

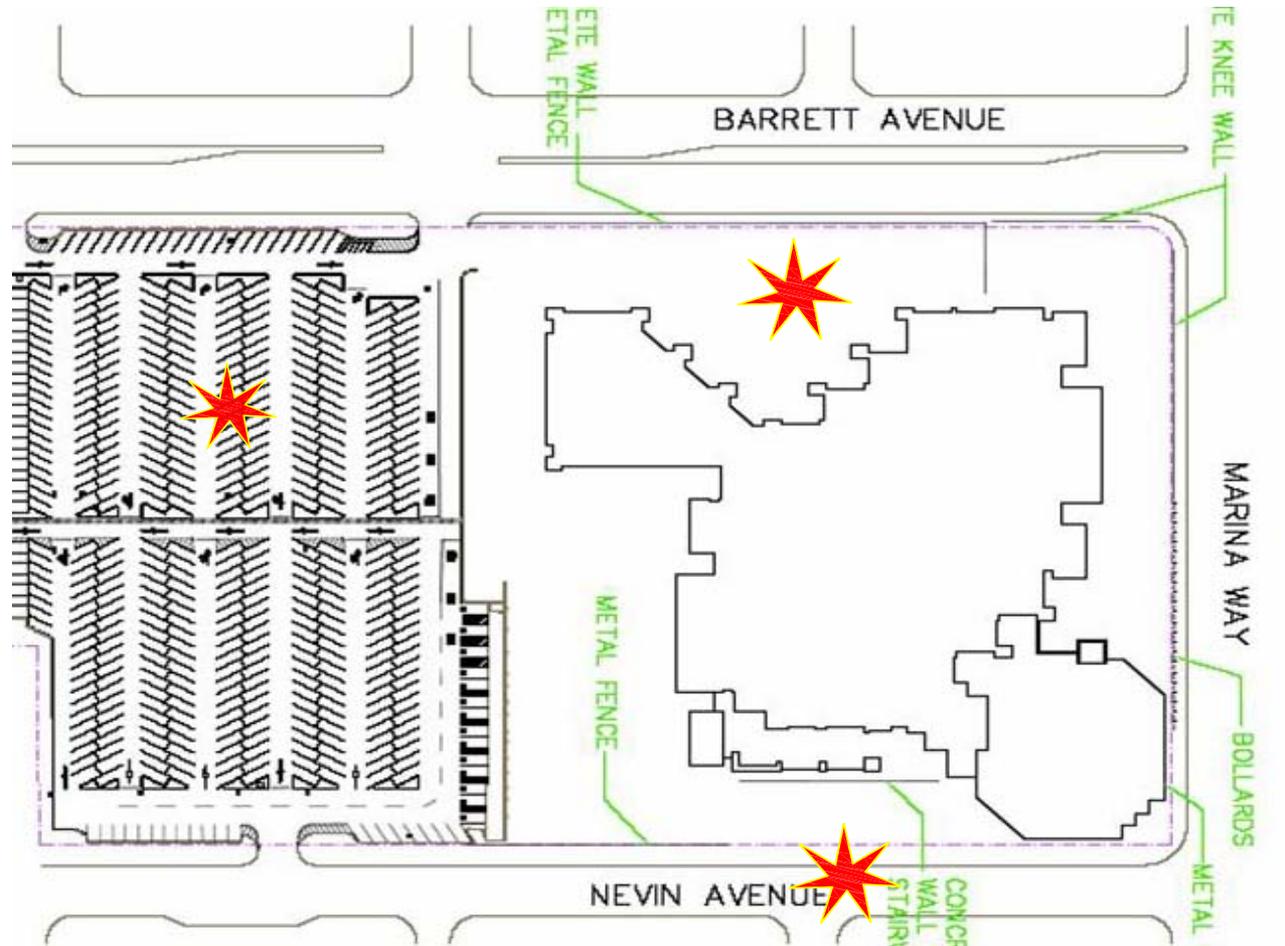
ROBUST STRUCTURES

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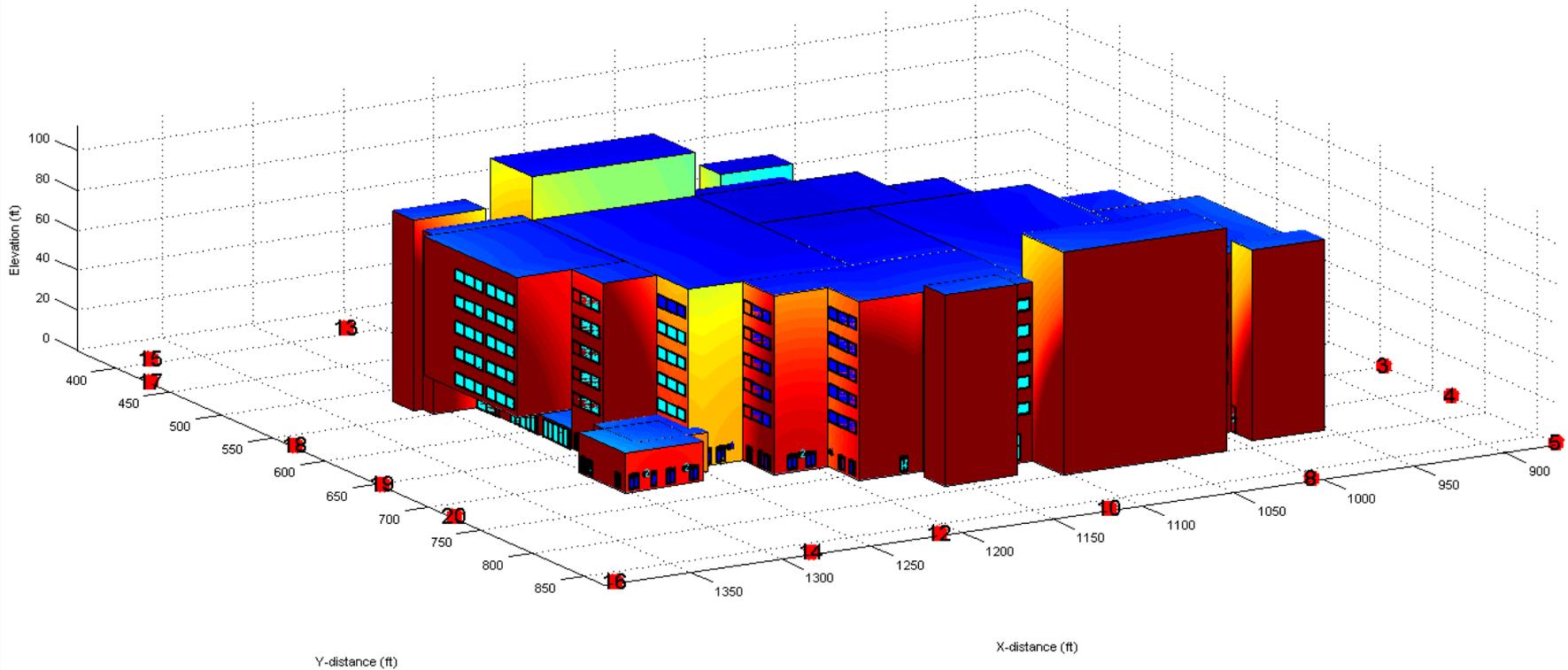


State of practice





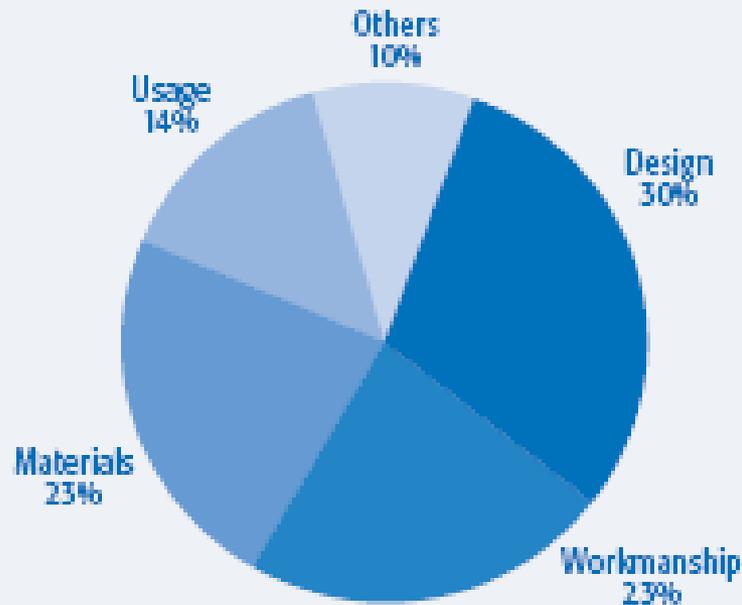
State of practice





Why is robustness an issue?

Grounds for construction losses



Source: SECO figures covering 800 losses. Combines results from 2 separate papers, published in the 1990s by the WTCB (Belgian Building Research Institute) as well as Matouzek and Schneider

Ref: Allianz Global Risks REPORT 2/2006

- Despite modernization of design codes the engineering profession is still facing problems in terms of:
 - collapsing structures and buildings
 - steady increase of insured damages



What is robustness?



- Robustness manifests itself only during an extreme events (i.e., blast/impact followed by fire) or during uneven loading (i.e. asymmetry, irregularity)



Robustness by others

- **Software Engineering**

- The ability...to react appropriately to abnormal circumstances (i.e., circumstances “outside of specifications”). A system may be correct without being robust

- **Ecosystems**

- The ability of a system to maintain function even with changes in internal structure or external environment

- **Statistics**

- A robust statistical technique is insensitive against small deviations in the assumptions

- **Language**

- The robustness of language...is a measure of the ability of human speakers to communicate despite incomplete information, ambiguity, and the constant element of surprise



What is the definition robustness?



1. From the Dictionary:

a : having or exhibiting **strength** or vigorous health

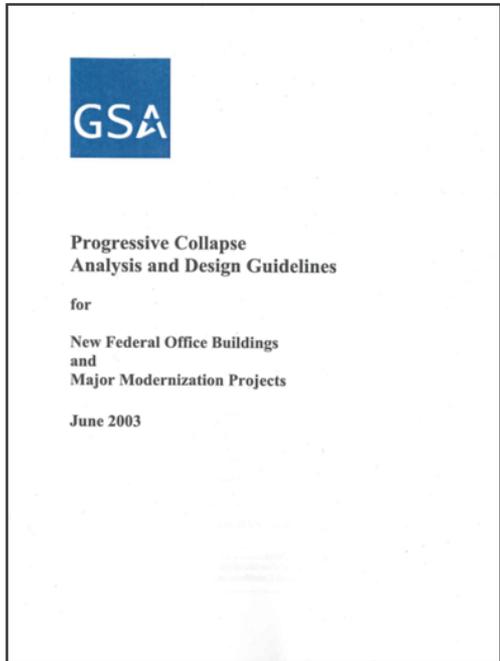
b : having or showing vigor, **strength**, or firmness

c : **strongly** formed or constructed

d : capable of **performing without failure under a wide range of conditions**



GSA



2. From the U.S. General Services Administration (GSA):

robustness: *ability of the structure to resist failure “due to its vigorous strength and toughness”**

*GSA Progressive Collapse Analysis and Design Guidelines)

EUROCODE

3. From Eurocode :

*robustness: ability of a structure to withstand events like fire, explosions, impact, or the consequences of human error, without being damaged to an extent disproportionate to the original cause**



*prEN 1991-1-7:2004, 1.5.14



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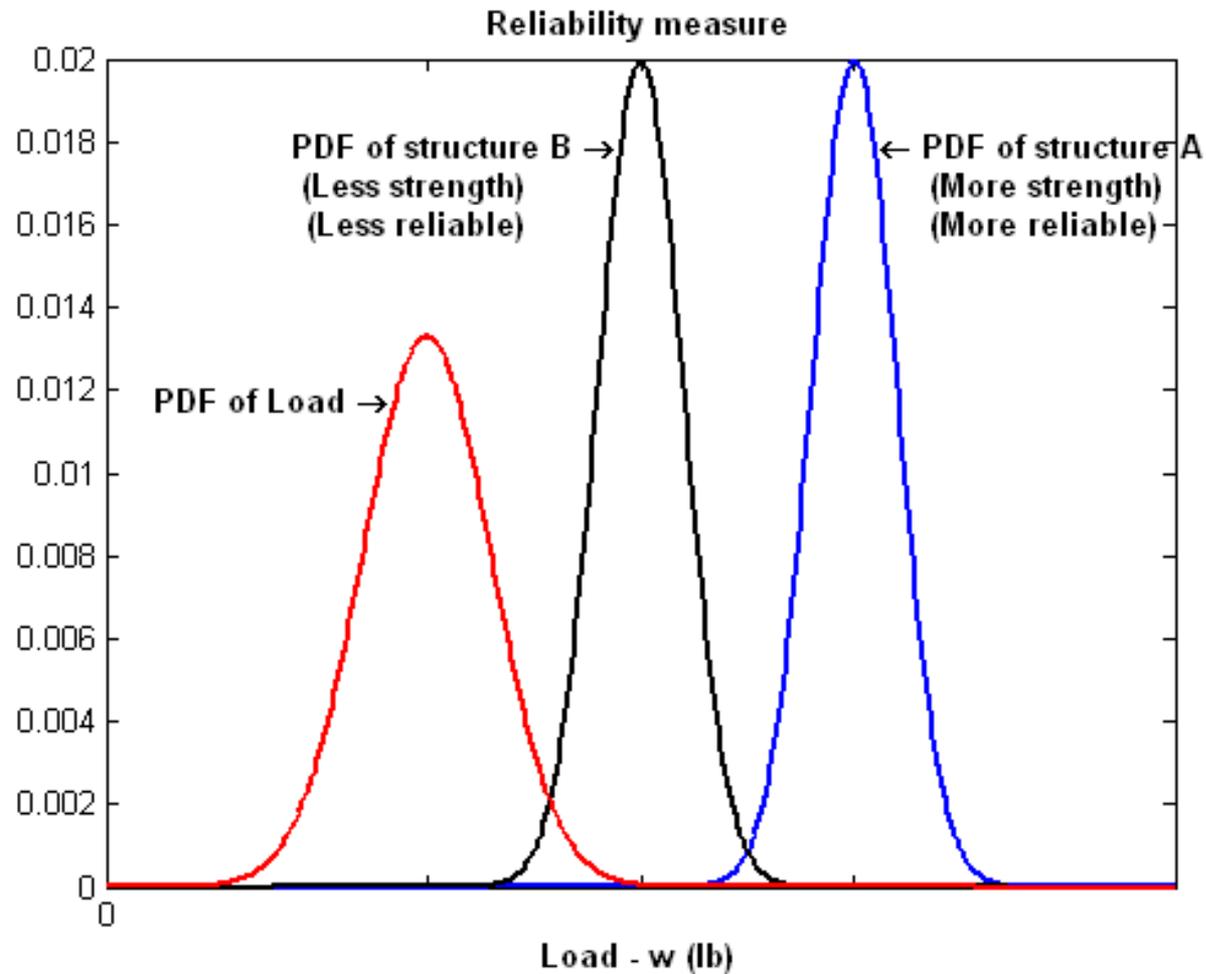
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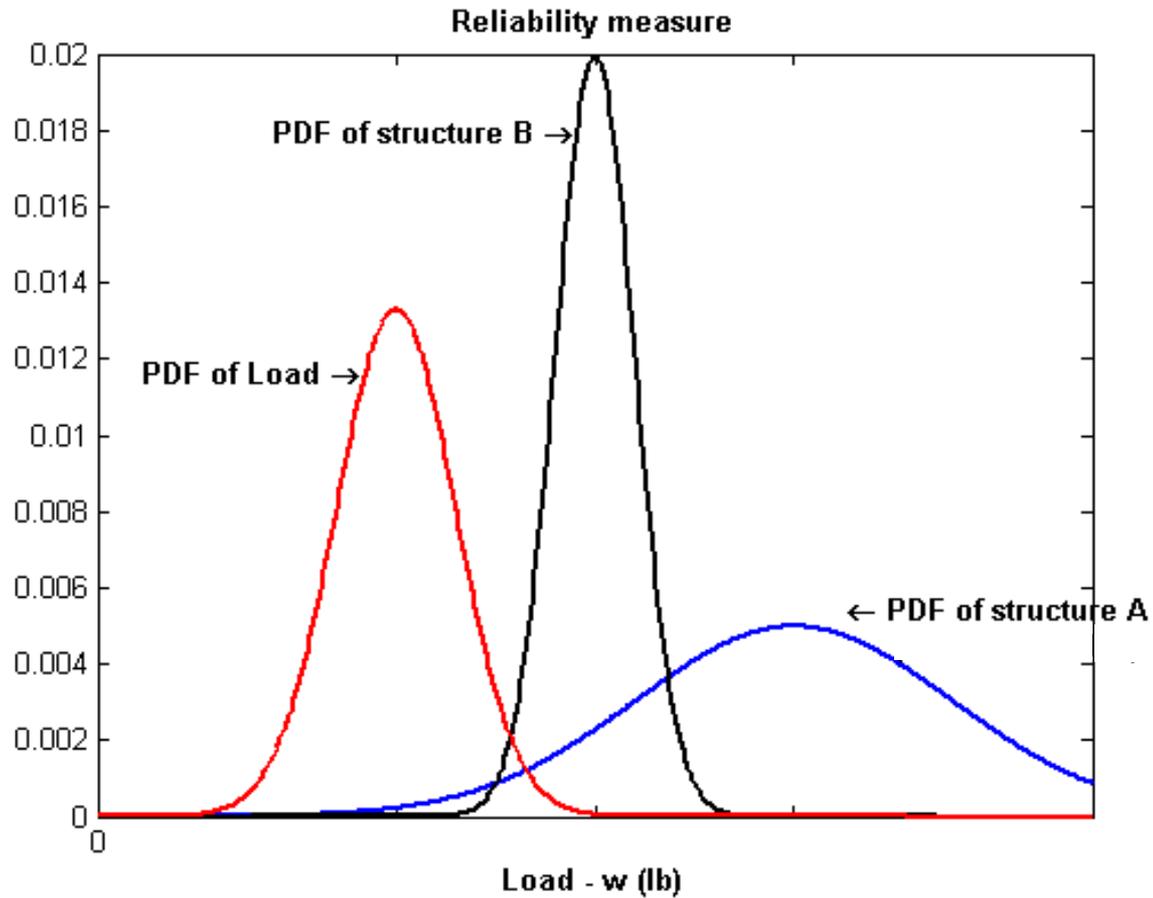


Reliability



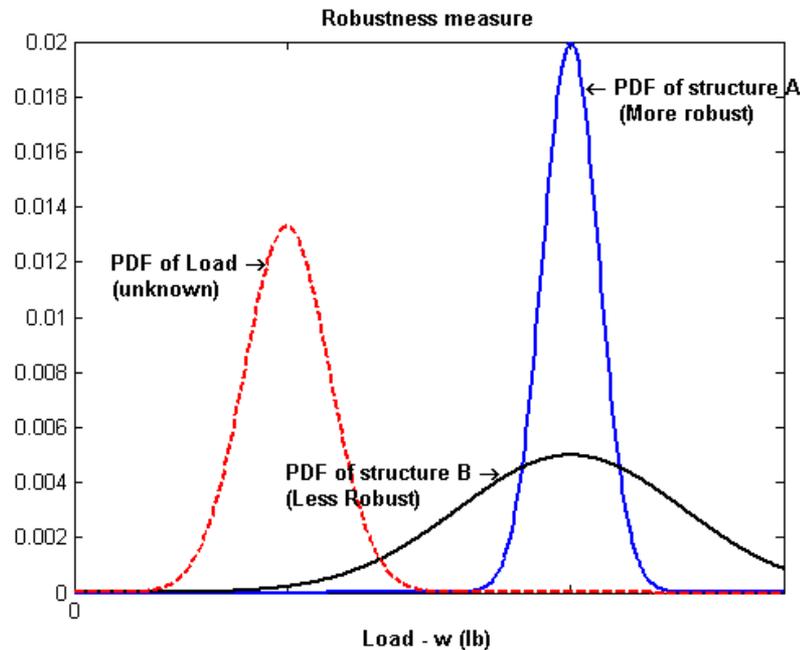


Reliability





In the absence of the loading...



Robust systems is system which is insensitive to small variations in input parameters



What is robustness?

