

Distribution of Surface Fault Rupture

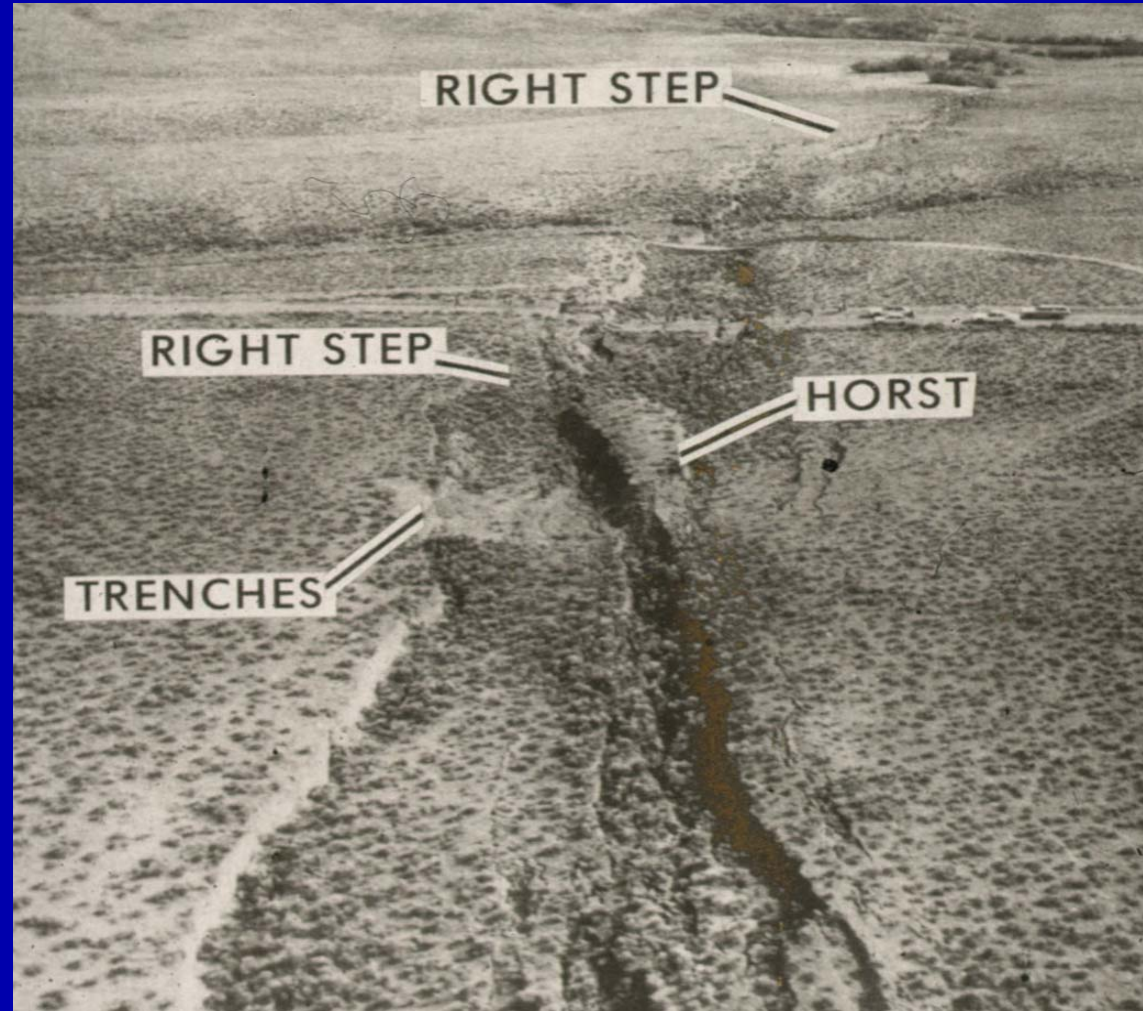
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University of California, Berkeley**

Surface Fault Rupture



1906 San Francisco EQ
Lawson et al. 1908



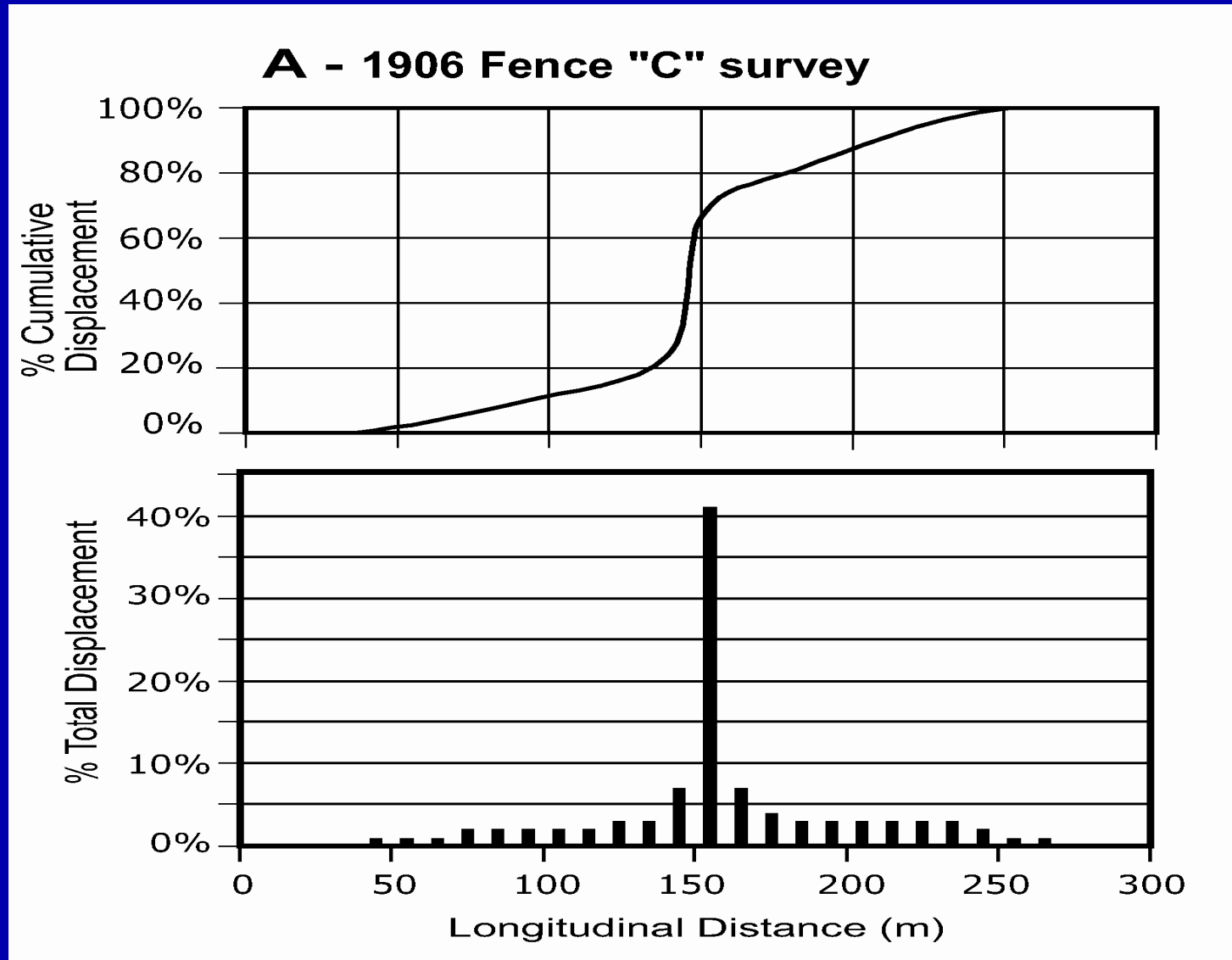
1983 Borah Peak EQ
Crone et al. 1987



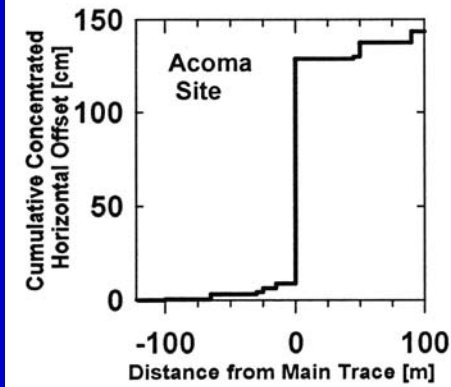
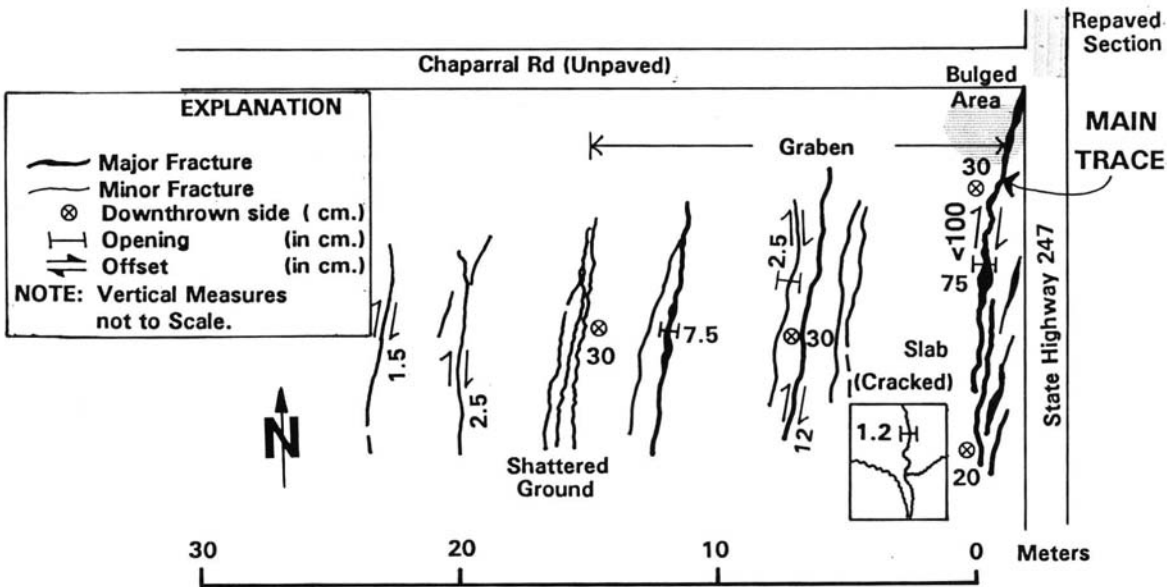
Characteristics of Surface Rupture Depend on:

- **fault type**
- **inclination of fault plane**
- **amount of fault displacement**
- **fault definition**
- **overlying earth material**
- **structure and its foundation**

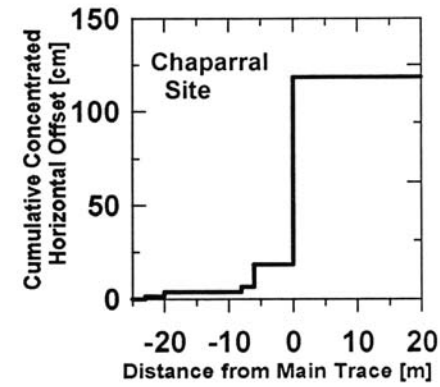
1906 San Francisco Earthquake (data from Lawson et al. 1908)



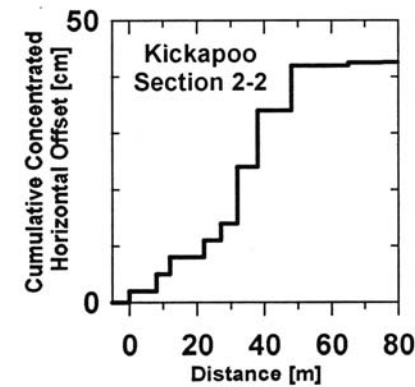
1992 Landers Earthquake



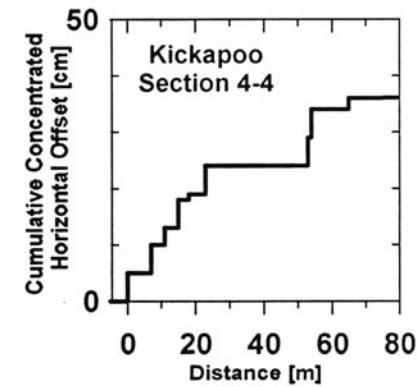
(a)



(b)



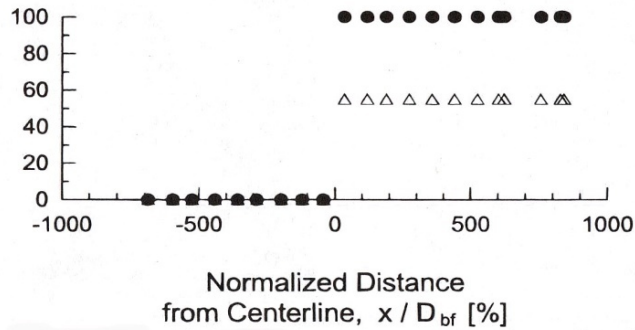
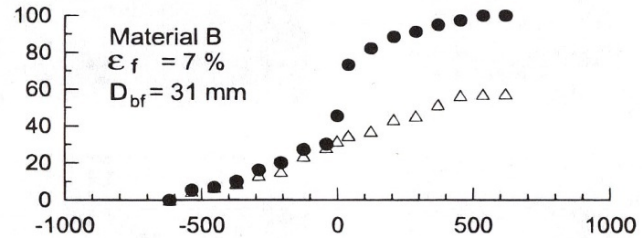
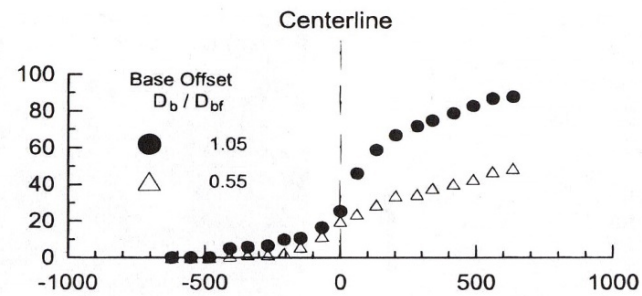
(c)



(d)

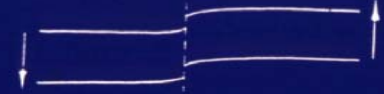


Normalized Displacement, u / D_{bf} [%]



Clay Model (Lazarte & Bray 1996)

NARROW ZONE OF DISTURBANCE



Plan View

WIDE ZONE OF DISTURBANCE



Plan View

1868 Hayward EQ
1906 San Francisco EQ
1940 Imperial Valley EQ

FLOWERING EFFECT



Cross Section

(A) "Stiff" Earth Materials

1906 San Francisco EQ
1966 Parkfield-Cholame EQ



Cross Section

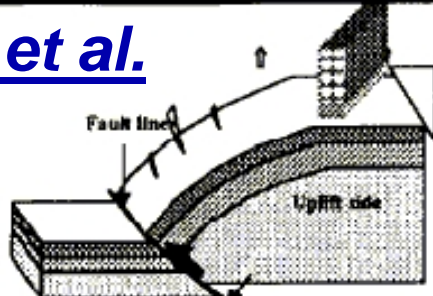
(B) "Ductile" Earth Materials

Broad area of building damage on hanging wall of reverse fault

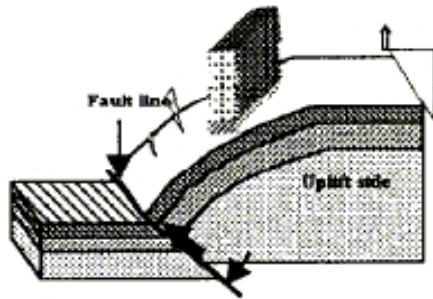


Not on footwall

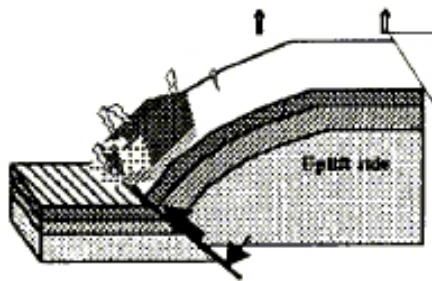




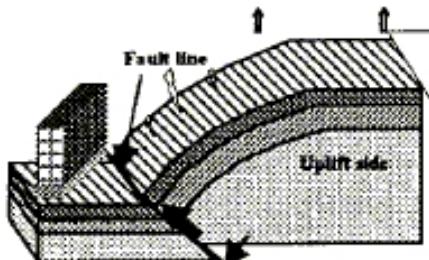
Building located on uplift side, but far from the fault line will be safe.



Building will suffer minor damage if located on uplift side and not far enough from fault line



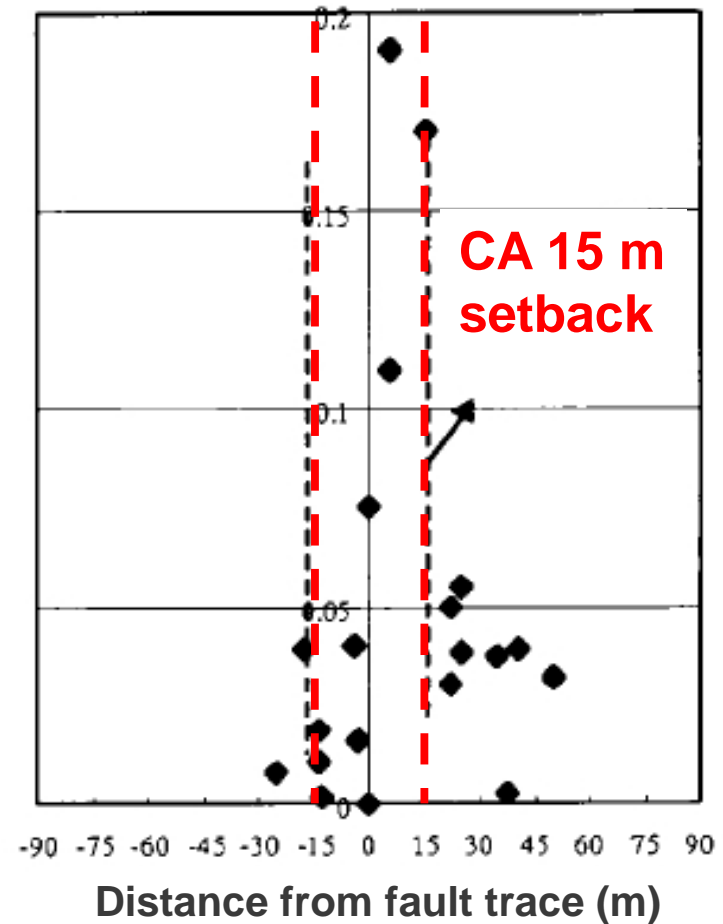
Building will suffer severe damage if located on the uplift side and very close to fault line



Most buildings on the non-uplifted side of the fault are safe

Footwall / Hanging wall

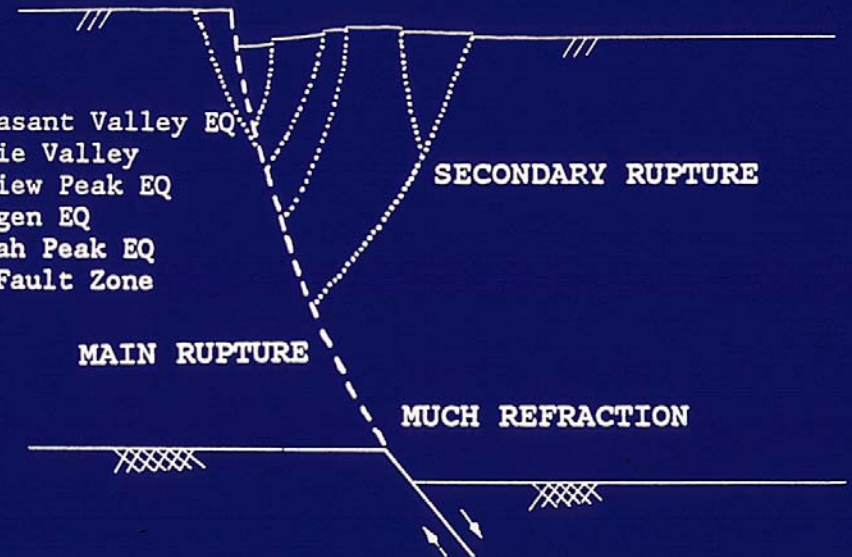
Structural Distortion Index



Building Distortion Distribution : Severe Damage



1915 Pleasant Valley EQ
 1954 Dixie Valley
 - Fairview Peak EQ
 1959 Hebgen EQ
 1983 Borah Peak EQ
 Wasatch Fault Zone

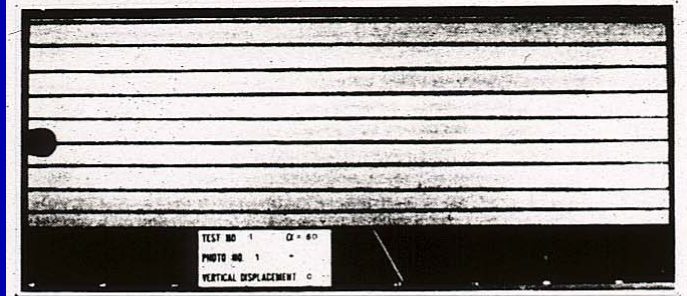


Soil Effects

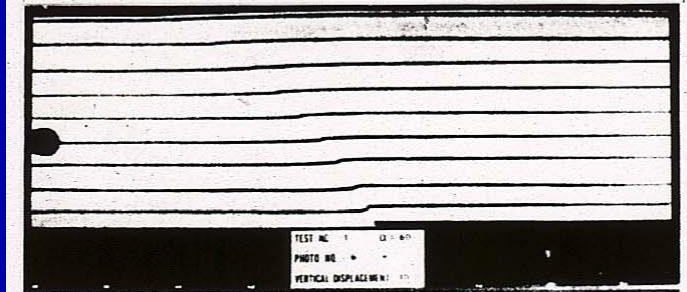


***“It could be traced as a multitude of small cracks in the swampy land ... then as a well-defined fissure up ... to where it disappeared in the sand dunes.”
(Lawson 1908)***

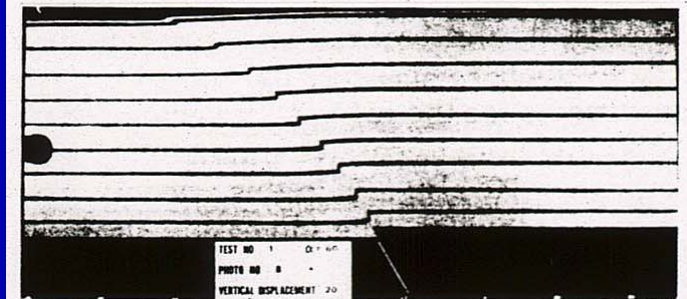




(A) Undeformed (Lade and Cole 1984)



(B) Initiation Of Failure Surface At Bedrock Fault



(C) Fully Developed Failure Surface



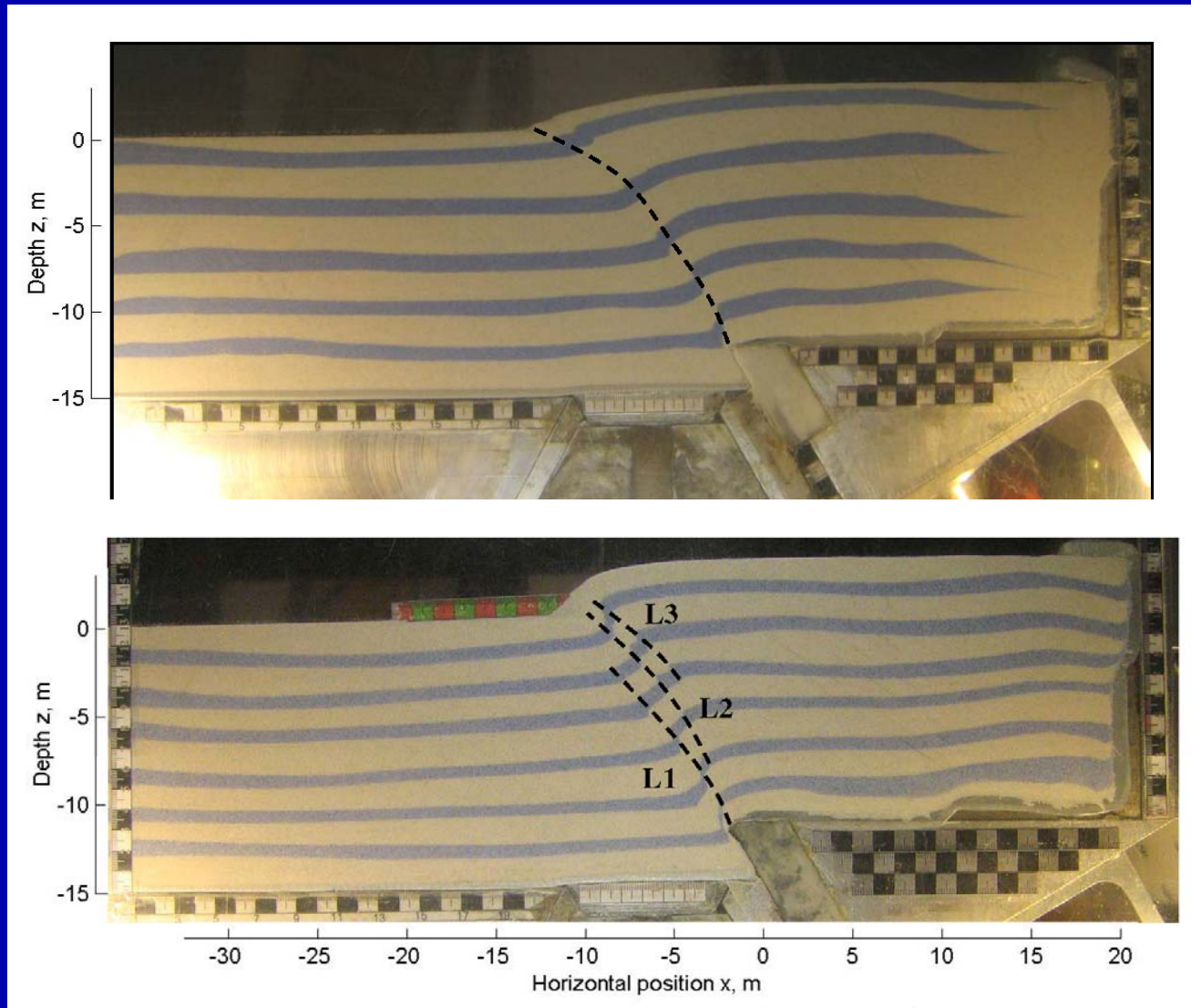
Interaction with Structures

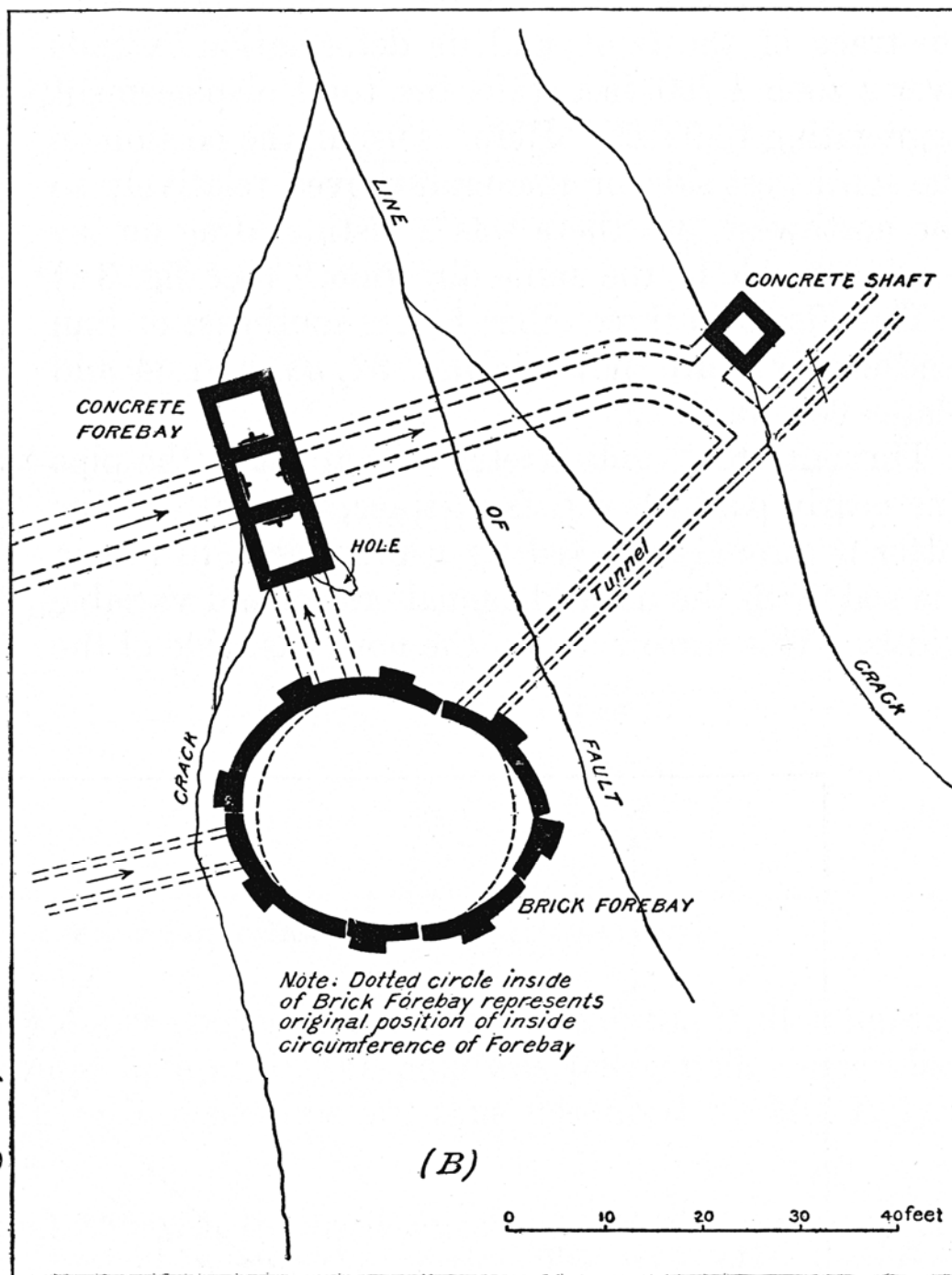


1992 Landers Earthquake



CENTRIFUGE TEST OF FAULT RUPTURE WITH AND WITHOUT MAT FOUNDATION (Ahmed et al. 2008)





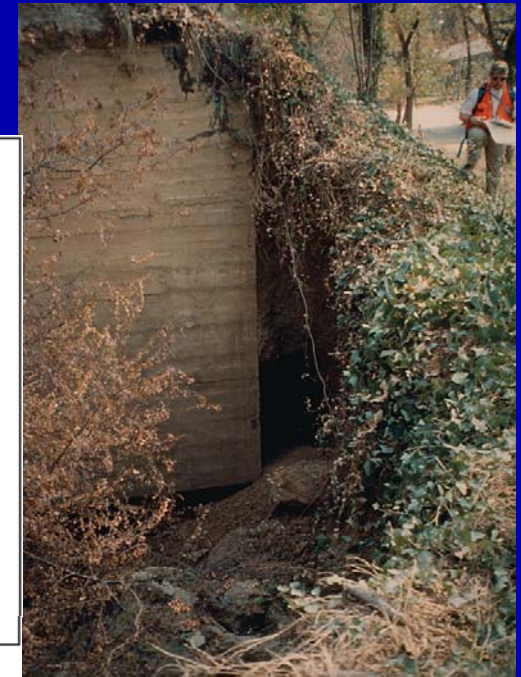
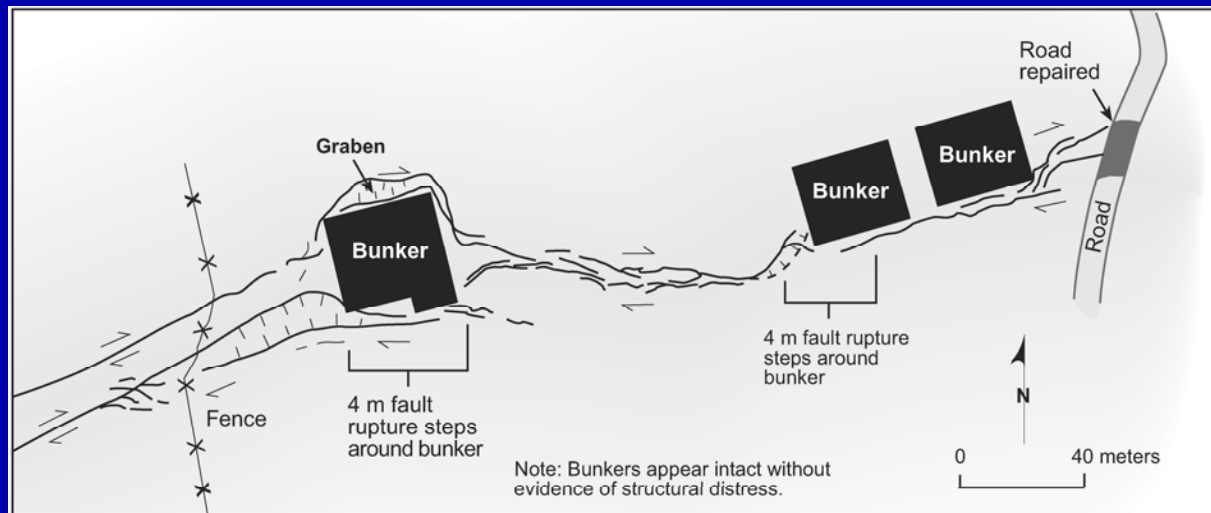
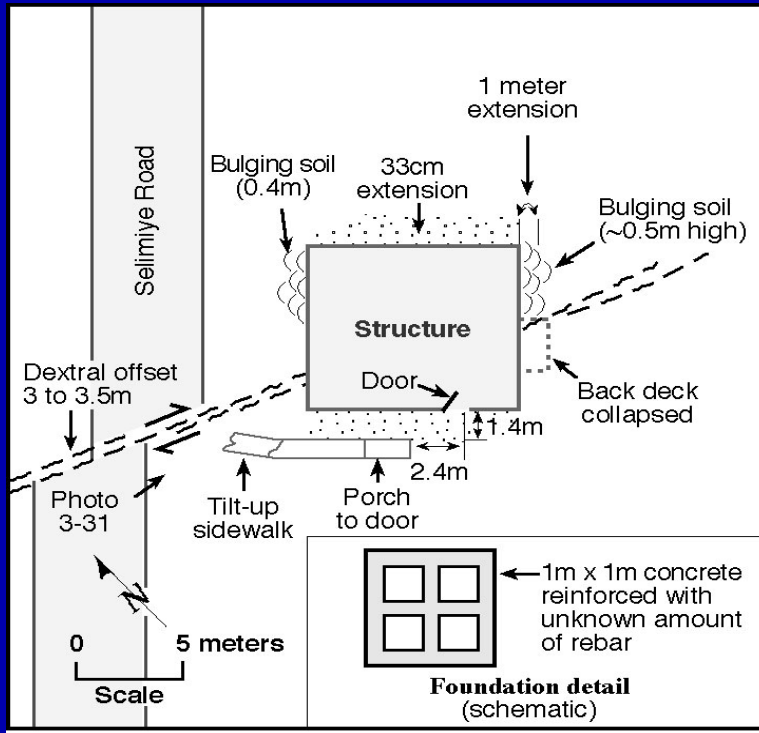
1906 San Francisco EQ
(Lawson 1908 & Schussler 1906)



Photo by K. Kelson



Examples of Surface Faulting Not Damaging Structures – “Decoupling”



Systems (Tied to the Ground) Damaged by Faulting



An Analogy



From Prof. R. Ulusay, Turkey

SUMMARY

- Effects of surface fault rupture can be devastating or acceptable
- Characteristics of surface faulting are affected by:
 - fault characteristics
 - overlying soil
 - foundation & structure
- Surface fault rupture is a hazard that can be analyzed, just like mining subsidence and landslides.