Wood Frame and Soft-Story Buildings CEA/FEMA Seismic Retrofit Standard ATC-110

Colin Blaney S.E.

ZFA STRUCTURAL ENGINEERS

OUTLINE

- Overall Project Goal
- What is the Vision of CEA/FEMA
- Past Residential Damage
- Typical Deficiencies
- Prescriptive vs. Engineered Approach
- What we have now …Codes, Standards and Plan Sets
- Next Steps

OVER-ARCHING GOAL

- National Pre-Standard and eventually Standard which will specifically address the seismic rehabilitation of one and two family residential dwellings (R3)

ATC -110 PROJECT TEAM

Project Technical Committee

Colin	**Blaney**	ZFA
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Kelly	**Cobeen**	WJE
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Frank	**Rollo**	Treadwell & Rollo
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ATC-110 PROJECT TEAM

Project Steering Committee

David	**Bonowitz**	Consultant
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Thor	**Matteson**	Consultant

WHAT IS THE VISION OF THE CEA/FEMA SEISMIC RETROFIT STANDARD?

- National Standard to Address most Residential Construction
  - Cripple Wall Buildings
  - Slabs on Grade
  - Pole Type Foundations, Pier and Beam Systems
  - Hillside Homes
  - House over Garages

WHAT IS THE VISION OF THE CEA/FEMA SEISMIC RETROFIT STANDARD?

- Focus on Prescriptive Approaches
  - Embed the Engineering
  - Make Implementation Simple & Effective

WHAT IS THE VISION OF THE CEA/FEMA SEISMIC RETROFIT STANDARD?

- Streamline an Engineered Approach
  - Create Design Tools and Detail Libraries to assist Engineers.

WHAT IS THE VISION OF THE CEA/FEMA SEISMIC RETROFIT STANDARD?

- To Answer other important Questions
  - When does a certain vulnerability become an elevated concern?
  - When does the slope of a particular site warrant additional design or rehabilitation measures
  - Can the rehabilitation of Hillside Homes follow prescriptive Standards.
  - How do we address the variance of construction practices

WHAT IS THE VISION OF THE CEA/FEMA SEISMIC RETROFIT STANDARD?

- To Address other important Goals
  - Can we develop a better idea of expected drift, the onset of damage and possible collapse for specific structures types and materials.
  - Cost to Benefit Indicators for Retrofits

PAST RESIDENTIAL DAMAGE

1983 Coalinga Earthquake- M 6.3[1]

- Almost destroyed - 309 single-family homes
- Major damage - 558 single-family homes
- Minor damage - 811 single-family homes

1. A disaster assessment by the American Red Cross

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PAST RESIDENTIAL DAMAGE

1989 Loma Prieta Earthquake -M 6.9

- Older homes that were not bolted to their foundations or which lacked properly braced cripple walls accounted for over 2,800 of the 16,000 or 17.5% of all housing units made uninhabitable. [1]

- In Watsonville 10-20% of all pre-1940 residences suffered cripple wall damage. Some blocks suffered nearly 100% [2]

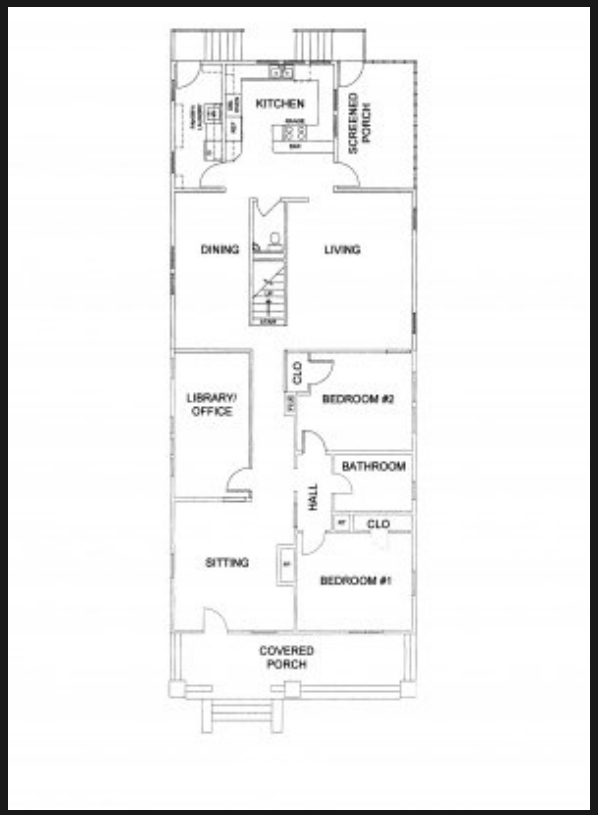
1. *"Preventing the Nightmare" 2003- Report by ABAG*
2. *The October 17th 1989 Loma Prieta Earthquake. EQE Report October 1989.*

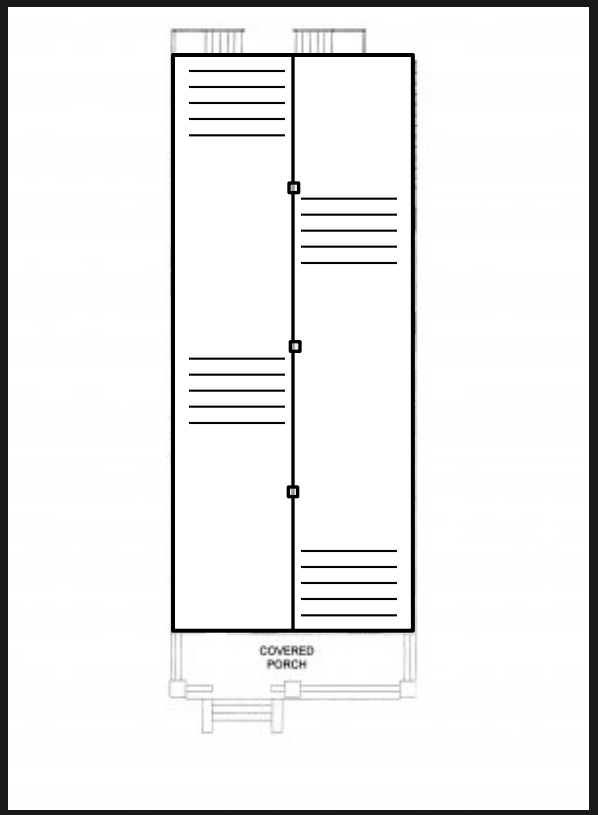
WHAT'S DEFICIENT?

- The lack of continuous concrete or reinforced masonry footings at the perimeter,
- Cripple walls with inadequate bracing,
- Minimal or no attachment between the floor framing and the top of cripple wall or mudsill,
- The lack of appropriate anchorage between the mudsill and foundation system.

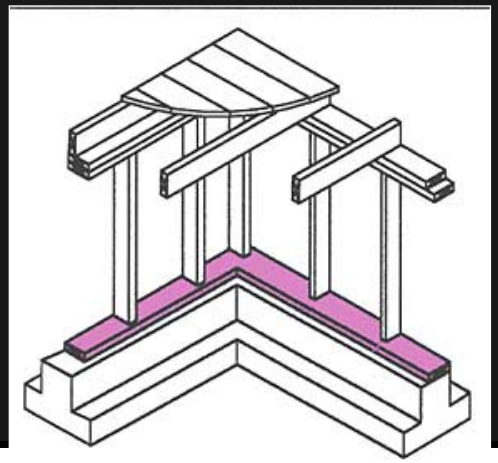
WHAT'S REALLY DEFICIENT?

- Lack of redundancy below first floor





MUDSILL ATTACHMENTS



MUDSILL ATTACHMENTS

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CRIPPLE WALL FAILURES

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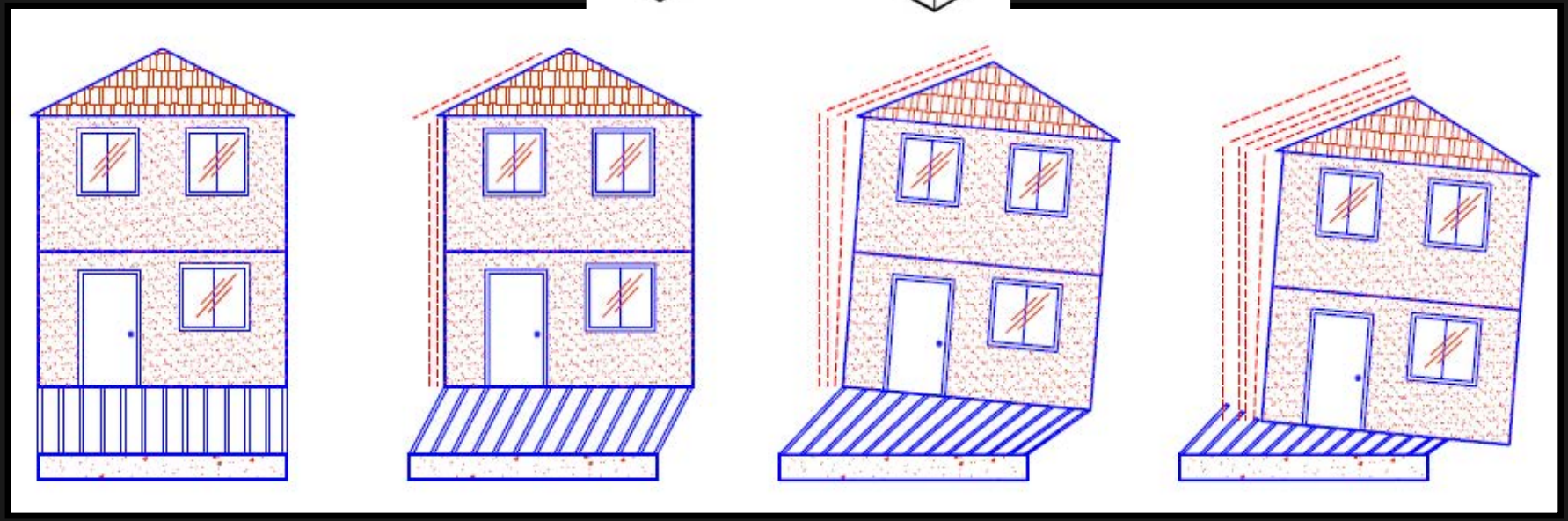
INADEQUATELY SHEATHED CRIPPLE WALLS



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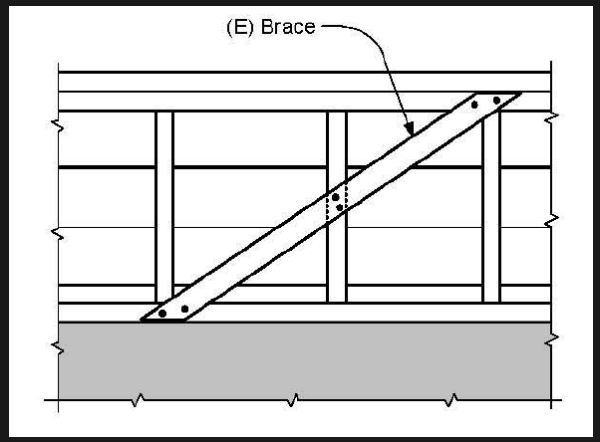
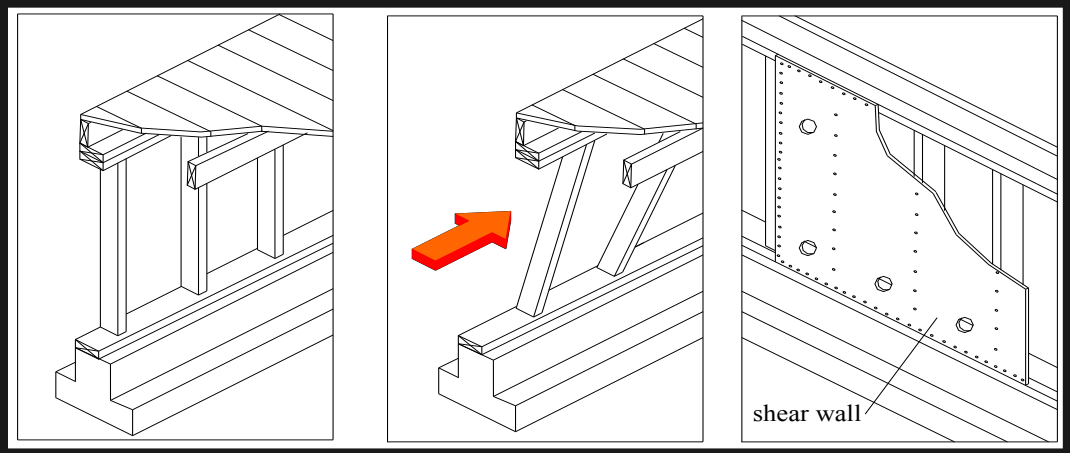
WHAT DOESN'T WORK?

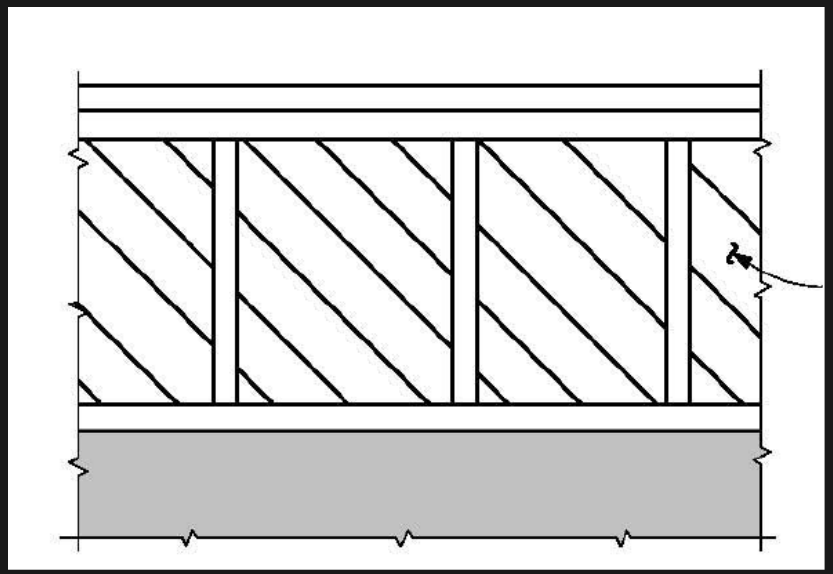
- Horizontal Wood Sheathing/Shingles
- Stucco/Plaster ?
- T1-11 Siding ?
- Let in Bracing



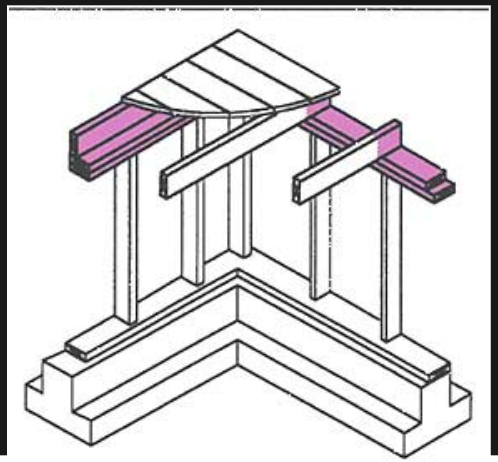


WHAT DOES WORK?

- Plywood
- OSB (oriented strand board)
- Diagonal Wood Sheathing

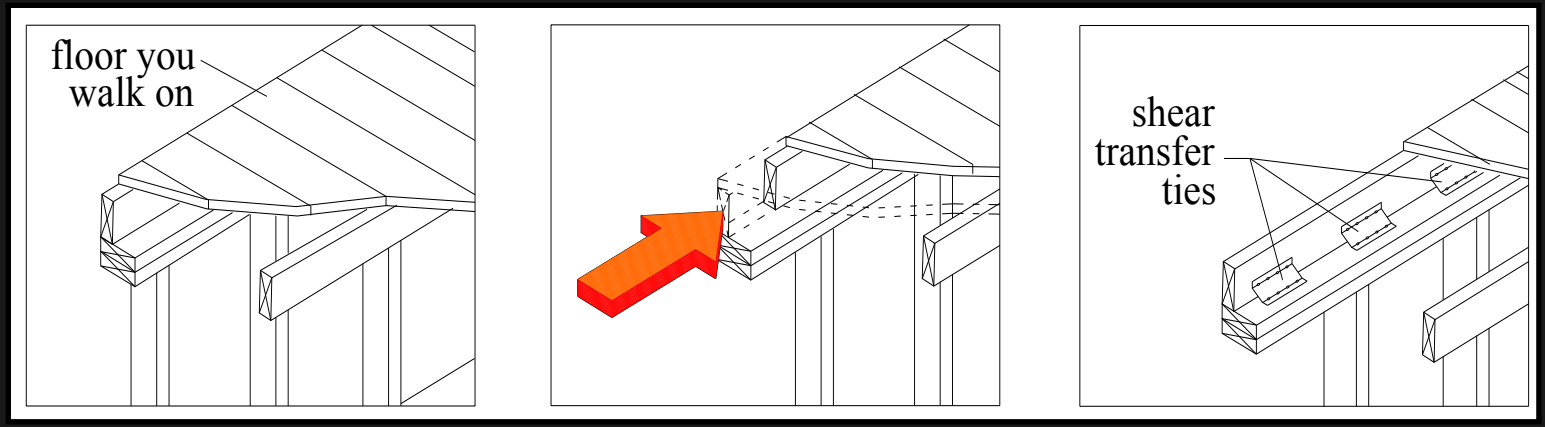


FLOOR TO CRIPPLE WALL ATTACHMENTS

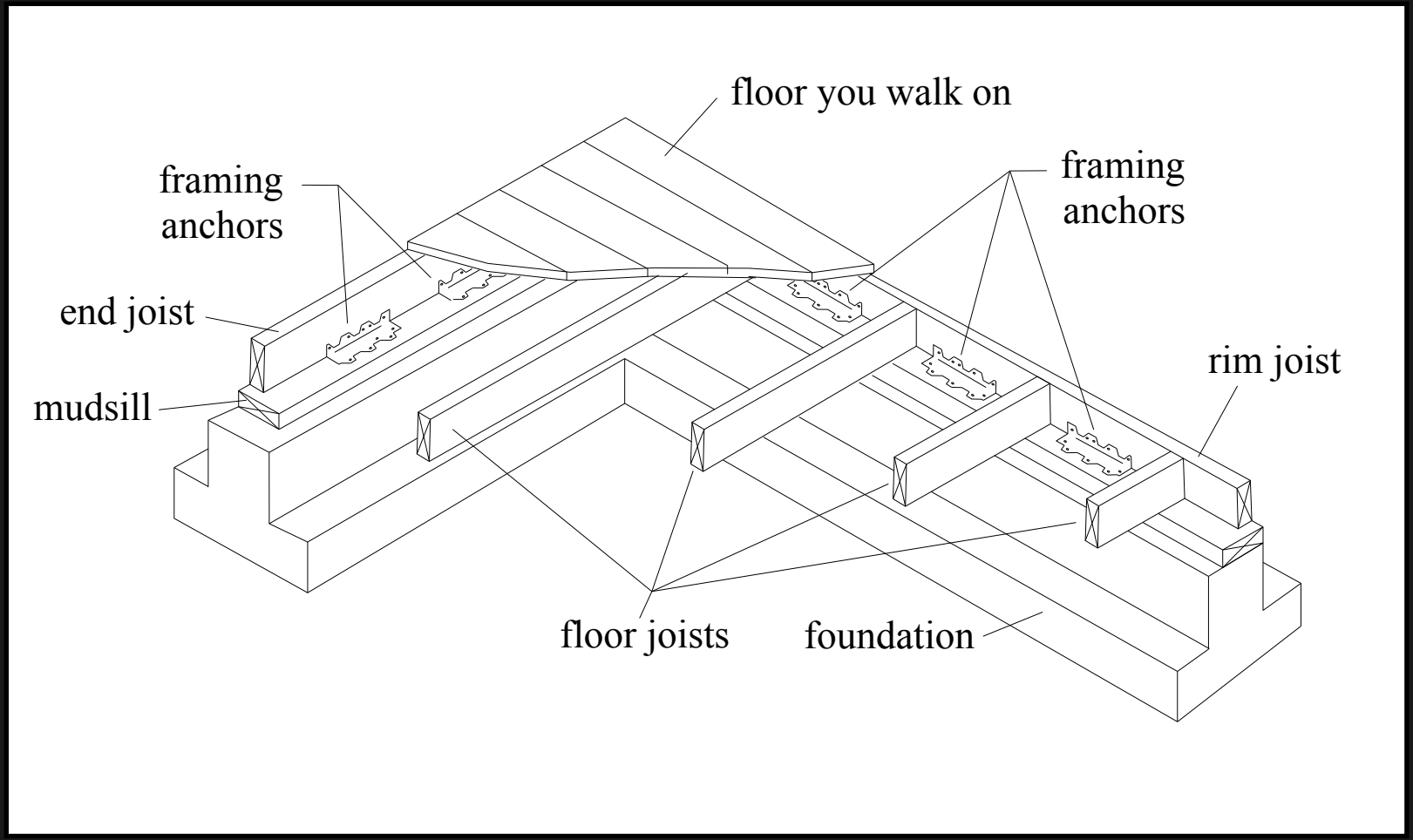


FLOOR TO CRIPPLE WALL ATTACHMENTS

Photos Courtesy By Area Retrofit



FLOOR TO MUDSILL ATTACHMENTS



WHAT DOCUMENTS DO WE HAVE

- FEMA P-50, P50.1
- IEBC A3
- Plan Set A
- City of LA - DBS Anchor Bolt Plan (2009)
- Simpson Strong-Tie
- Plan Set B ?? - (Standard Plan B)

PRESCRIPTIVE STANDARDS

- Engineering Intent “Embedded”
- Developed for Specific “Most Typical Conditions”
- Use in Manner Consistent with Details

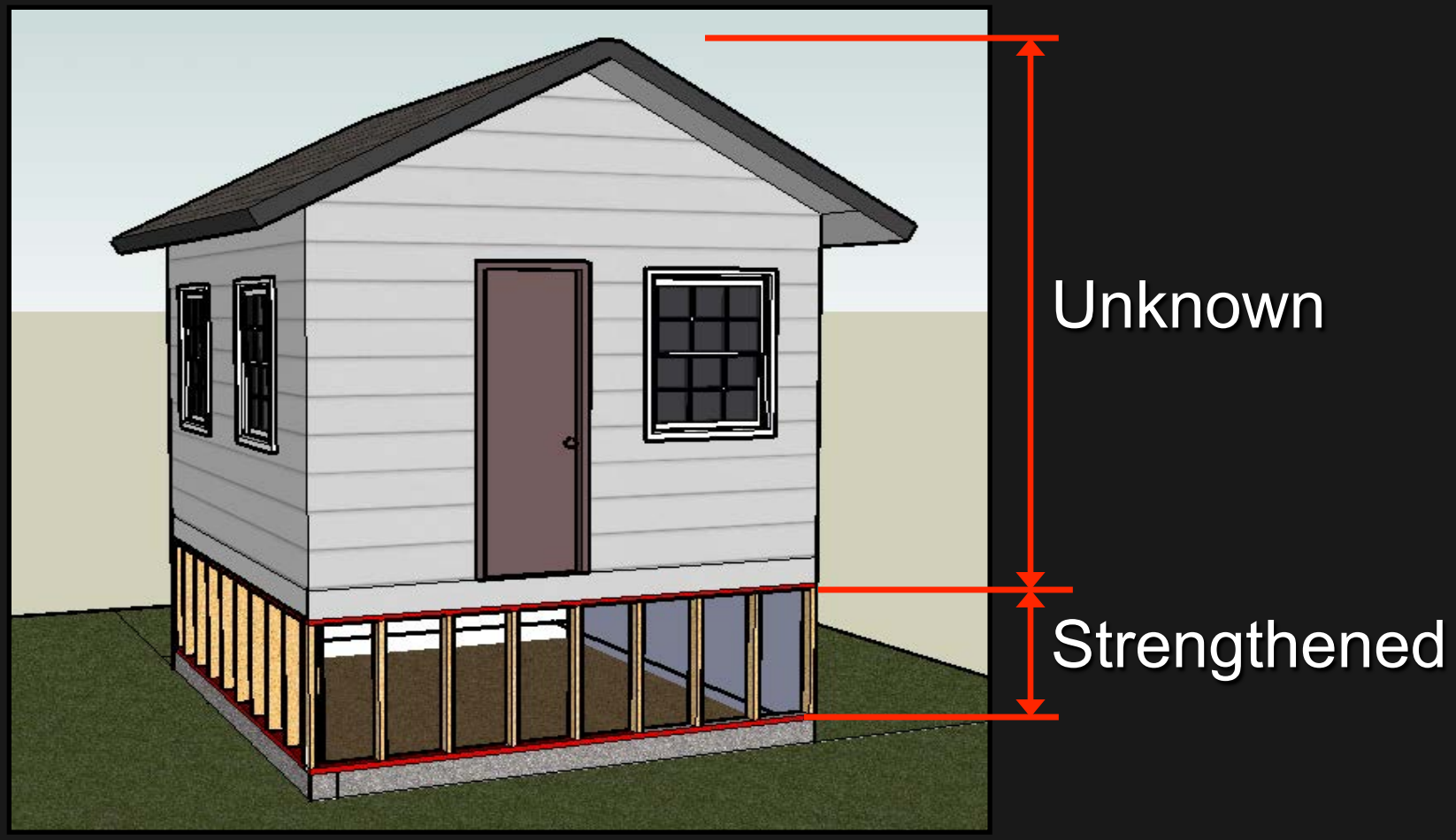
ENGINEERED SOLUTION

- Required when building falls outside of Scope (Example-A301.2)
- When the existing detailing falls outside of the “Most Typical Conditions”
- 75% of Code Design Forces

WHAT MAKES THESE DOCUMENTS DIFFERENT?

- Developed for Homeowners, Contractors, & Engineers
- Focus on “Critical Risk”
- Recipe of “Prescriptive Requirements & Details”

WHAT IS "CRITICAL RISK"



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IEBC A3 & WHERE DOES IT APPLY?

- Residential Buildings of Light Frame Construction (R-3)
- Not More than Four Dwelling Units
- 16 or fewer Primarily Permanent Occupants
- Cripple Walls Less Than 4’ in Height

WHERE DOES IEBC A3 APPLY?

- Homes with post & pier and URM Foundation Systems
- Engineering Assessment or Prescriptive Foundations

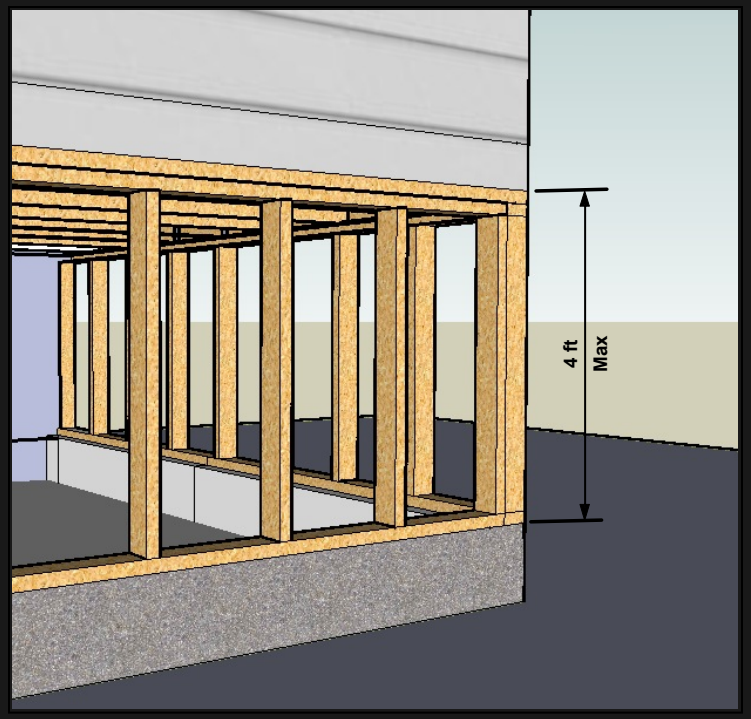
Jim Russell

Anderson Niswander

WHERE DOESN'T A3 APPLY?

- Cripple walls over 4' in Height
- Homes with Pole Foundations
- Buildings Exceeding Three Stories in Height
- Buildings With Slabs on Grade

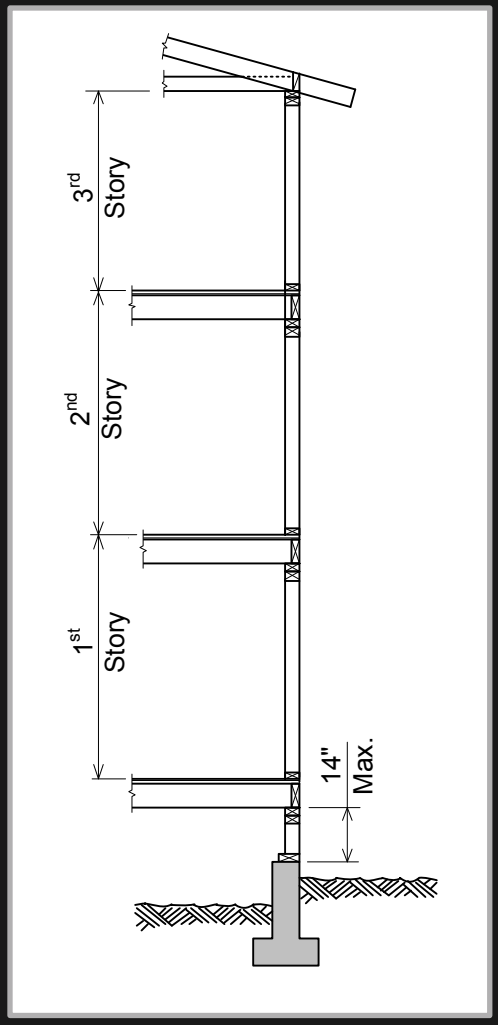
WHERE DOESN'T A3 APPLY?



4' Max Height

Steinbrugge Collection EERC, UCB Homeowner's Guide to Earthquake Retrofit

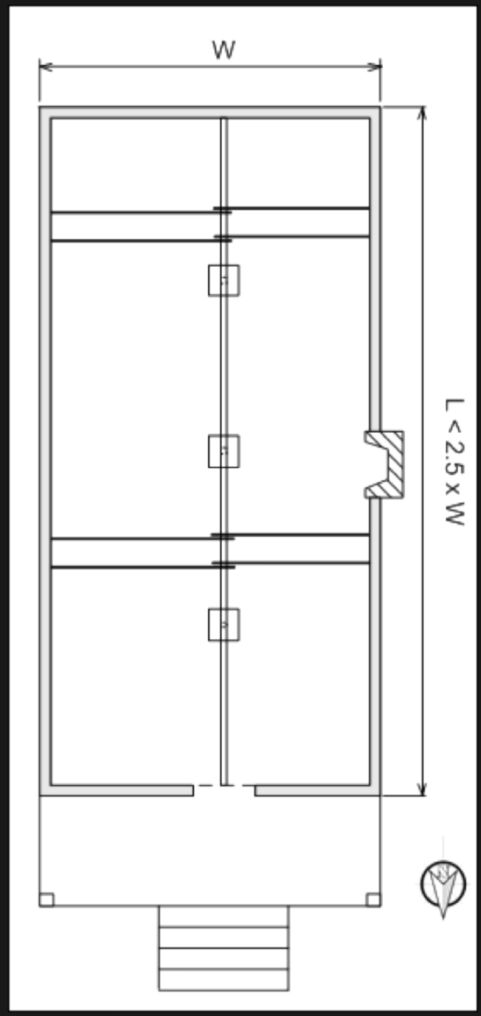
Wall Stud Movement



Cut-Off Height

WHERE SHOULD YOU APPLY IEBC A3 WITH CAUTION?

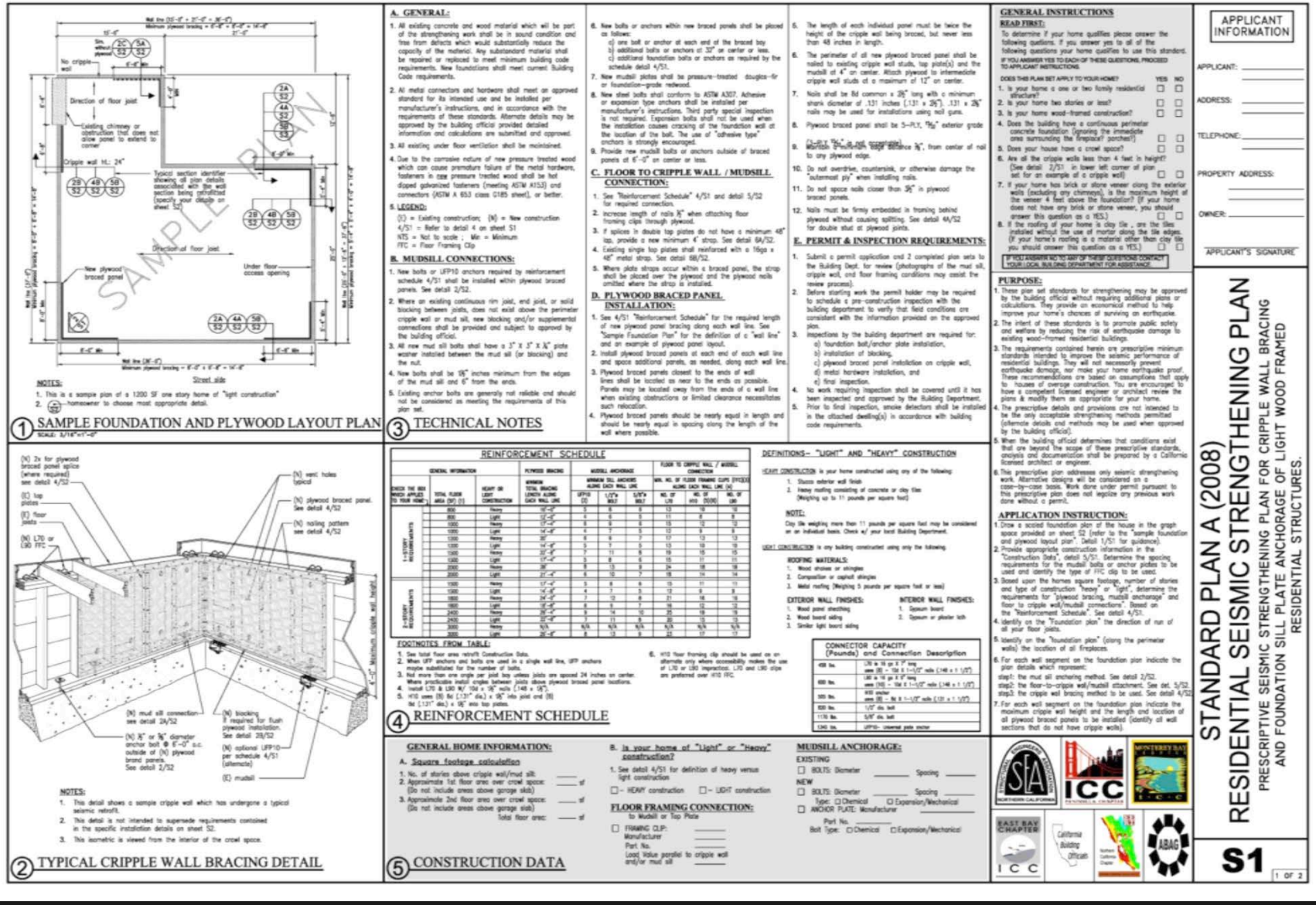
- Sloping Sites
- Long - Rectangular Homes
- High Seismicity (CS > .192g, SDS> 1.25)
- Split Levels
- Homes with Heavy Finishes
- Unusual Configurations & HOG



OTHER PRESCRIPTIVE METHODS

- Plan Set A - (Standard Plan A - 2008)
- City of LA - DBS Anchor Bolt Plan (2009)
- Simpson Strong-Tie
- Plan Set B ?? - (Standard Plan B)

PLAN SET A- PAGE 1



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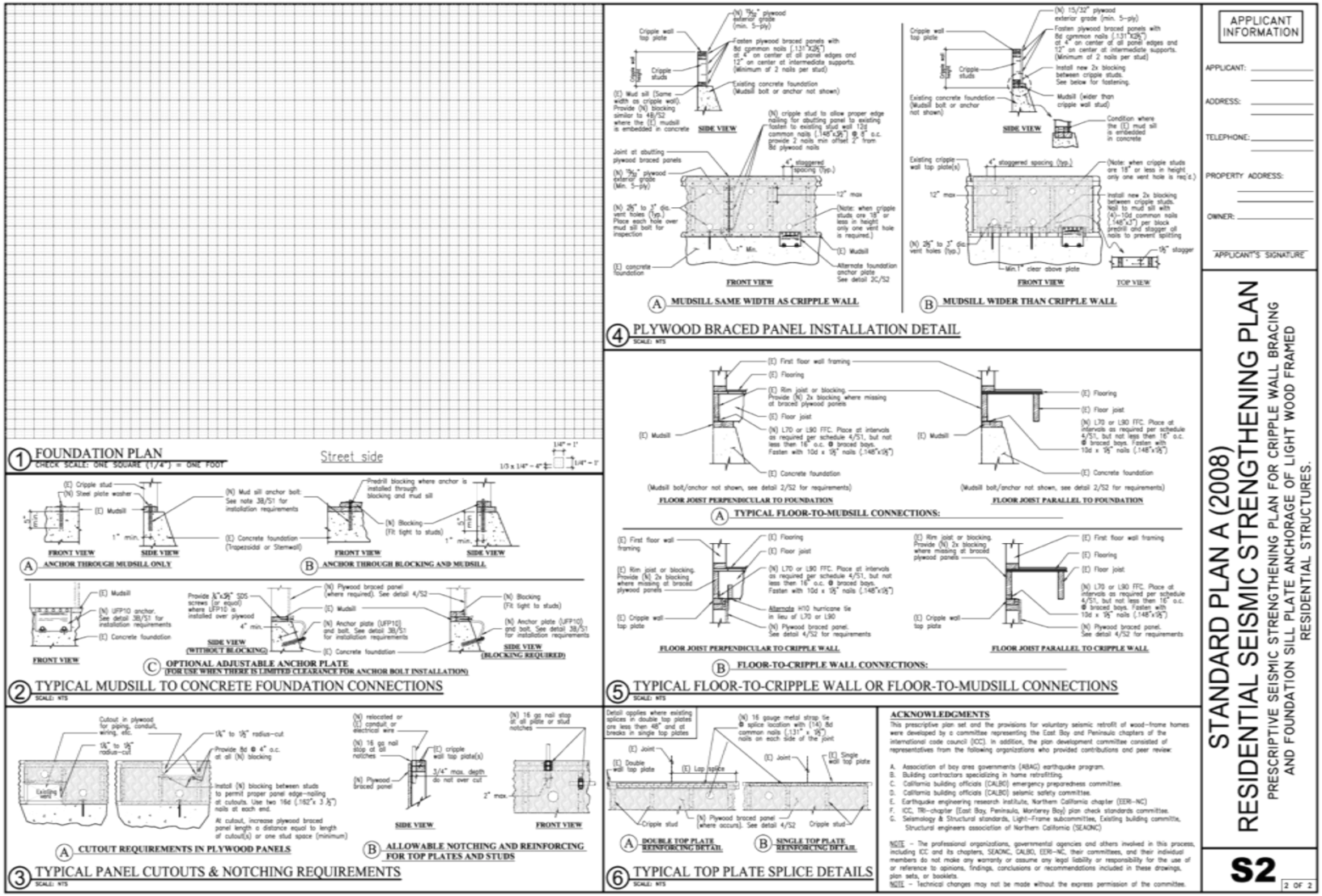
PLAN SET A- PAGE 2



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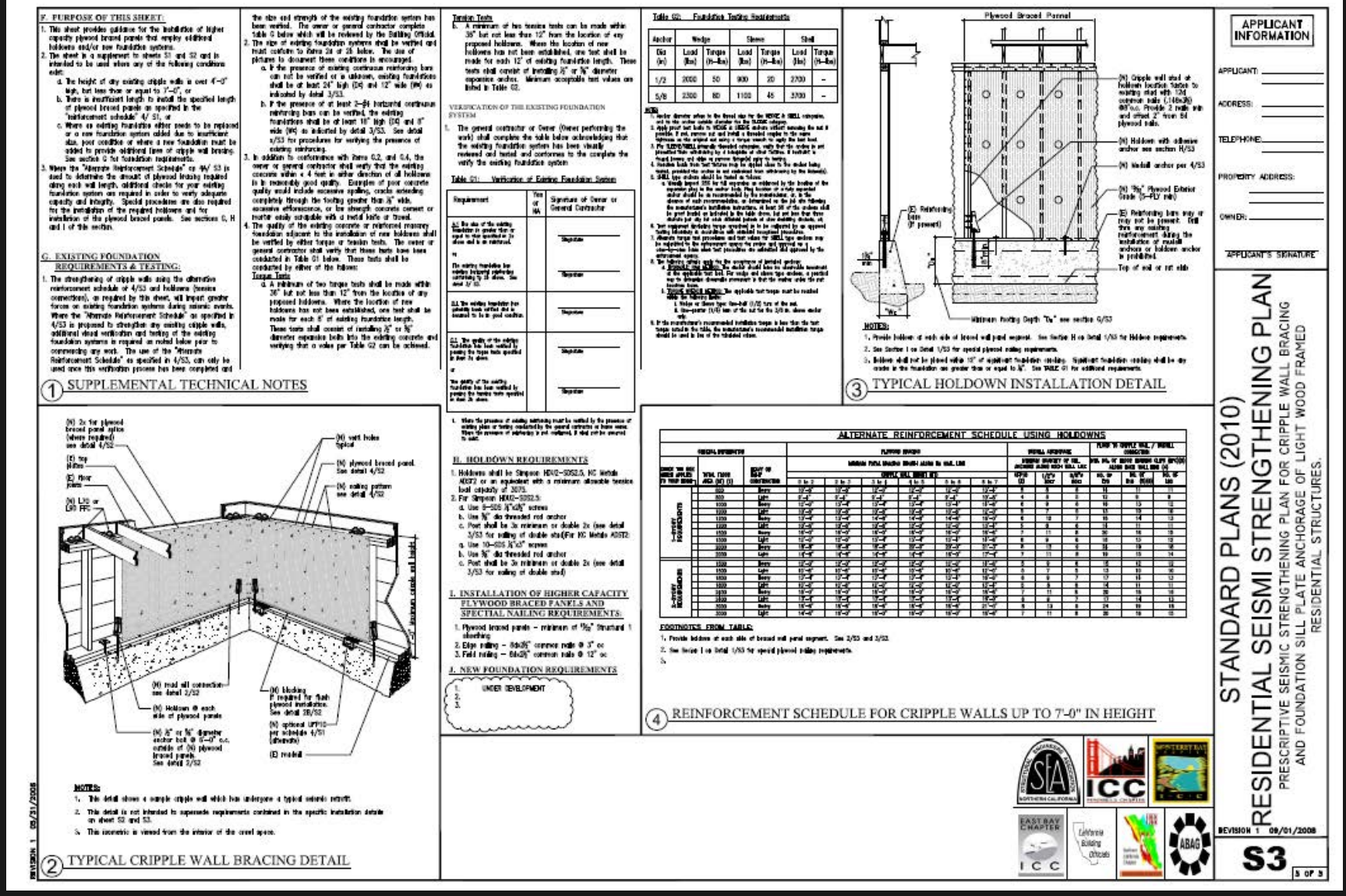
PLAN SET B



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PROS & CONS OF IEBC A3

- Pro's
  - Adopted into the Code/ National Presence
  - Regularly Updated
  - Coordinated with Other Codes
  - Broad applicability with engineered design
  - Standardized and prescriptive details

PROS & CONS OF IEBC A3

- Con's
  - Does not easily Produce Plans and Details
  - Not easily available
  - Limited prescriptive details

PROS & CONS OF PLAN SETS

- Pro's
  - Developed for Home Owners and GC's
  - Consistent notes, detail, procedures
  - Formatted for Construction
  - Easy to Follow

PROS & CONS OF PLAN SETS

- Con's
  - No Official Update Process
  - Limited Applicable Details/ Conditions
  - More Limited Applicability
  - No Direct Engineered Approach

CONTRIBUTORS TO SUCCESS

- Regulatory Agencies
  - Embrace the Program
  - Quality Control and Quality Assurance of Program

NEXT STEPS

- Review all Current Data
- Study & Define the Opportunities
- Develop & Prioritize Realistic Goals
- Implement- Anticipated 5 year Program

Thank you

PAST RESIDENTIAL DAMAGE

1994 Northridge Earthquake- M 6.7

- 48,000 residential units made uninhabitable.
- Only 439 of the 48,000 or slightly less than 1% had cripple wall failures. [1]
- Difference due to newer homes, slab on grade construction, or homes retrofitted after 1971 San Fernando EQ. [1]

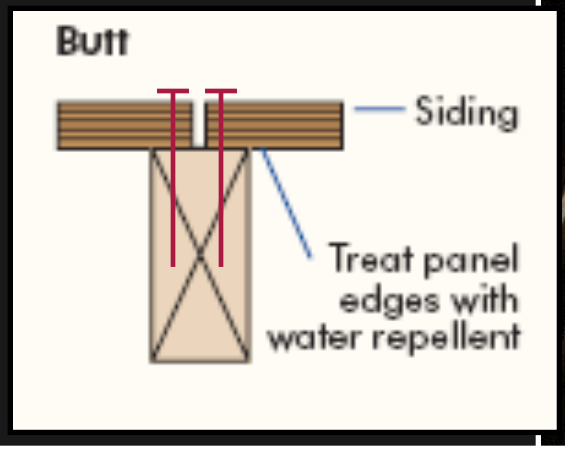
1. *"Preventing the Nightmare" 2003- Report by ABAG*

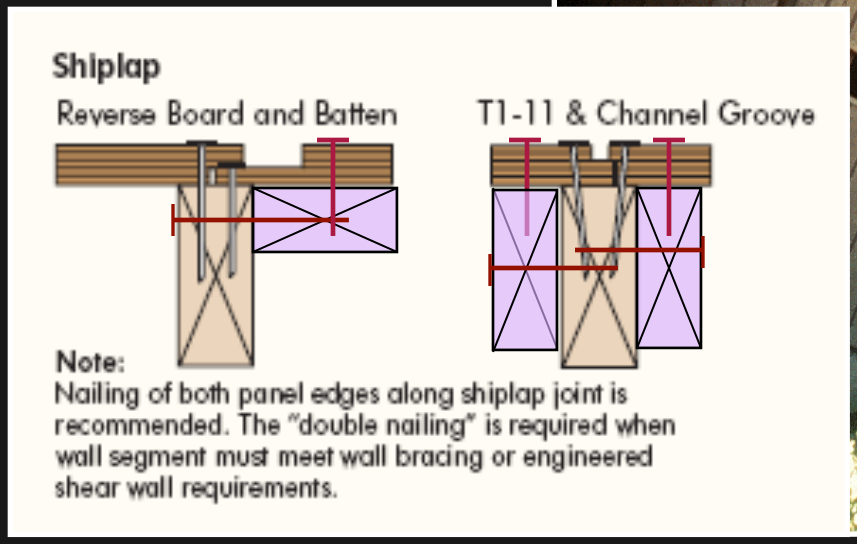
WHAT'S REALLY DEFICIENT?

- Cripple Walls Below First Floor
  - Sheathed one side
  - Stucco, horizontal sheathing

- Walls Above First Level
  - Covered both sides
  - Lathe & plaster, button board & plaster, gypsum board

T1-11 siding failure at edges





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MUDSILL ATTACHMENTS

- Anchor Size & Spacing
- Use of Existing Anchors?
- Check for Sound Concrete