



PROBATIONARY FIREFIGHTER TRAINING FIRE STATION 11-C

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Un-reinforced Masonry



INTRODUCTION

In today's construction industry Masonry buildings are constructed under much more strict building codes. Prior to 1933 and for some time there after, masonry buildings were built without using the structural supports common in buildings today.

LONG BEACH EARTHQUAKE

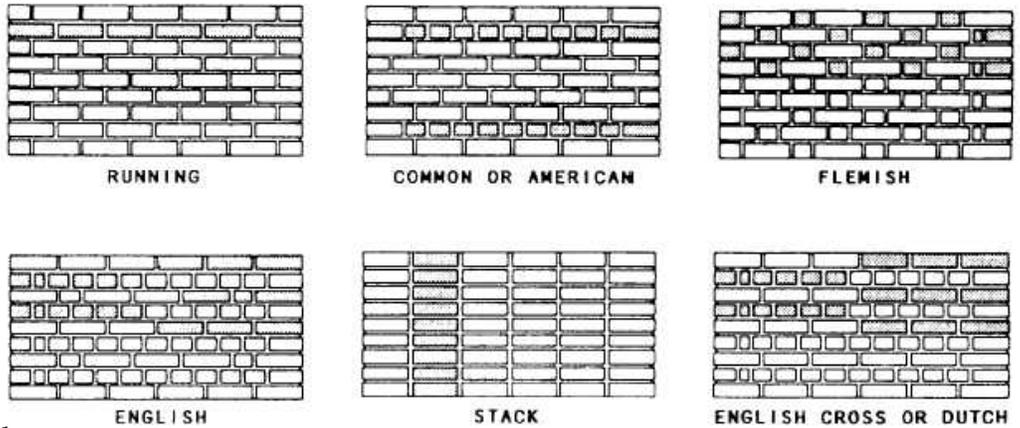
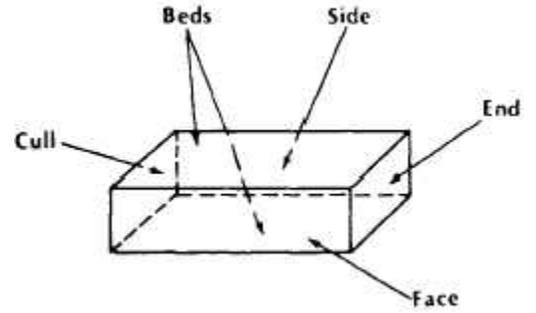
On **March 10, 1933 at 5:55 pm** a magnitude 6.25 earthquake struck off the southern coast of L.A. County, causing widespread failure of structures throughout the city of Long Beach. 115 lives were lost, including 2 Firefighters at Station 1 and 5 children in a gymnasium, and over \$1.5 billion damage (in today's dollars) was suffered. 70 schools were destroyed and 120 were severely damaged. Fortunately, schools were not in session at the time of the quake.



After many years and through several pushes for amendments to Building Codes, many upgrades were mandated. There are over **500 URM**s currently in Long Beach. Today all Un-reinforced Masonry Buildings in Long Beach have been seismically upgraded and reinforced. These buildings still pose a significant threat to firefighters when placed under fire conditions. In fact, some of the reinforcements used to combat racking forces have actually caused buildings to be more dangerous when the structure is on fire.

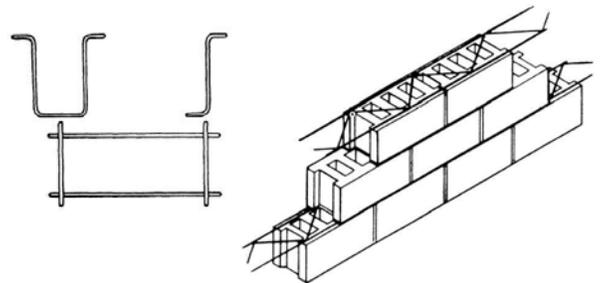
BRICK WORK

- U.S. Standard size brick: 2 1/4" x 3 3/4" x 8"
- Bricks weigh 100 – 150 lbs per cubic foot
- 6 sides of a brick
- Strength of a brick structure comes from:
 - brick strength
 - mortar strength and elasticity
 - bricklayer workmanship
 - brick uniformity
 - method used to lay brick

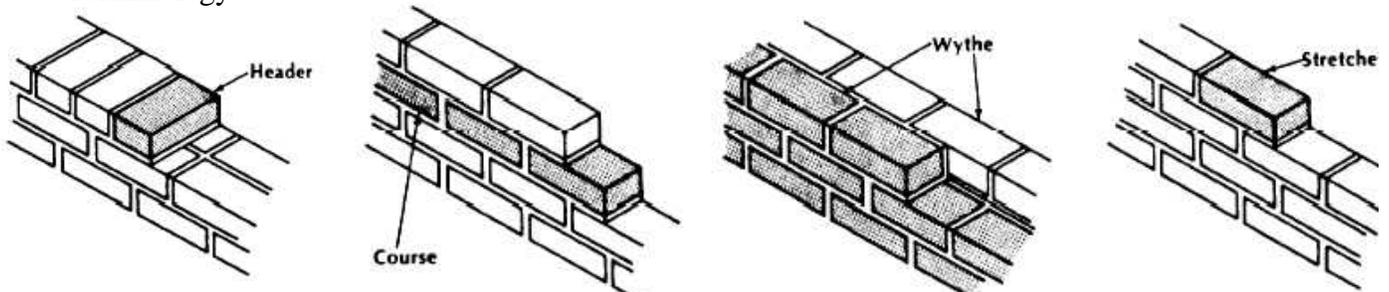


- Strength of a single brick:
 - Ingredients and manufacturing method
 - Ultimate compressive strength as low as **1,600 psi**.
 - Well-burned brick has compressive strength exceeding **15,000 psi**.
 - Load carrying capacity of a brick structure is cut in half when sand lime mortar is used versus Portland cement mortar
 - The compressive working strength of a brick wall or column laid with sand lime mortar normally ranges from **500 to 600 psi**

- Today's Brick structures will include metal ties or corrugated steel to bond the exterior wall brick to the backing courses



- Terminology



COMPONENTS OF UN-REINFORCED MASONRY



- Brick walls up to 3 wythes thick
 - 1 wythe = 1 masonry unit
 - In excess of **13” and tapering vertically**
- Weak Foundation Walls
 - Masonry
 - Rock
 - Motor used contains very little cement
 - Deteriorates from moisture penetration over time
 - Concrete was used in some structures
- Lintels used over windows and doorways
- Wood floor and roof assemblies
- Fire cut joists (allowed floors and ceilings to collapse without pulling the walls in)
- No rebar

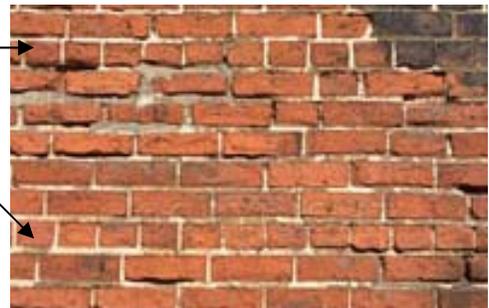


IDENTIFYING A PRE-33 STRUCTURE

- Deep recessed windows
- Tie Plates
 - Squares, diamond, stars
 - Tie the rafters and joists into the exterior walls
 - Eliminates the effectiveness of Fire Cuts
 - Used most commonly in retrofits



- King Rows
 - Header course every 4-7 stretcher courses
 - Header course showing the ends of the bricks
 - Ties wythes together
 - Today’s construction will use metal ties and corrugated steel to serve this purpose



- Concrete Bond Beams
 - Reinforced concrete beams used to replace brick courses in URMs
 - Between floors and at weak spots in the walls
- Concrete Caps
 - Reinforced concrete beams used at roof lines and on parapet walls



- Sand Lime Mortar
 - Can be scrapped away with your finger
 - Visibly weathered and deteriorated

- Arched roofs are common in Pre-33 structures



HAZARDS

✓ **Wall Collapse**

- Failure of wall foundation

90 degree

- Extreme “Bounce factor” involving bricks

- Failure of Floor or ceiling joists

Inward/outward collapse

- As the collapsing joist inside fall, the exterior walls are pulled in causing a break horizontally along the wall in between the ground and the failing member.
- The upper portion of the wall collapses inward
- The lower portion of the wall collapses outward

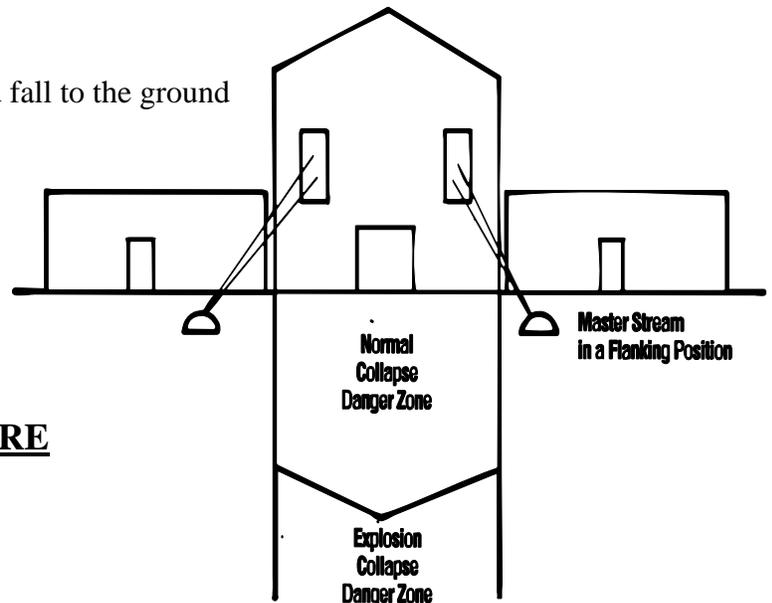
- Failure of deteriorated mortar

Curtain Fall

- The bricks and blocks peel away and fall to the ground

- ALL bricks falling from significant heights have significant Bounce Factors

- A collapse zone should be established 1 ½ times the height of the structure



INDICATORS OF COLLAPSE DUE TO FIRE

- ✓ Sagging floors, ceilings, or roofs
- ✓ Spongy floors and/or roofs
- ✓ Walls out of plumb, bulging, and/or leaning
- ✓ Smoke or water leaking escaping through cracks
- ✓ Twisted or warped columns or beams
- ✓ Significant burn time
- ✓ Cracking, groaning, and/or creaking noises
- ✓ Tie Plates protruding from walls
- ✓ Tie Plates pulled into the walls
- ✓ Cracks running the wall height
- ✓ Numerous bricks fragmenting or breaking in localized areas
- ✓ Separation of stucco or plaster overcoat

FIREFIGHTERS LOST DURING 1933 FIRE STATION 1 COLLAPSE

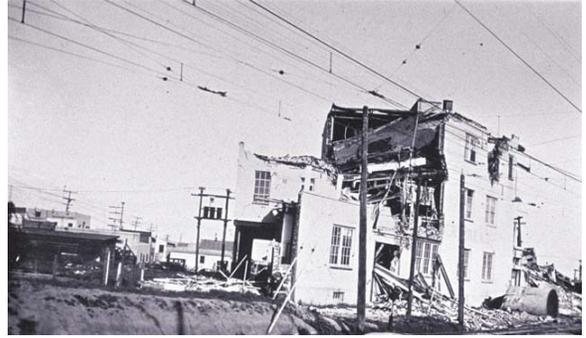
- Percy Forker
- A. B. Stephens

SUFFERING STRUCTURES OF THE LONG BEACH EARTHQUAKE

Jefferson Junior High School



Bakery in Long Beach



Parapet and marquee damage



Church in Long Beach



Luther Burbank School



First Presbyterian Church in Long Beach



Buena Vista Apartments



Fire Station 1



Temporary Station 1

