HolmesConsultingGroup

New Technologies in Reinforced Concrete

A Practioner's viewpoint

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Why?

- Without awareness of what has gone wrong, we cannot do better
  - Is our life safety standard appropriate?
  - Was it met adequately?
  - Were our damage expectations exceeded?
  - Were building owners/users adequately prepared?

- Question:

"Acceptable imperfection or absolute perfection?"

Is this good enough?

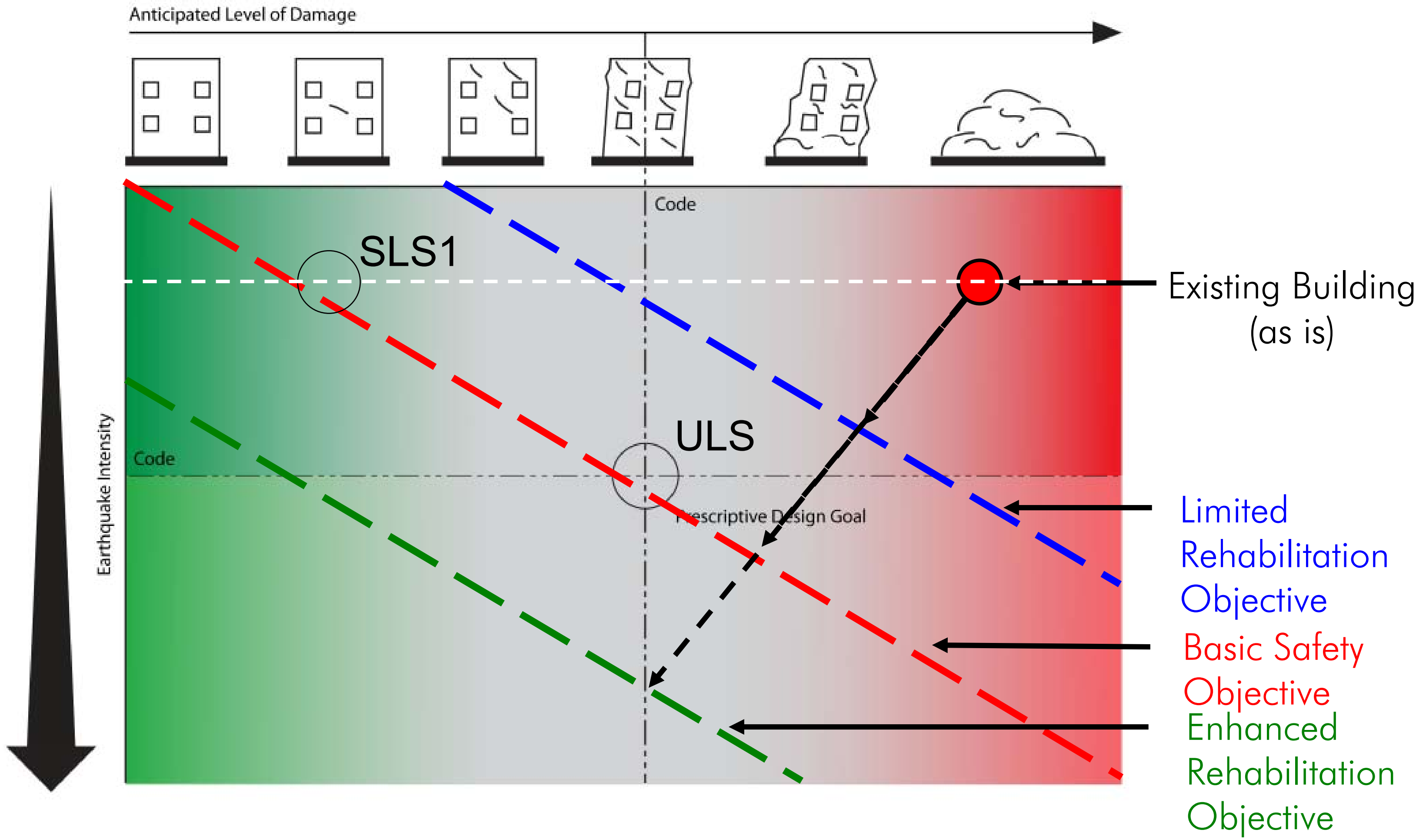
Existing RC System shortcomings

- Frame elongation
- Floor diaphragm failure
- Wall behaviour
- ‘Labcrete’ vs ‘realcrete’
- Low cycle fatigue
- Detail failure, e.g.
  - grouted ducts
  - Panel connections

If Better Performance is Required

- Will new technologies perform better?
  - Low Damage Design (LDD)
  - How is this defined?
- What are the drivers?
  - Regulated (Codes, Standards)
  - Or by informed owners, engineers (guidelines)
  - Or by insurance
- How is it determined?
  - Performance Objectives
  - Limit states
  - What defines 'low damage'

Defining Performance Objectives



Performance Objectives for LDD

- Damage mitigation effectiveness
- Reparability
- Self-centring ability
- Non-structural Damage
- Durability
- Affordability

Damage mitigation effectiveness

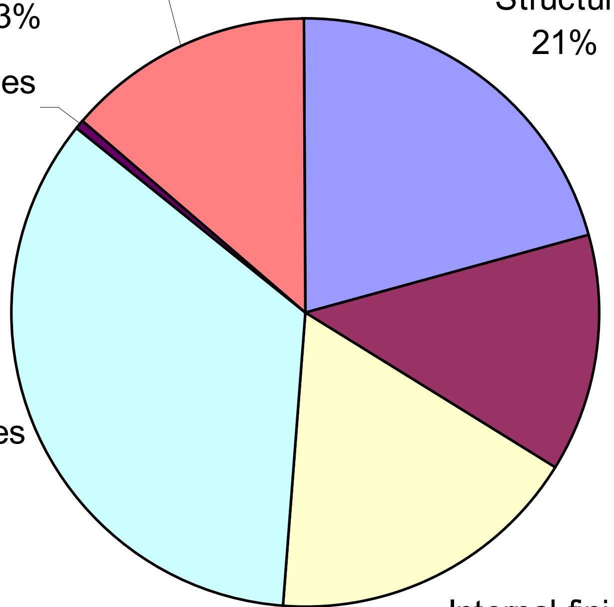
- Ensure we are not trading one set of issues for another
  - Frame elongation leading to diaphragm issues in articulating systems
  - Low cycle fatigue issues in key members
- Define performance parameters that could be considered 'low damage'
  - At performance points

Repairability

- Ductility is damage in the form of hysteretic damping
- Design systems that can be repaired
  - Either not encapsulated
  - Or allow easy retrofit of external replacement systems
- Consider cost of replacement
- Consider implications of replacement

Breakdown of Costs

- Typical 6-15 storey office building



From Rawlinsons NZ
Construction Handbook 2010

Self-centering ability

- How critical is this?
  - Maybe <0.5% after major earthquake?
- Active systems
  - PRESSS
  - Base Isolation
- Passive systems
  - Secondary structure

Non-structural damage

- Stiffer = less drift
  - Less damage to non-structural elements
  - Greater accelerations – more contents damage
- More flexible = lower accelerations
  - Less damage to contents
  - Greater displacement – more damage ot non-structural elements
- Can only reduce this by adding more damping to reduce both drift and displacement

Durability

- Must not deteriorate over time
  - E.g. friction systems – constant μ? or fail-safe?
- Must consider maintenance requirements
  - E.g. tests/inspection regimes for dampers?

Affordability

- Difficult to justify if too expensive
  - B/C study unlikely to show positive retuen, given low probability of earthquake
- Must include downstream factors, e.g.
  - Loss of space for BI systems
  - Cost of maintenance
  - Increased design and compliance costs
- Insurance may tip balance
  - NZ insurance levels unique – hence our current circumstances

Design Methodologies

- Whatever works!
- Concentrate on the 'what', not the 'how'.
- Must be able to defend designs as well as develop
  - Compliance costs important
- Must be applicable in a design office context

Designers' Needs

- Complete research
  - Not always fully considered
  - Risk to early adopters
- Industry guidelines ➔ Standards ➔Building Code
- Efficient design methodologies

‘New’ Technologies

- Base Isolation
- PRESSS/PRESLAM
- Rocking walls with dissipators
- Slotted beams
- Viscous damping options
- Buckling restrained braces
- Rocking foundations

Old Technology

- Get it right…..
  - Regular
  - Well conceived
  - Well detailed
  - Well constructed
  - On good ground
- Contrast that to some already seen

End