

2016 PEER Meeting

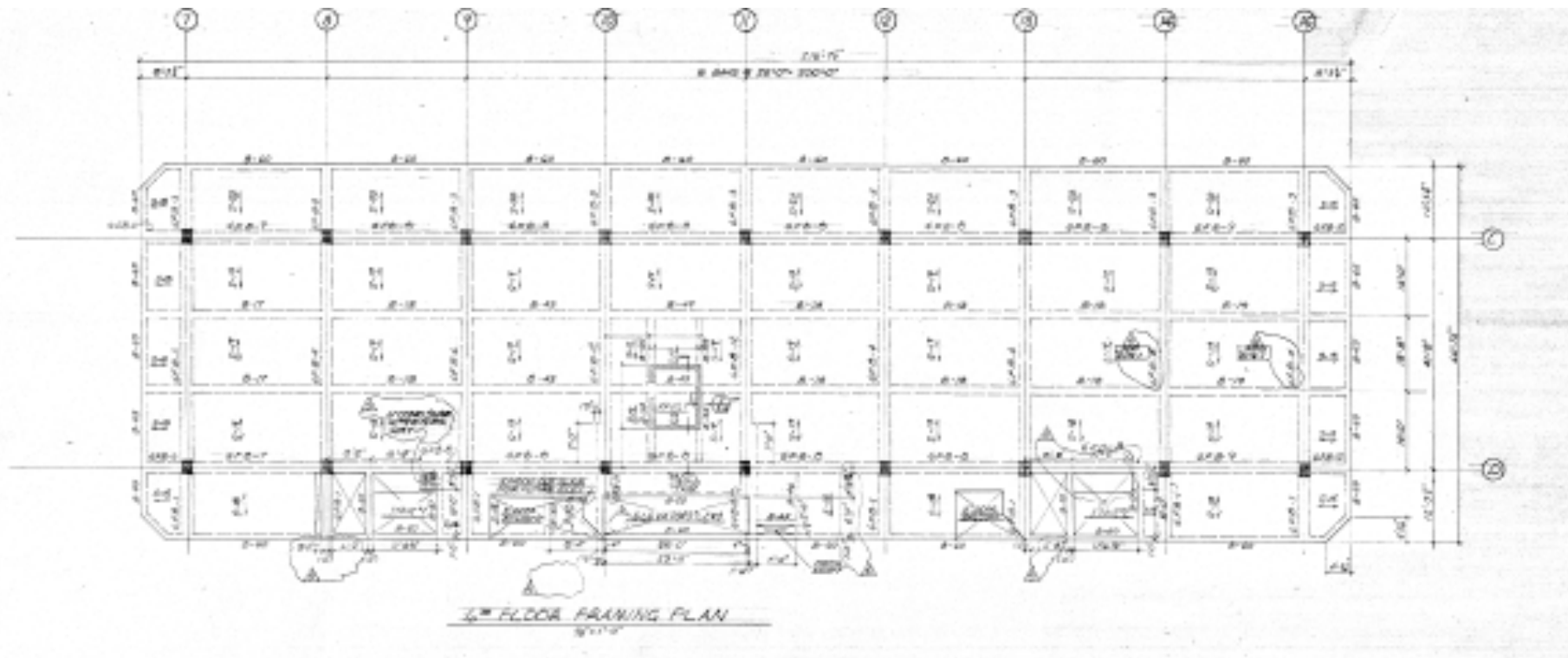
Rapid Seismic Evaluation of Older Concrete Buildings for Collapse Potential



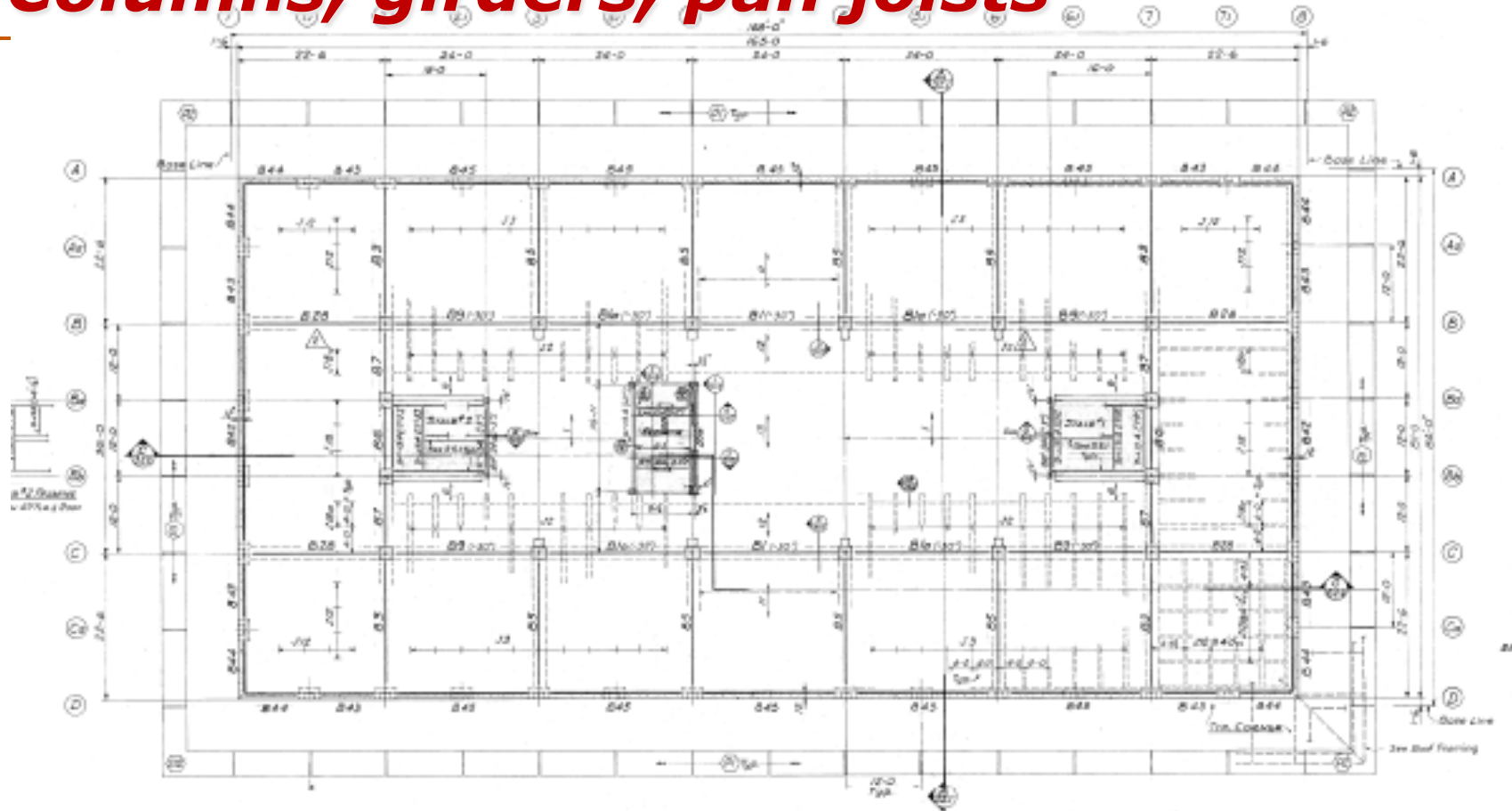
Bill Holmes

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- Hugh variety of buildings in the category

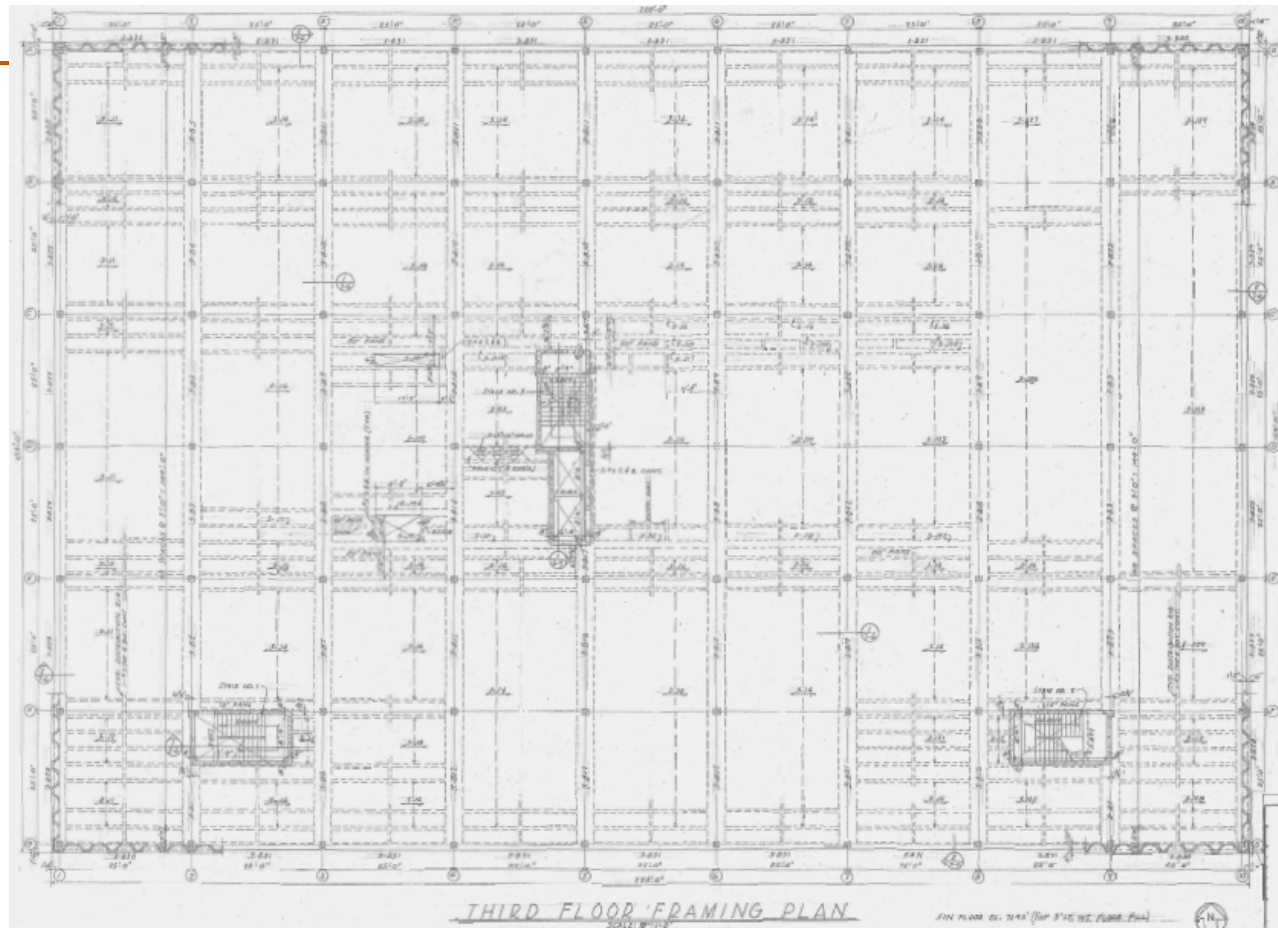
Columns, girders, beams, slabs



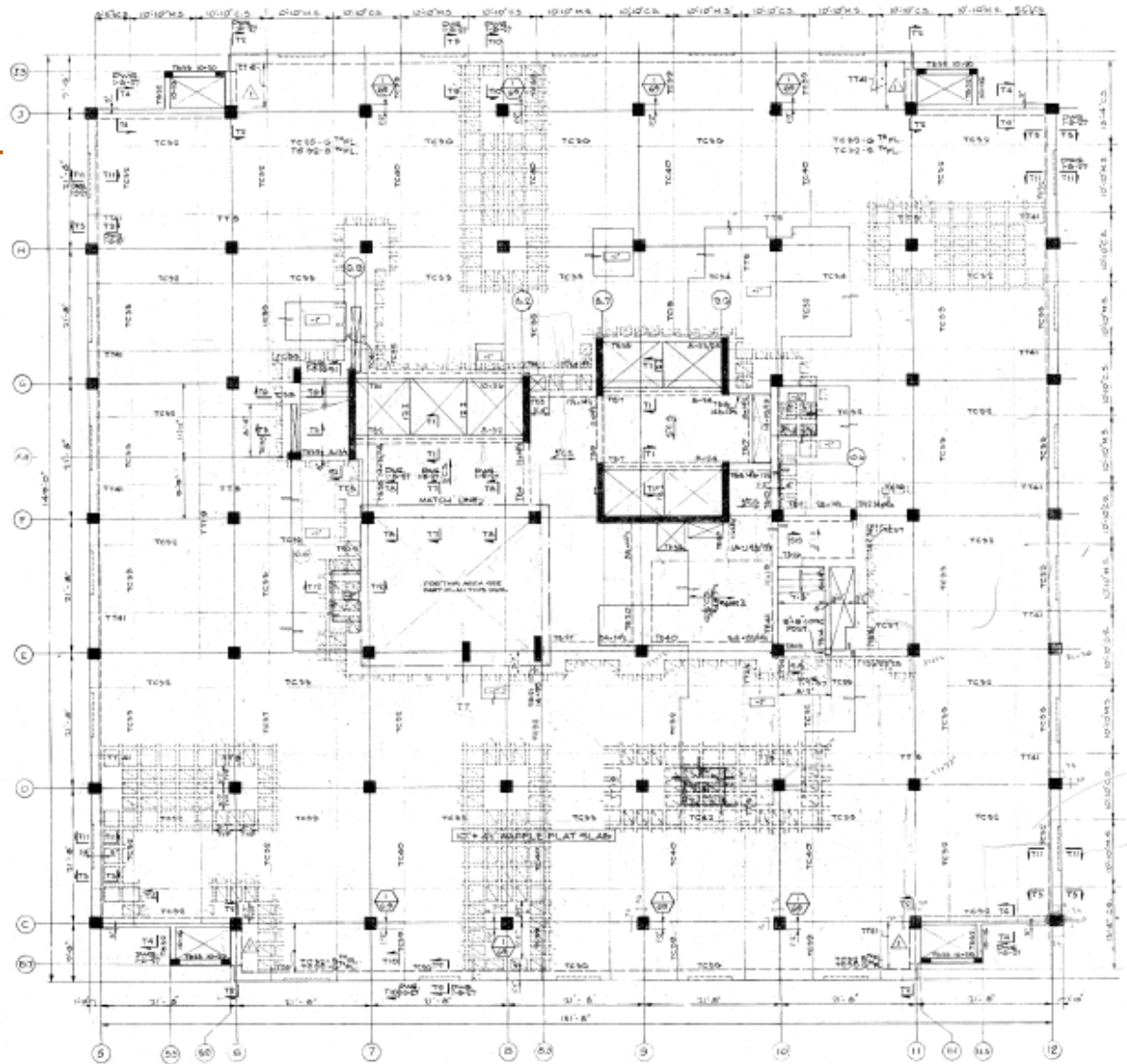
Columns, girders, pan joists



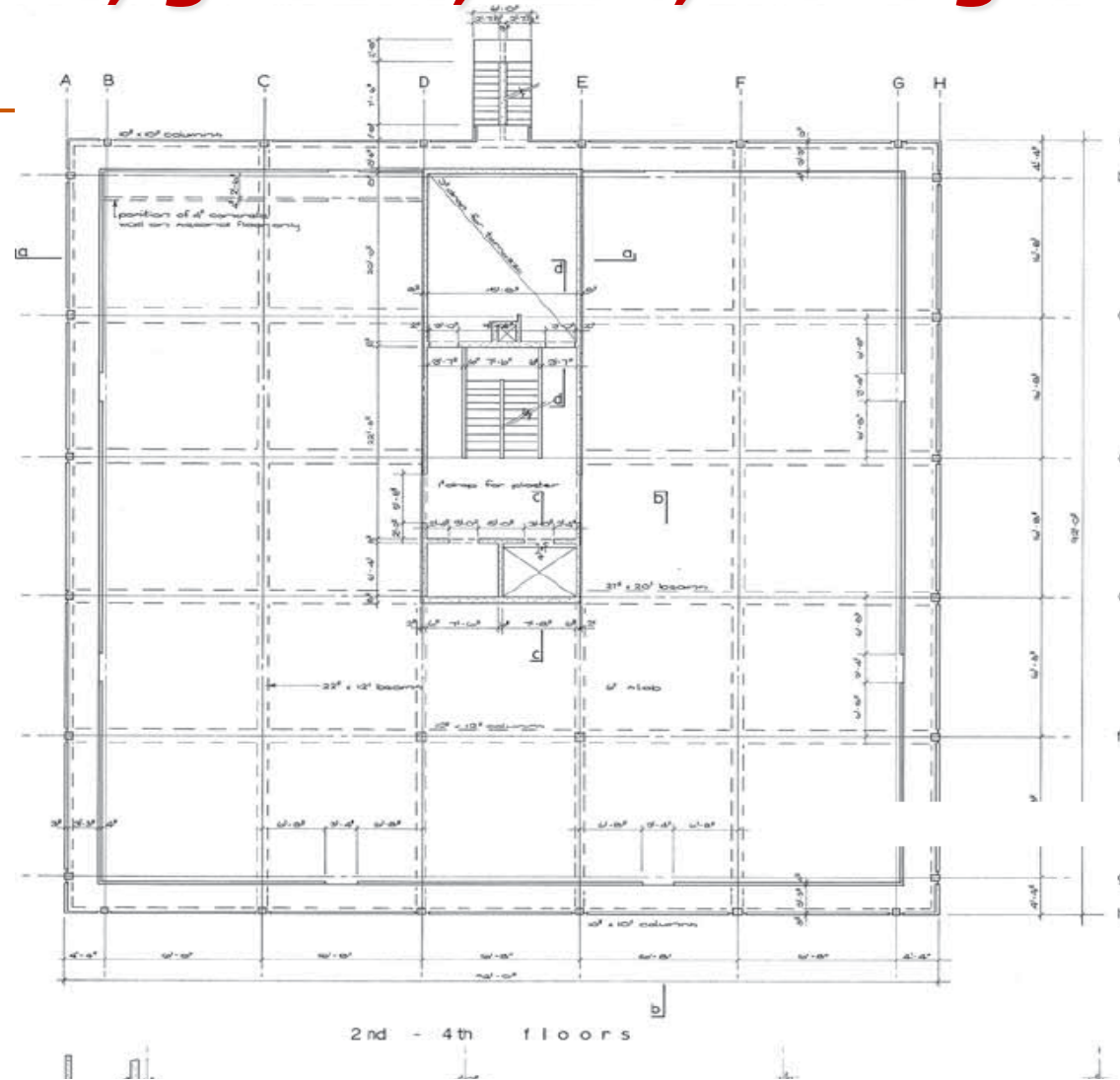
Columns, girders, pan joists, a few walls



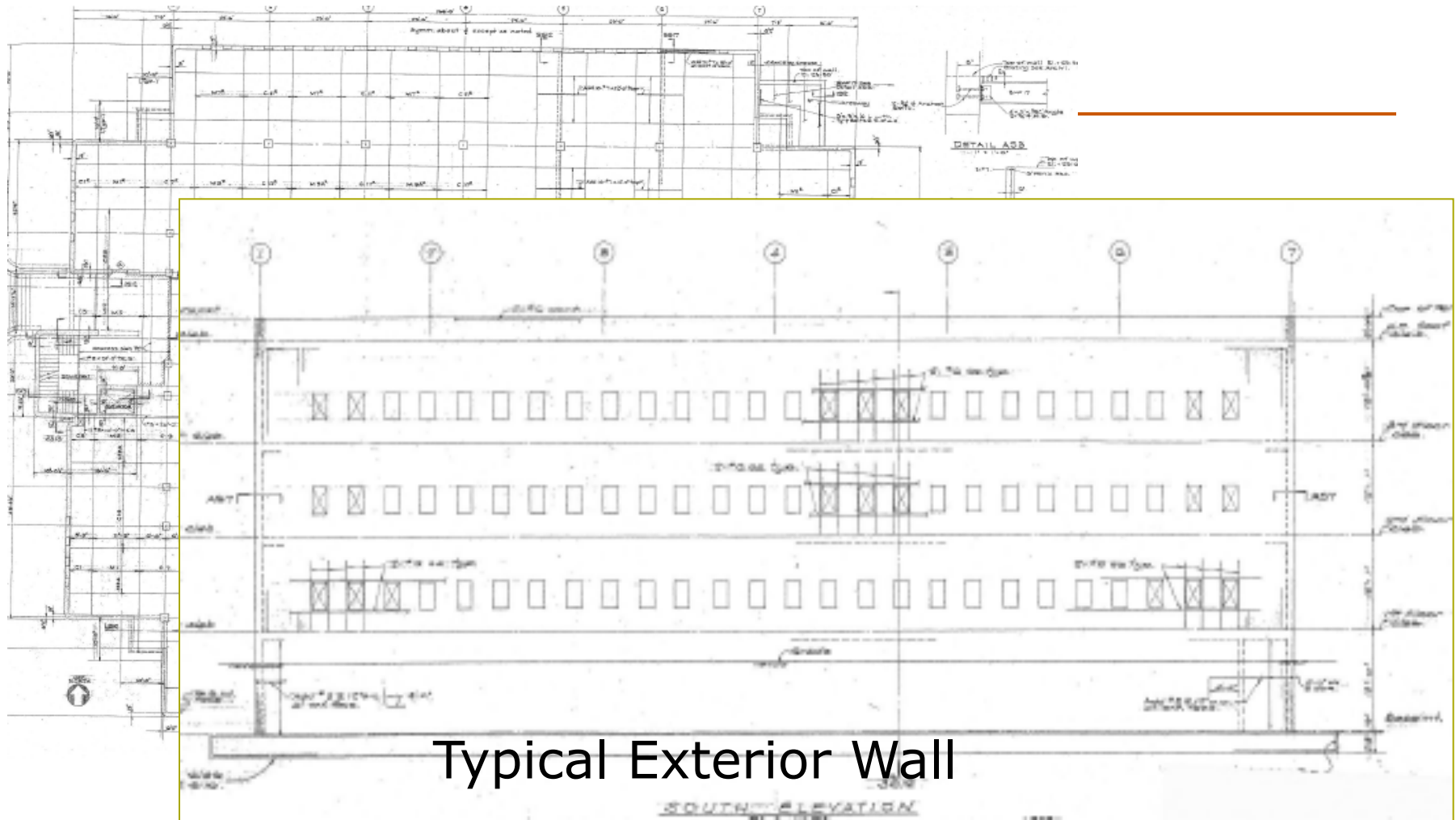
Columns, waffle slab, a few walls



Columns, girders, slab, 40% gravity on wall



Punched exterior wall

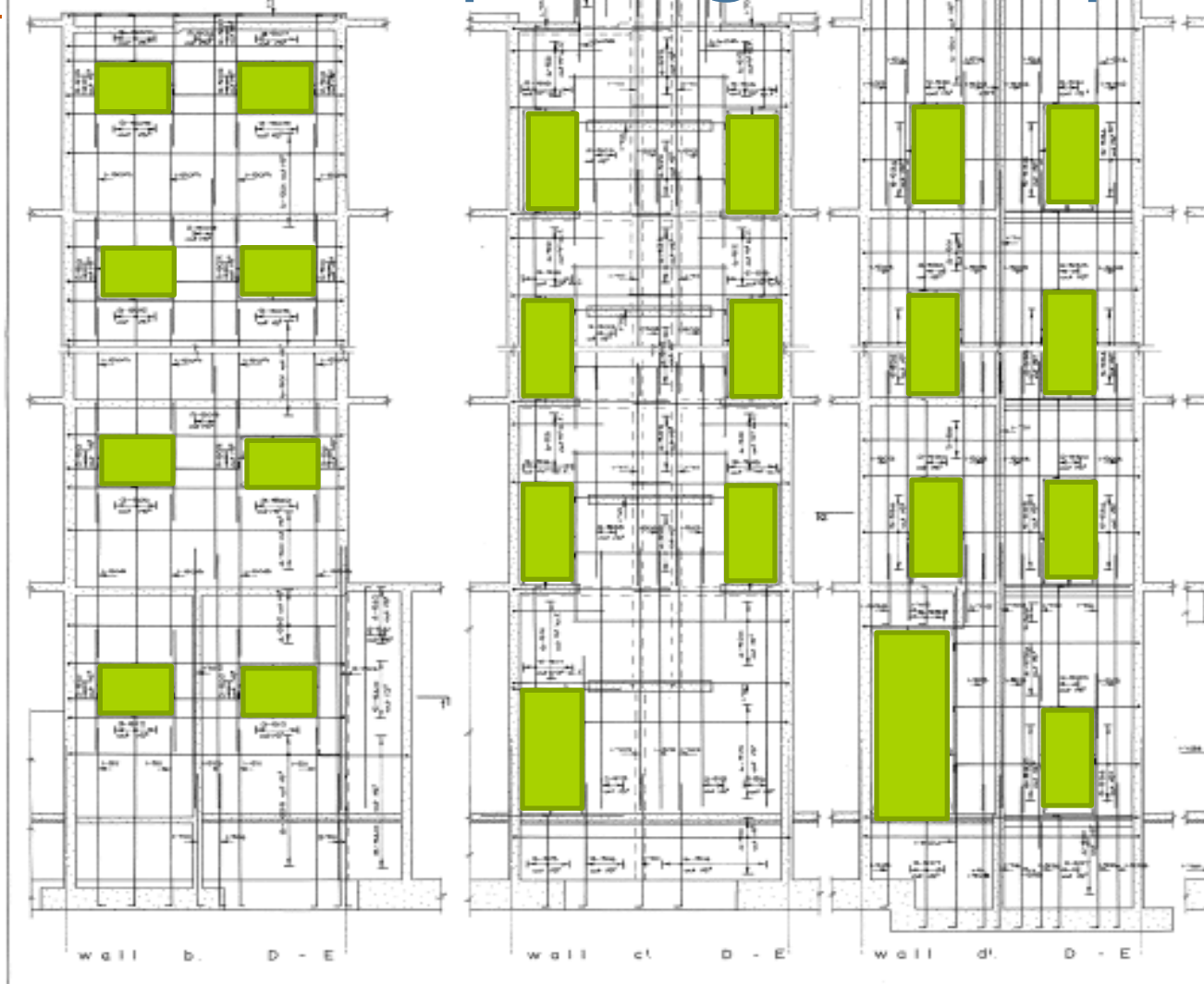


Bearing Wall Buildings—100% gravity

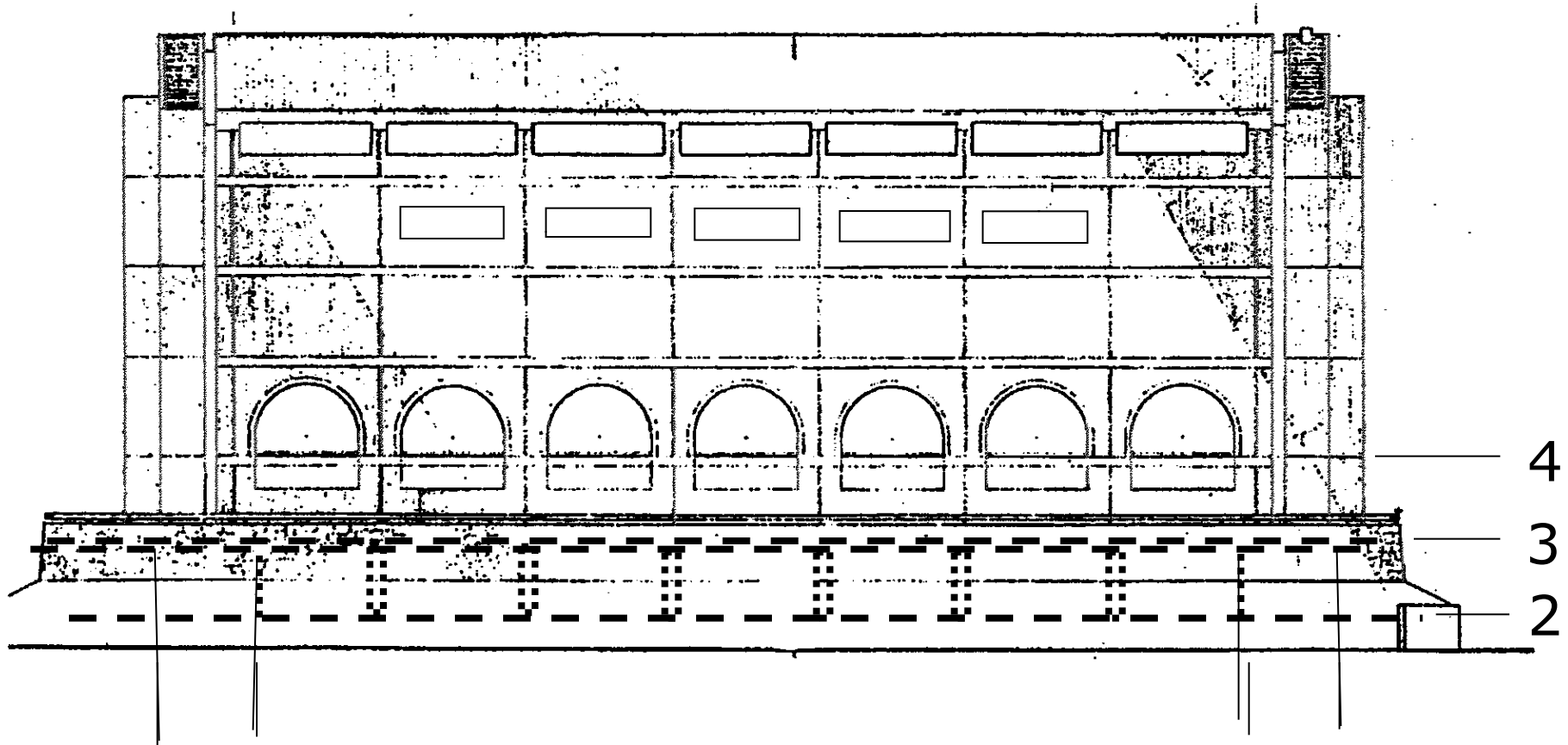


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- “Walls” are seldom idealized blocks:

Wall with openings example



Wall with opening example



[illegible]

FEMA/ATC Development of “Rapid” Identification of Concrete Buildings with High Collapse Potential (ATC 78)

- Need to mitigate buildings with high risk of collapse
- How to Identify?
 - Existing methods (ASCE 31-41)
 - Conservative
 - Labor intensive (non-linear response history)
 - Component based
 - Performance based on state of components rather than state of overall building (particularly collapse).

ATC 78 Procedures for Frames (buildings without walls) (1)

- Estimate period using formula $T = a h^b$
- Estimate spectral displacement (global drift)
- Estimate story drift based on α x global drift
 - α based on rules developed from analysis of frames with various story strength relationships
- Add torsion, and estimate column drift (with uncertainty based primarily on record to record variation plus the α factor)
- Estimate column drift collapse capacity and uncertainty using database of tested columns (based primarily on Axial Load Ratio and V_p/V_n)

ATC 78 Procedures for Frames (2)

- Estimate probability of individual column collapse using structural reliability concepts.
- Derive probability of story collapse using Monte Carlo analysis of individual column collapse probabilities
 - Story collapse when 25% of columns collapse
- Story collapse assumed to be sufficient to define “killer building”

Extension of Frame Methodology to Buildings with Walls

- Given rules for period and α for such buildings (not straightforward)
 - For buildings with many columns, use of column collapse similar to frame method ok
 - As number of columns decrease and extent of wall increases, story collapse as function of column collapse may not be appropriate
 - What is the contribution of wall “failure” to building collapse under different conditions?

Primary Issue:

Need to consider GLOBAL Collapse

- In analytical methods, what is definition of collapse?
 - In ASCE 41, component failure (collapse prevention)
 - Mathematical instability (normally sidesway)
 - Tracked loss of lateral resistance (percentage)??
 - Tracked loss of gravity support (percentage)
 - No practical consideration of redistribution of load
- Better definition and prediction of global collapse will enable significant improvements not only to ATC 78 but also
 - ASCE 41
 - P695
 - ATC 58

Secondary Issue:

- How does “failure” of wall contribute to building collapse?
 - Loss of lateral load capacity
 - Loss of gravity load capacity
 - Wall as a whole
 - Locations along wall
 - Boundary elements
 - Point gravity loads