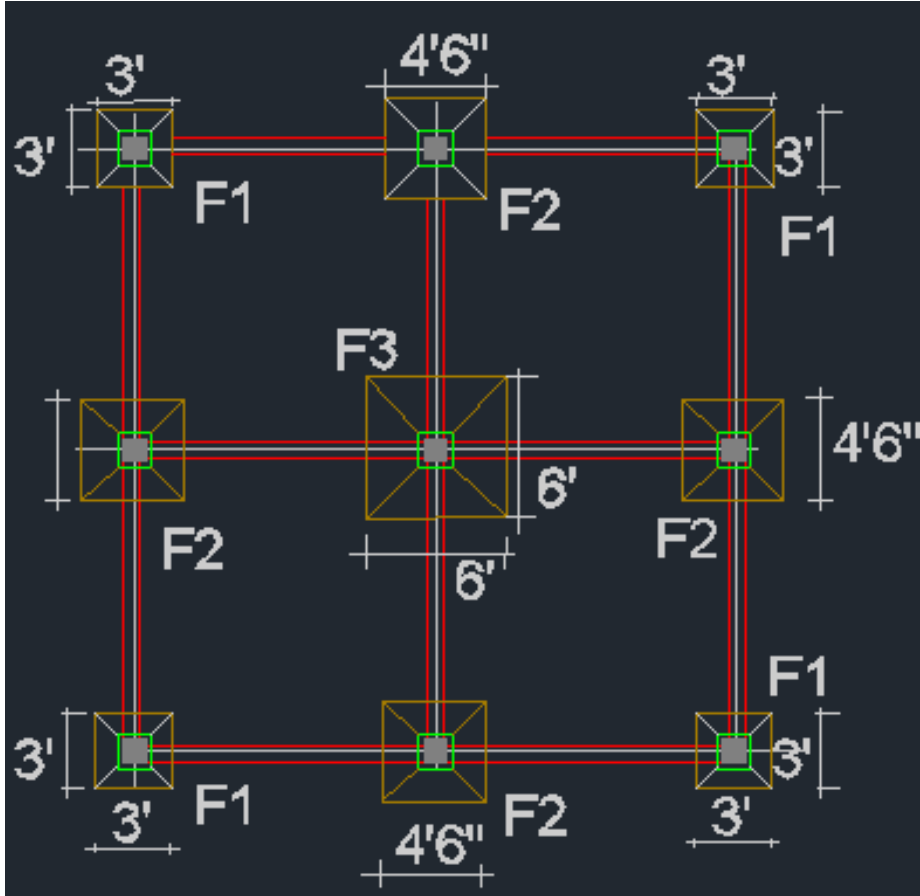
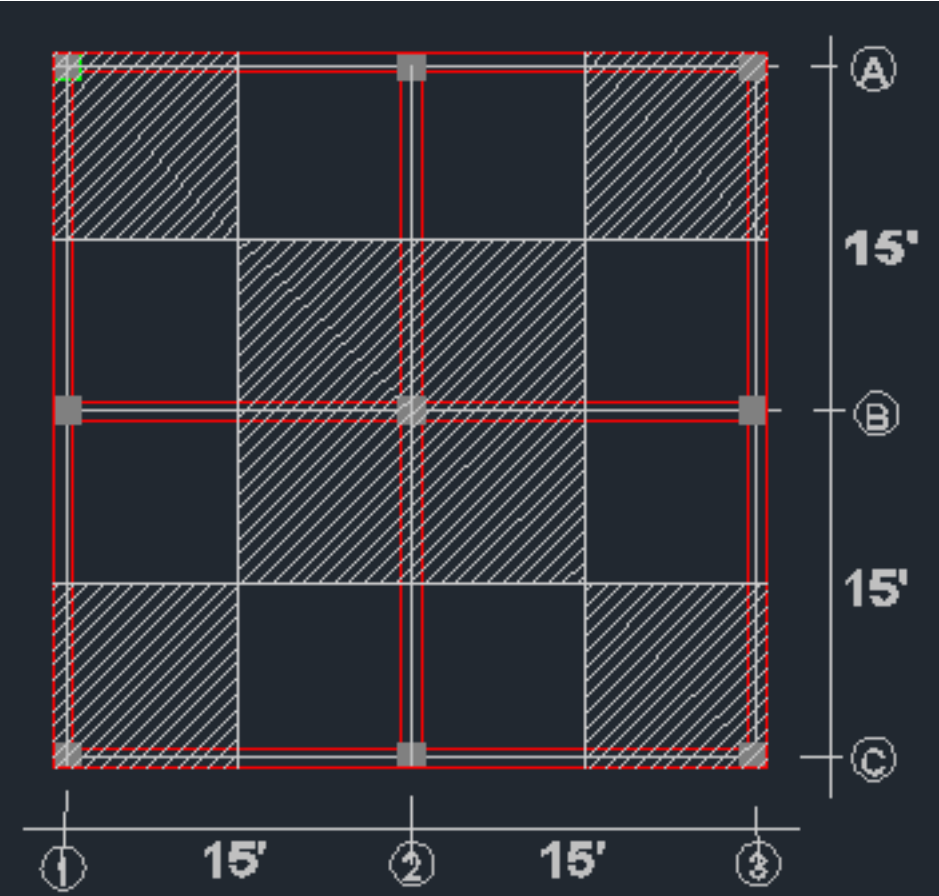


Framed Structure, Dharmasthali
(No damage)



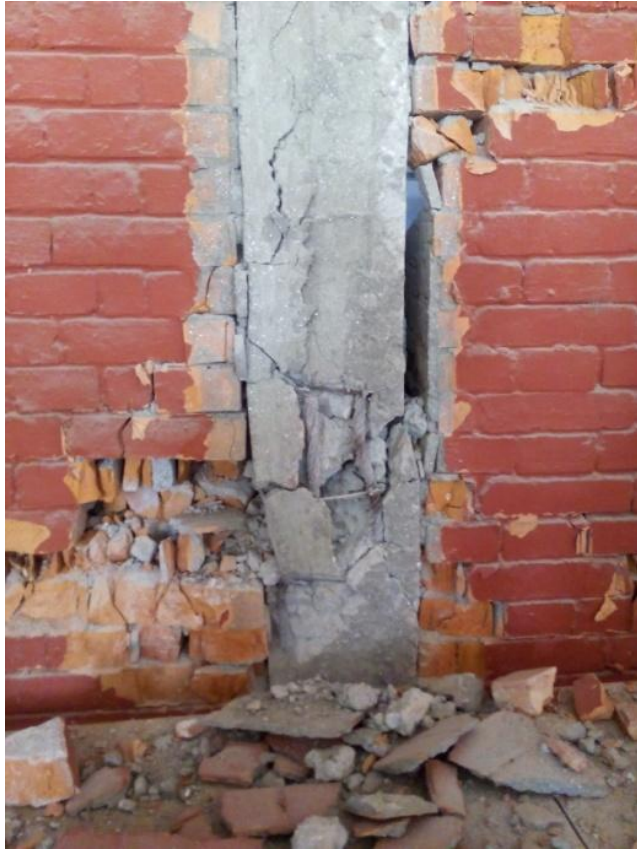
Wall bearing Structure, Kapan3
(Totally damage)

Differential settlement due to Lack of Foundation Design



Footing Design for Ideal Case

Poor quality of construction material & Lack of application of Detailings



Lack of lateral ties & hook requirement

Poor quality of construction material & Lack of application of Detailings (IS 13920:1993)

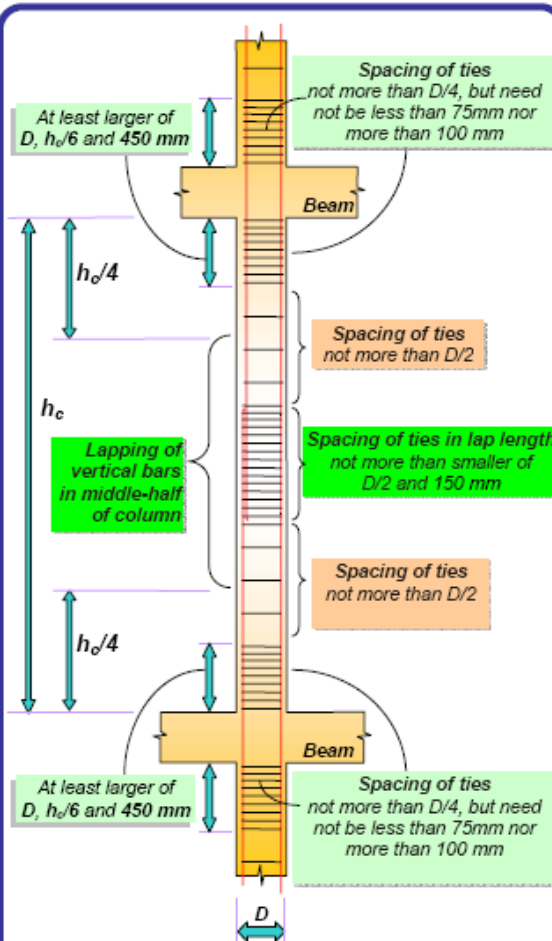


Figure 4: Placing vertical bars and closed ties in columns – column ends and lap lengths are to be protected with closely spaced ties.



Lack of Lateral ties

Anchorage of Beam bar in Column

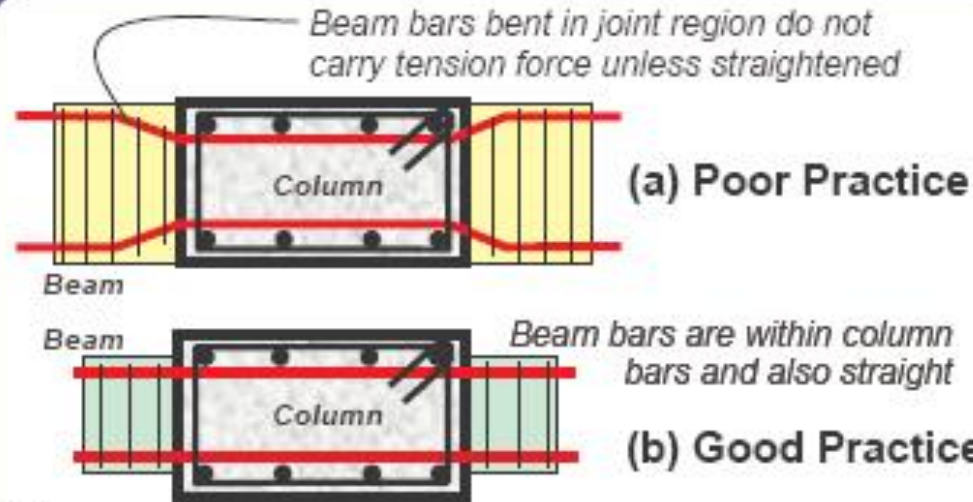
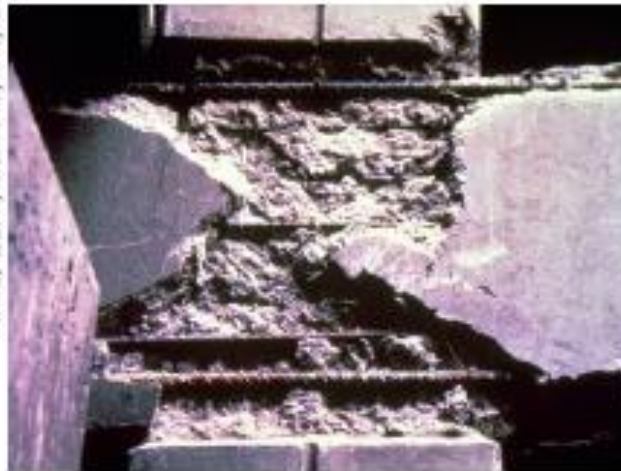


Photo from: The EERI Annotated Slide CD, 98-2, EERI, Oakland, CA, USA



Shear failure of RC beam-column joint during the 1985 Mexico City Earthquake, when beam bars are passed outside the column cross-section

(c)

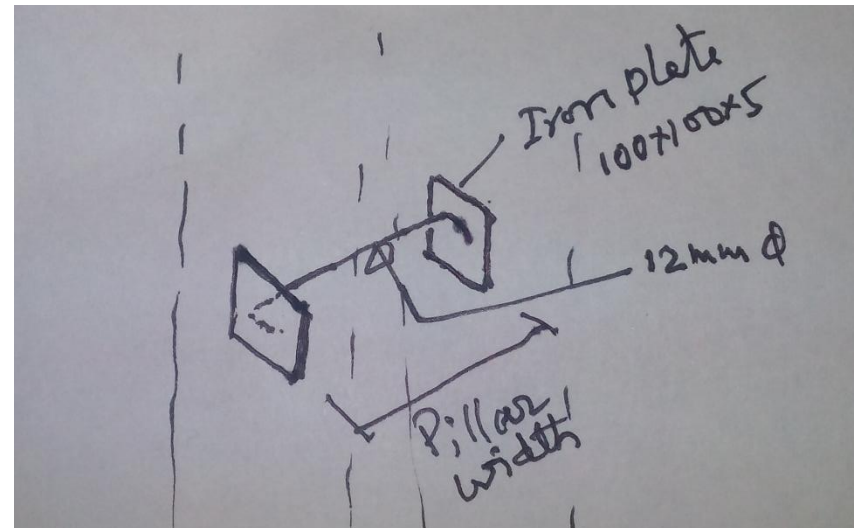
Figure 6: Anchorage of beam bars in interior joints – diagrams (a) and (b) show cross-sectional views in plan of joint region.

Poor Quality of Construction



Shutter connection with Column

Proper fixing of Shutter



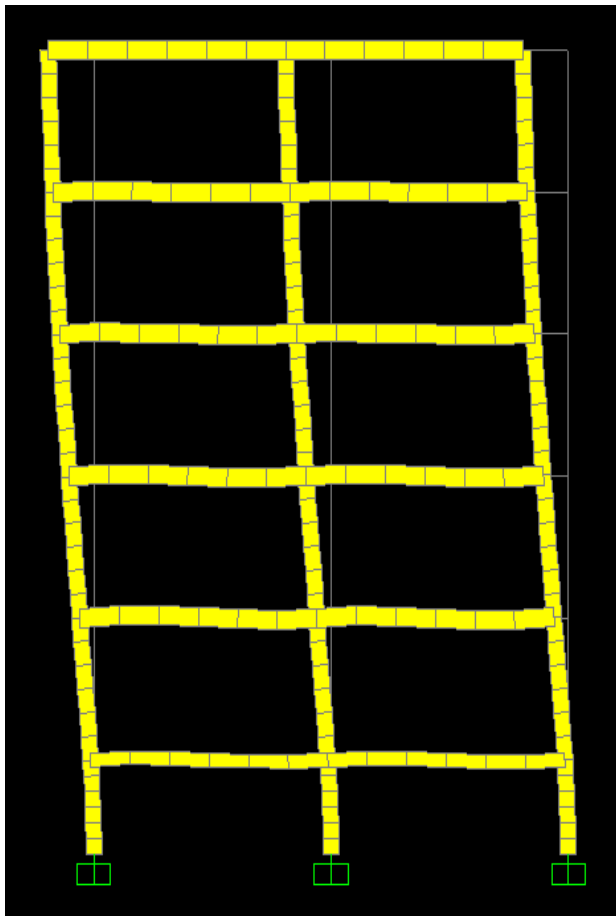
Adjacent building joint consideration (pounding effect)



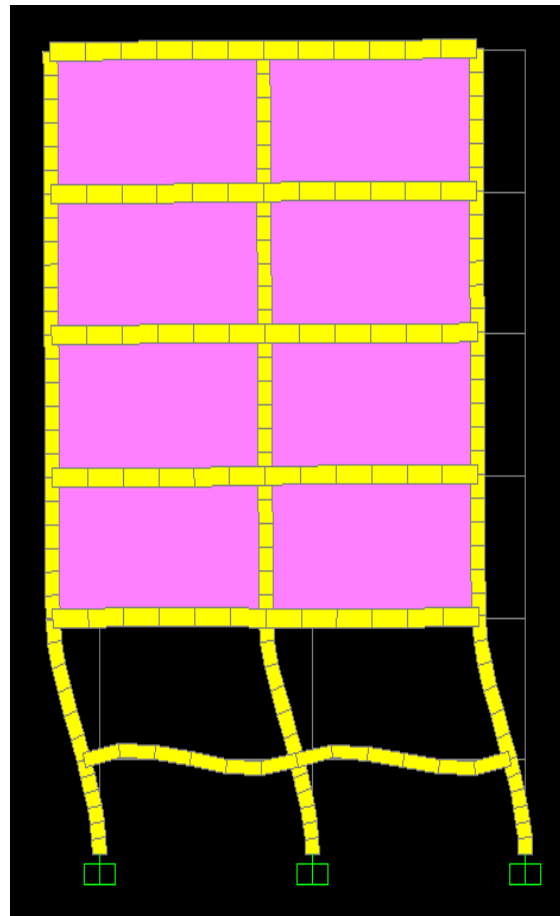
Building Attachment Failures

Soft Storey Effect

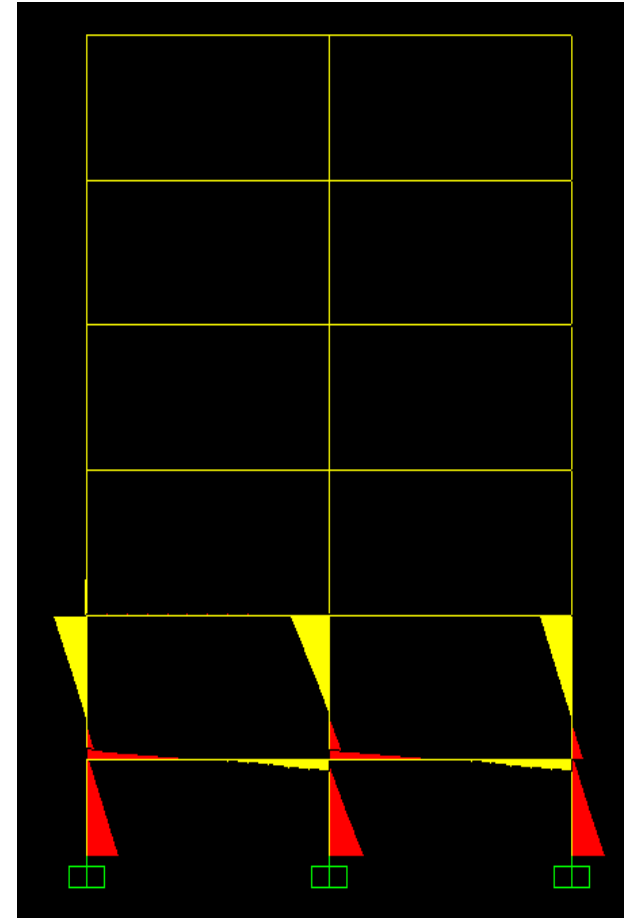
Normal Frame with inactive filler wall



EQ Force



Deformation



Moment

Short Column Effect (Increment in Relative Stiffness, EI/L)

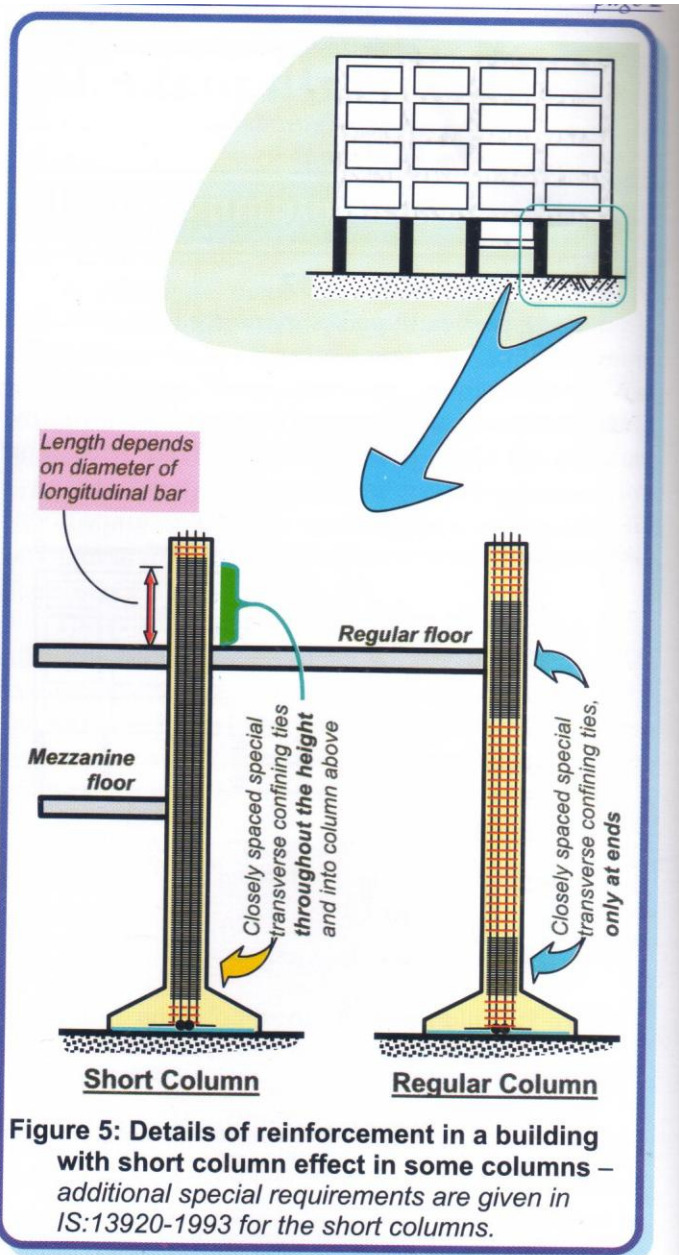


Short column
between lintel
and sill of
window

Source:
Wakabayashi, M.,
Design of Earthquake-Resistant Buildings,
McGraw Hill Book Company, New York,

Figure 4: Effective height of column over which it can bend is restricted by adjacent walls – this short-column effect is most severe when opening height is small.

Short Column Ties & Elimination of its effect



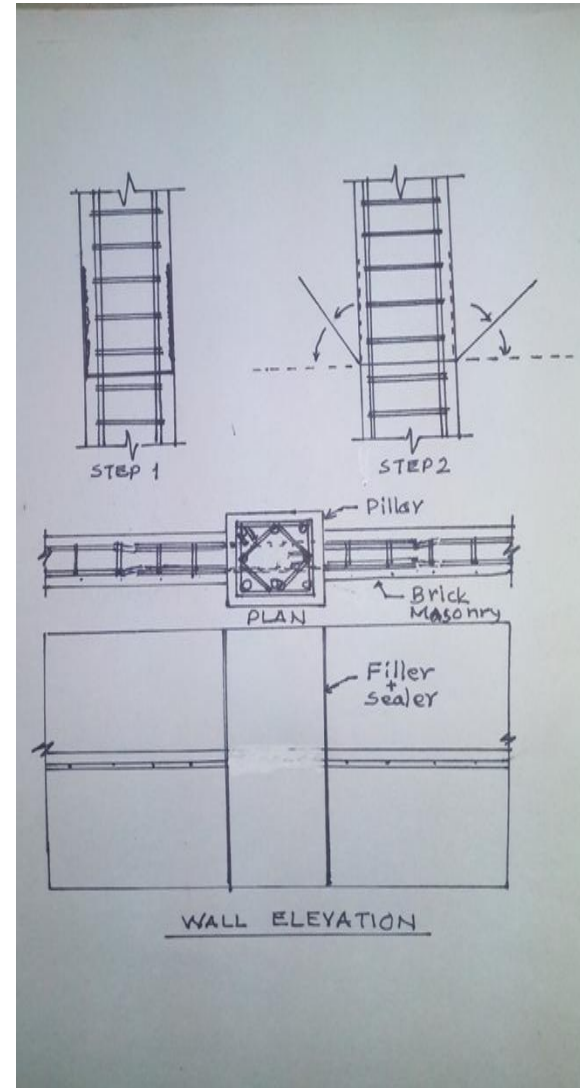
Vertical Cracks in Beam



Breakdown of Infill wall



Infill wall connection



Cracks in Masonry works

- Horz. cracks just bottom of the beams
 - Repairable
- Horz. cracks between the top & bottom of beam
 - Repairable by inserting hard wood wedge at mortar between each brick
- Vert. crack in between column & wall
 - Repairable
- Vert. crack
 - Mostly non-repairable
- Diagonal crack
 - Repairable by inserting hard wood wedge at mortar between each brick
- Cross diagonal crack
 - Mostly non-repairable

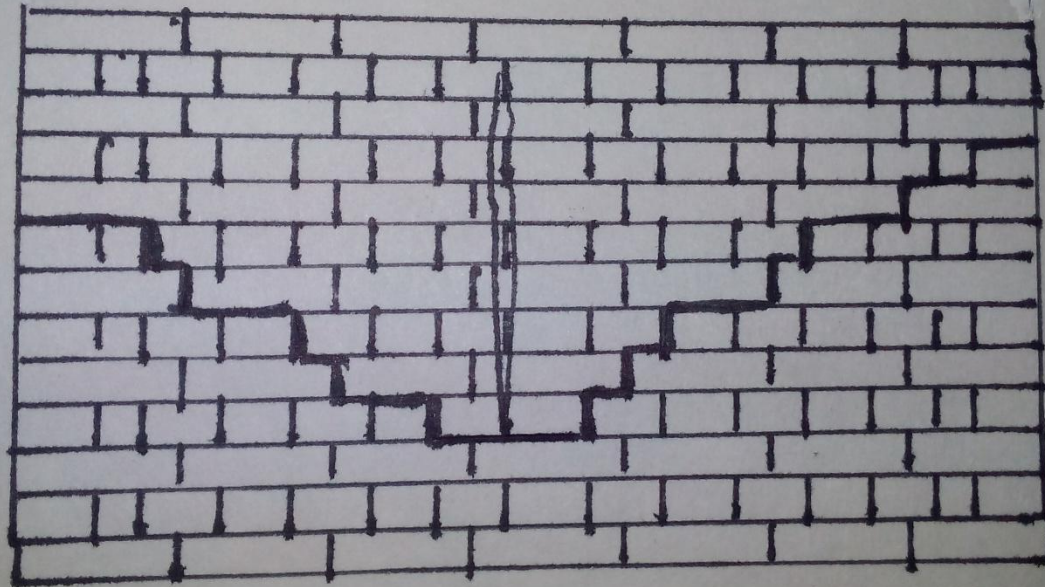
Vertical Crack between infill wall & column



Diagonal Cracks



Repair of Vertical Crack



Repair of Vertical Crack

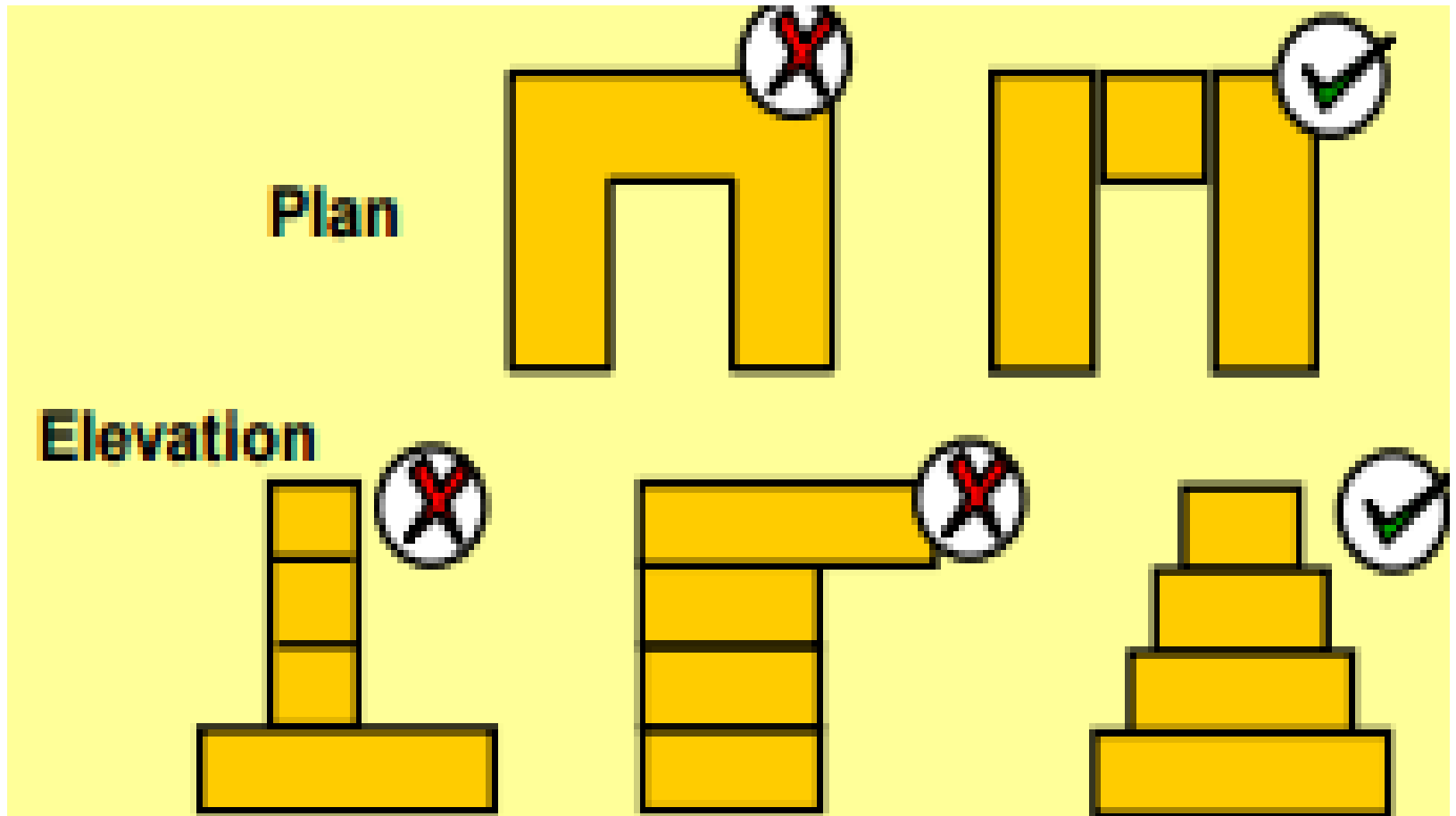
Cross Cracks



Cracks in Reinforced Concrete

- Hair cracks may be avoided if there are no cracks seen in RCC member on removing plaster.
- After removing plaster, if hair cracks are seen in the member and crack is not prolonged up to reinforcement bar, minor repair is required.
- If crack found deepen upto reinforcement bar, special treatment of the member is required.(Strengthening of member by repair with grouting only or retroficing along with grouting, depending upon damage)

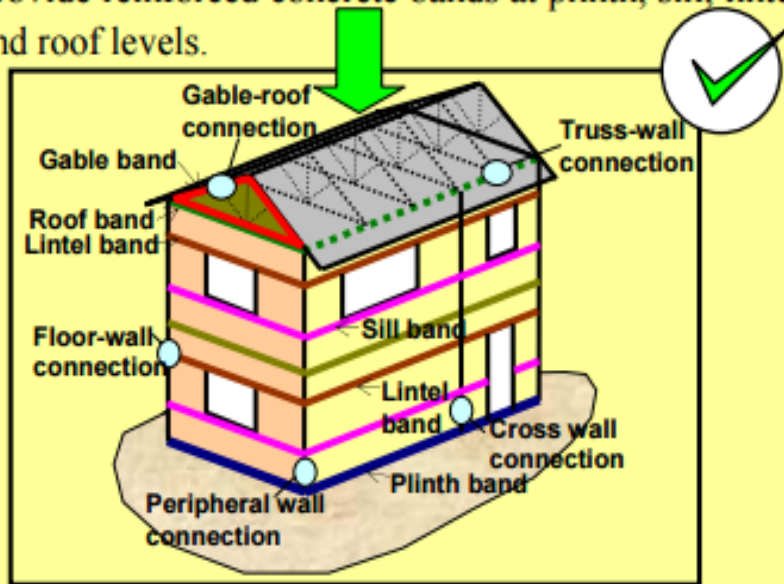
Building Configuration



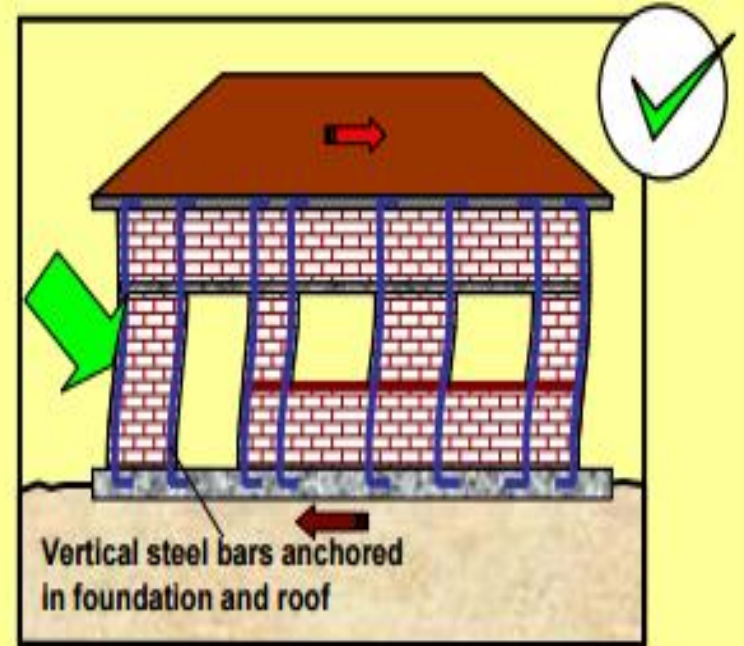
Wall Bearing System

Correct Design / Remedial Measures

- Provide reinforced concrete bands at plinth, sill, lintel and roof levels.

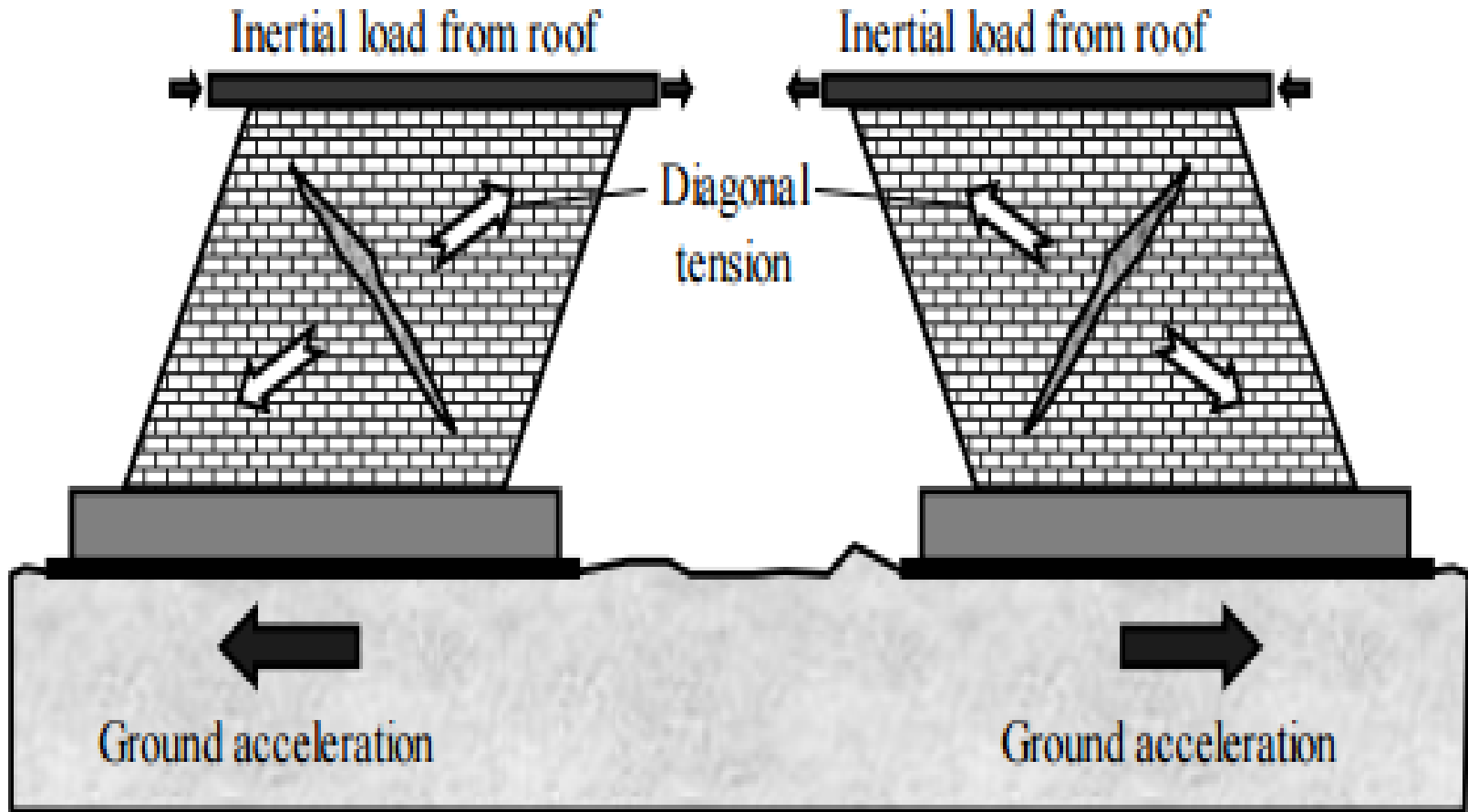


- Provide vertical steel bars at corners of wall segments and between openings to improve seismic resistance.



- Provide adequate cross walls, with proper connection at the junctions.

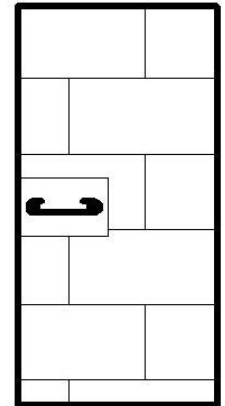
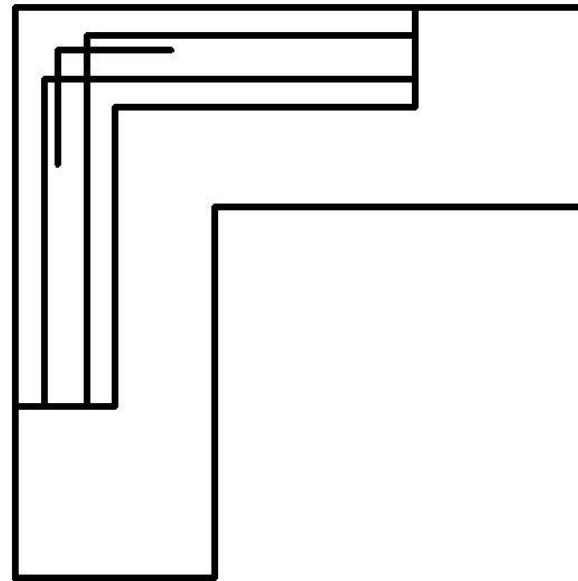
Diagonal Cracks



Temporary Supports



Masonry cracks at corner



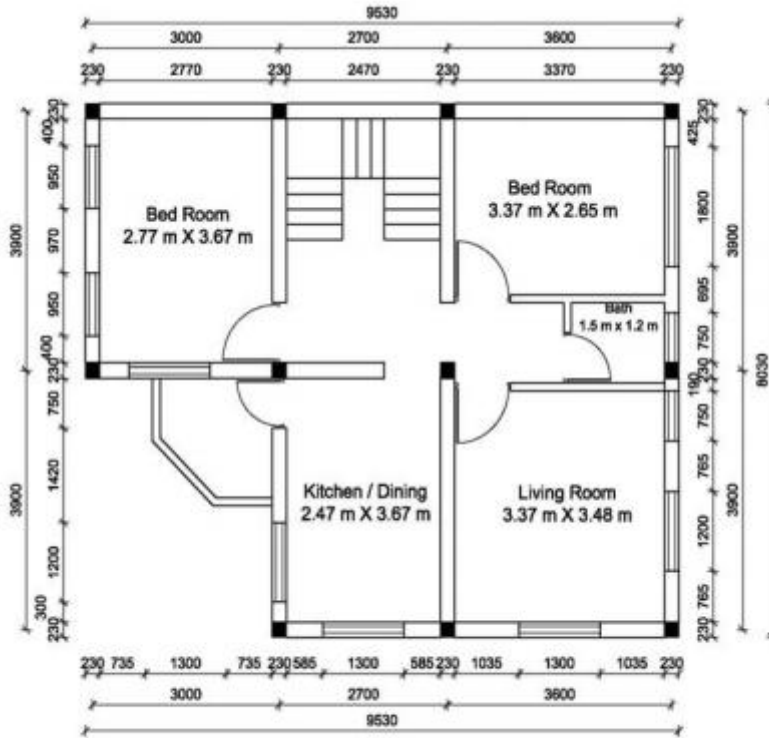
Different types of crack & Shoring



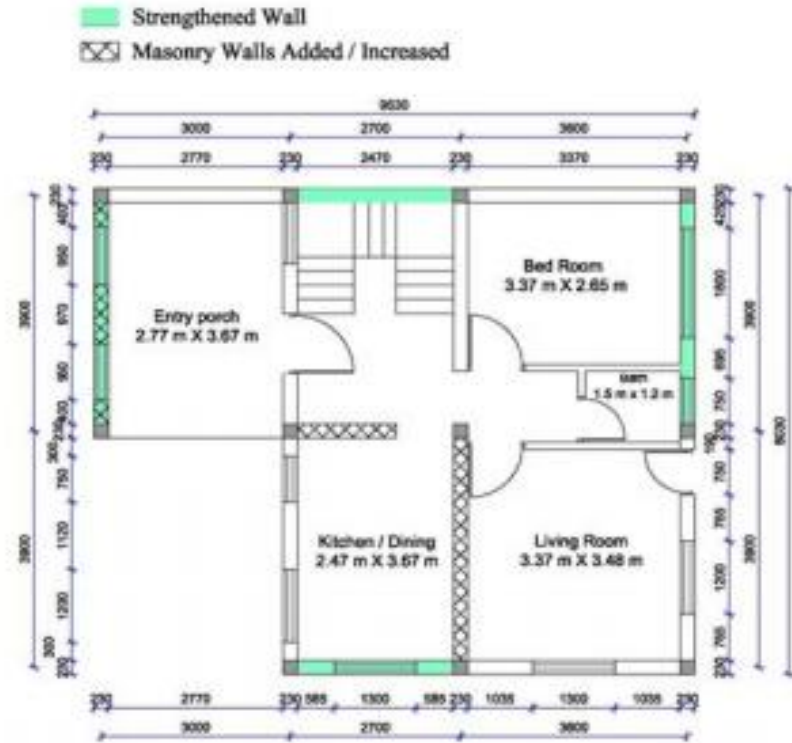
Strengthening of Wall



Retrofication

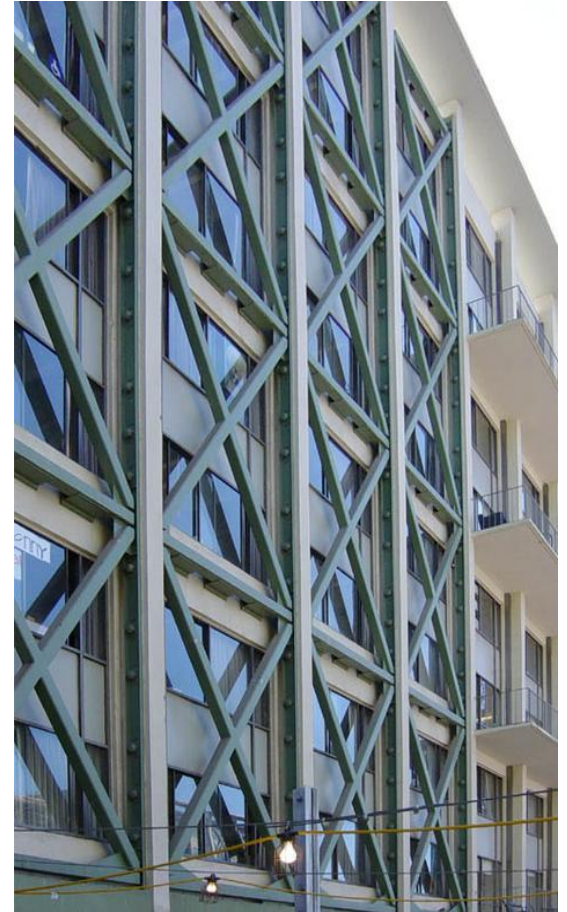


1st, 2nd, 3rd Floor Plan, Type 1 Building



Building Type 1, Retrofitting Option

Heavy Retrofit for RCC Beam & Column



Retoficating



Strengthening for RCC Beam & Column

Retroficingating of Columns

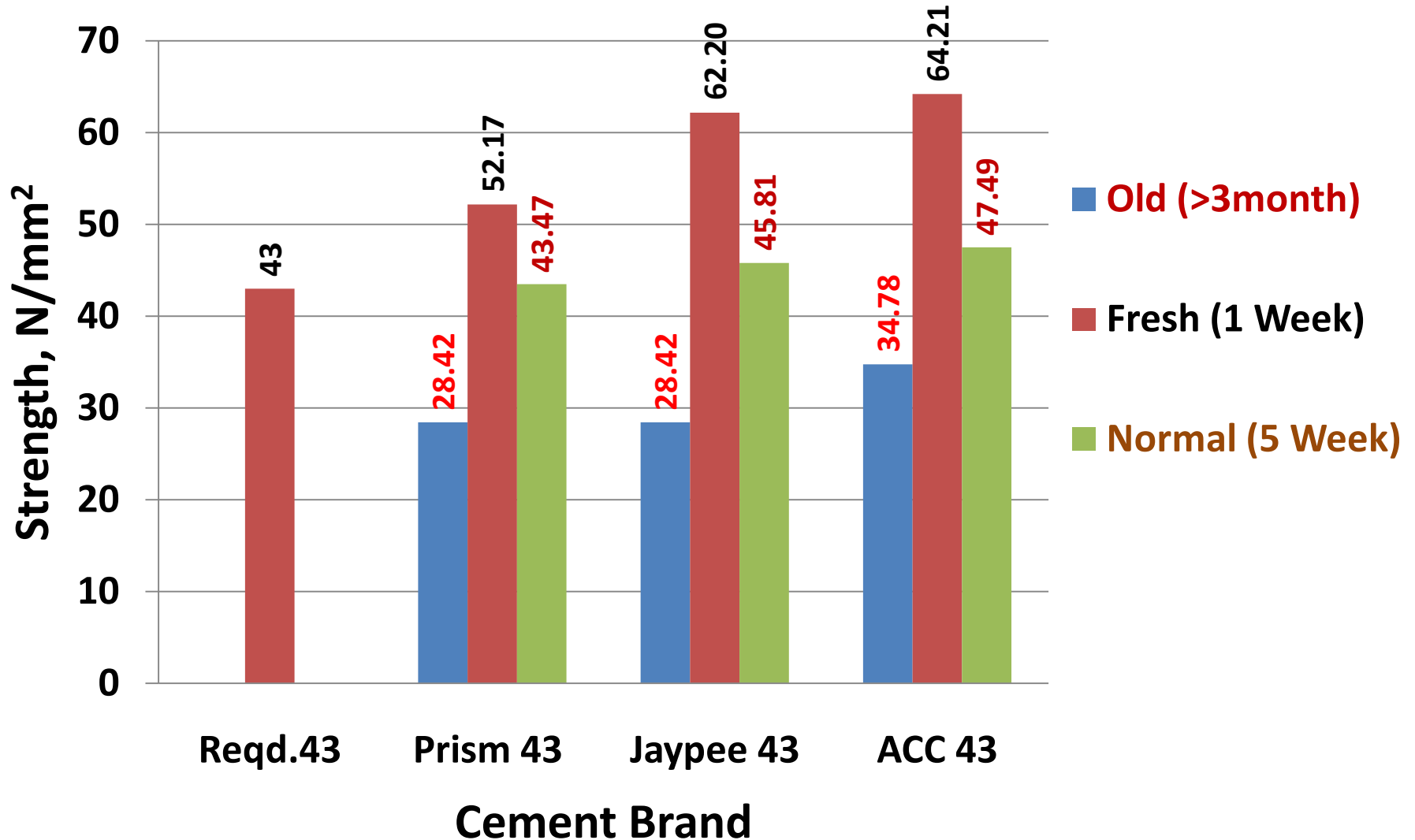


Compound Wall

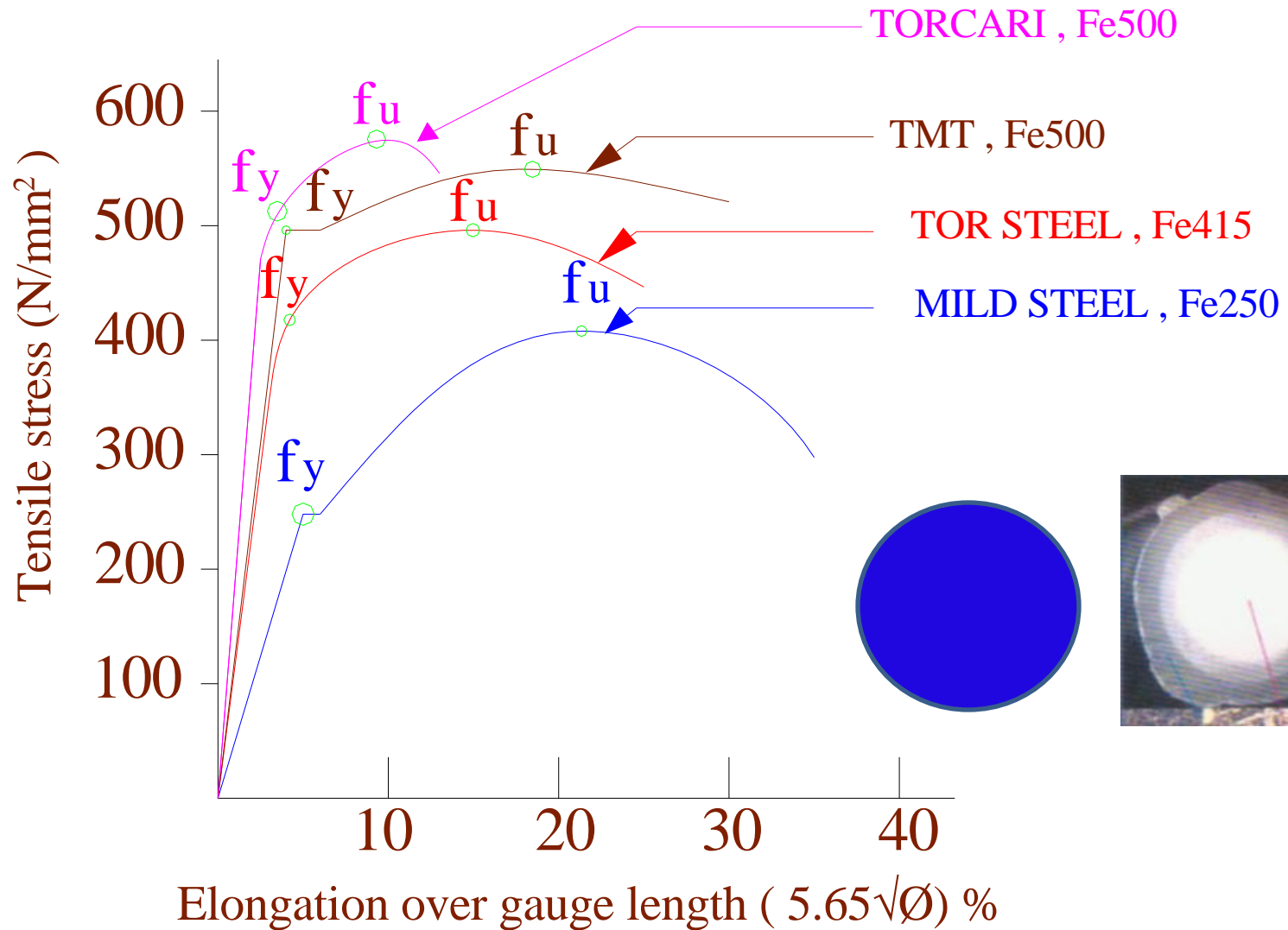


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