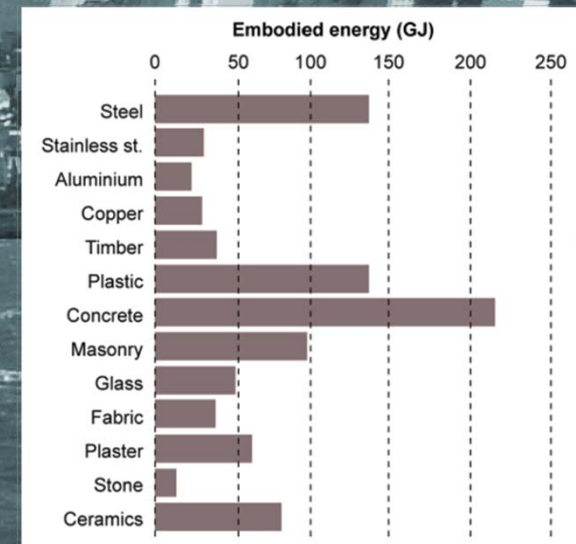
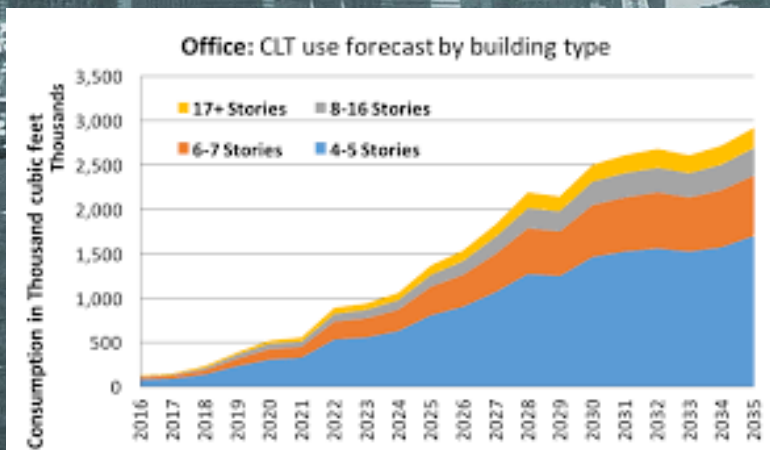
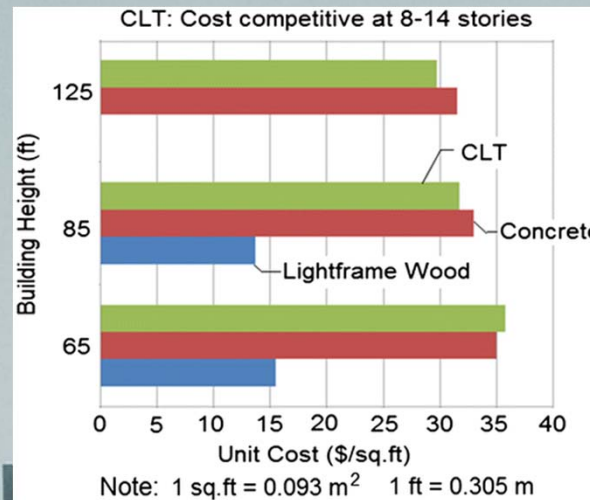
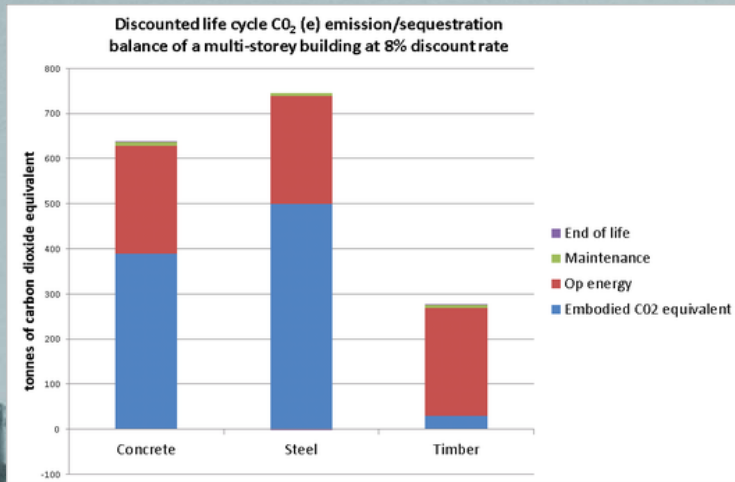


Quantifying Concrete Resilience



Evan Reis, SE

Sustainability has largely been defined in terms of CARBON



Concrete industry research and “sustainability”



- *CO2 and the Concrete Industry: Cement and Concrete as a Carbon Dioxide Sink – PCA*
- *Cement Producers Are Developing a Plan to Reduce CO2 Emissions – Scientific American*
- *UCLA researchers turn carbon dioxide into sustainable concrete – UCLA*
- *Concrete CO2 Fact Sheet – NRMCA 2012*
- *Case Studies of CO2 Utilization in Concrete – ACI 2015*
- *Life Cycle Assessment of Structural Concrete... “the environmental impact of concrete structures” – ACI 2018*



Resilience Is different than "Green Design"

LEED certified buildings in Superstorm Sandy were designed to have a low impact on the environment...

...but not for the environment to have a low impact on them.



Superstorm Sandy	
Deaths	>200 in 7 countries
Buildings damaged or destroyed	380,000 in NY, NY, CT
Estimated cost	\$71 billion in NY & NJ.
Insured losses	\$16 billion to \$22 billion.
Estimated business losses	\$25 billion
Homes without power	8.5 million
Debris generated	> 10 million cubic yards

Sustainability is more than eliminating carbon



RESILIENT
SAN FRANCISCO

PlaNYC

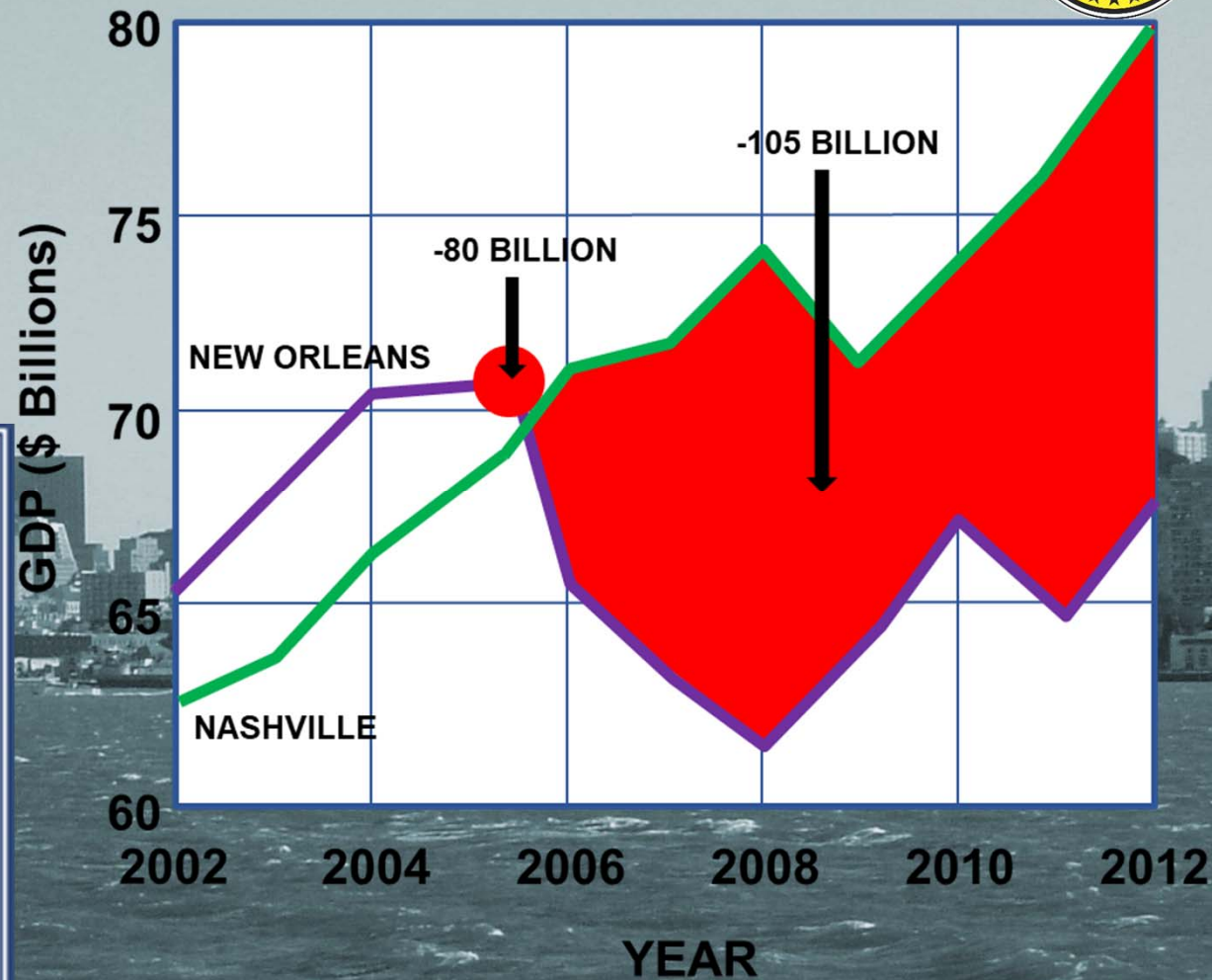
Buildings
Water
Telecommunication



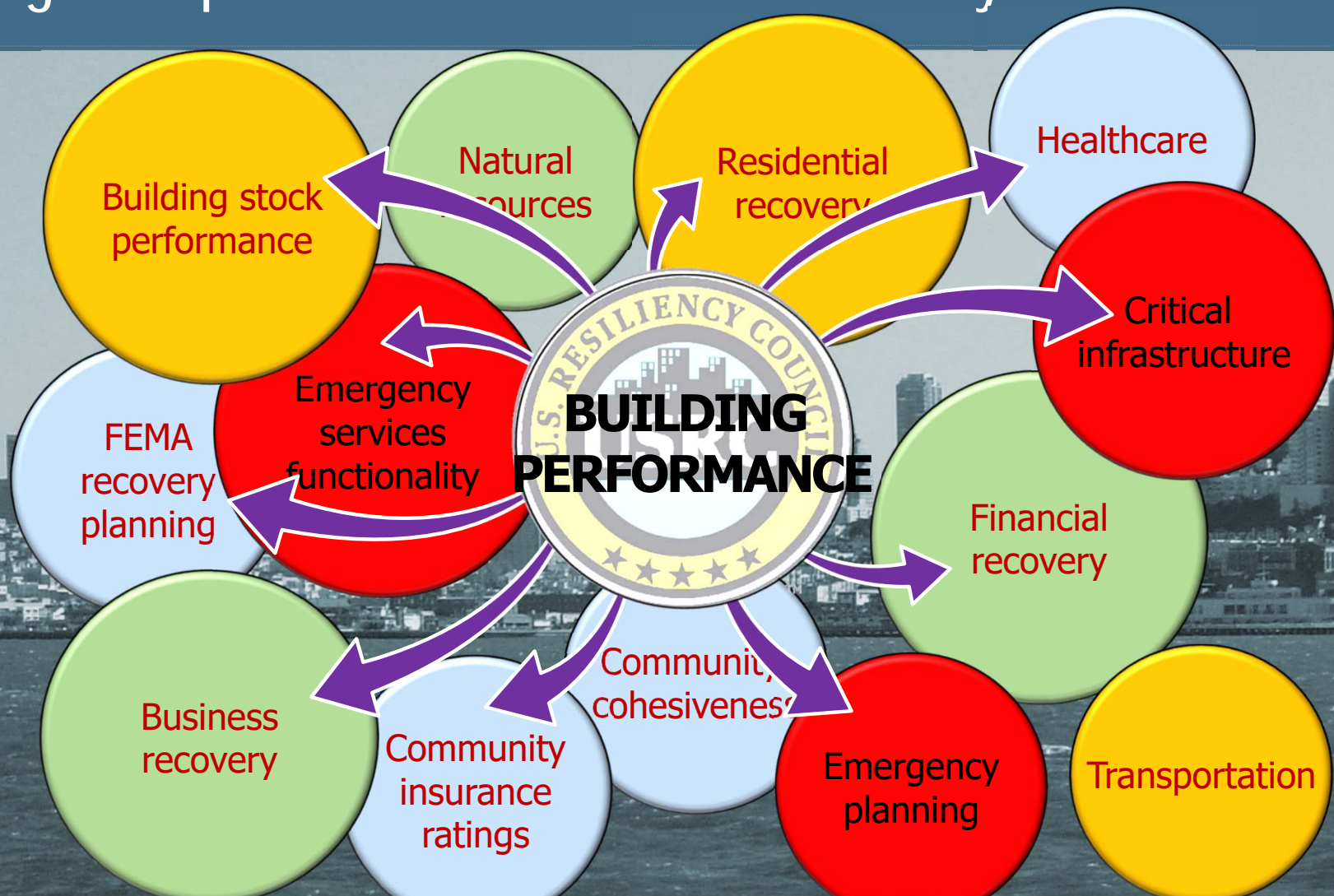
Presidential Policy
Directive-8/PPD8



March 30, 2011



Buildings As part of a resilient community



Benefits of mitigation and enhanced design



A public/private partnership designed to reduce the economic & social costs of natural hazards



the MMC is a council of the
National Institute of Building Sciences

NATURAL HAZARD MITIGATION SAVES: An Independent Study to Assess the Future Savings from Mitigation Activities

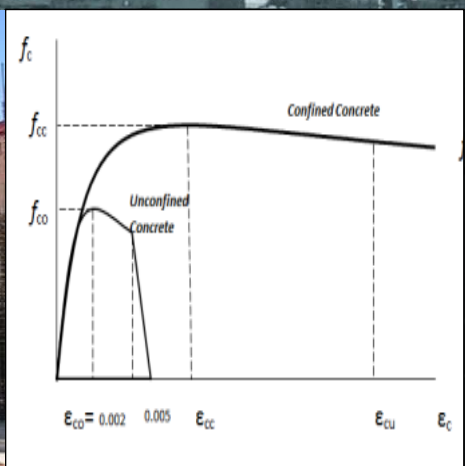
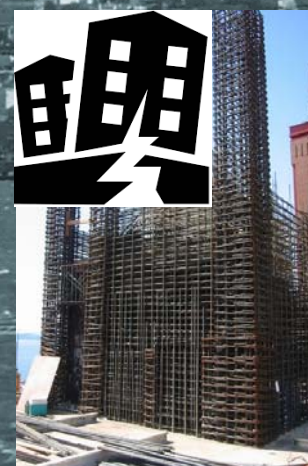
Federal grants can save the nation, on average, \$6 in future disaster costs, for every \$1 spent on hazard mitigation.

Investments in hazard mitigation measures that exceed 2015 model building codes can save the nation, on average, \$4 for every \$1 spent.

Implementing these strategies would prevent 600 deaths, 1 million injuries and 4,000 cases of (PTSD) in the long term.

In addition, designing new buildings to exceed the 2015 codes would result in 87,000 new, long-term job.

Concrete's unique multi-hazard resilience



The Bullitt Center - Seattle



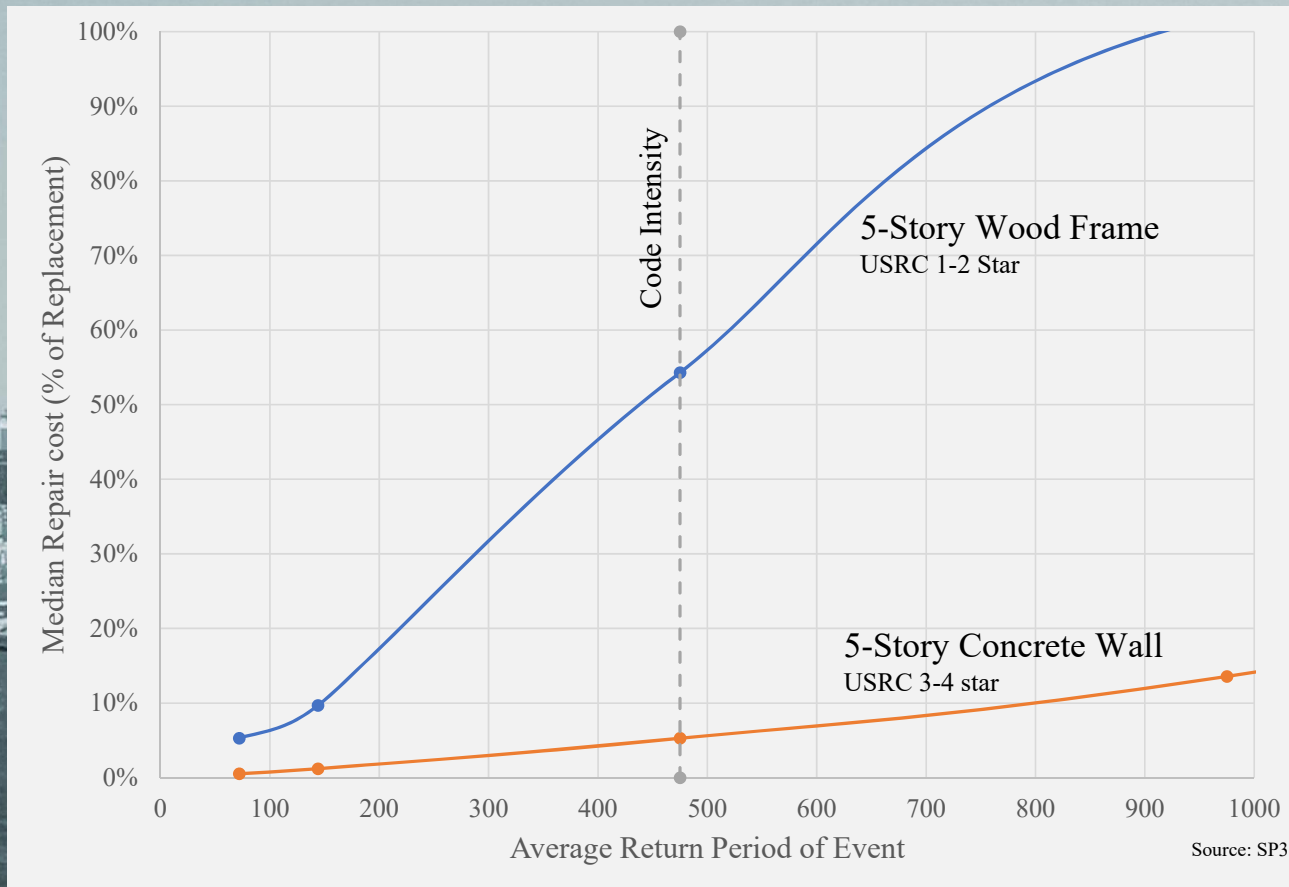
“THE GREENEST COMMERCIAL BUILDING IN THE WORLD”

“250 years: Lifespan of the building”

“The Bullitt Center is designed to show what’s possible, increasing the pace of change in the movement toward high performance green buildings and resilient cities.”




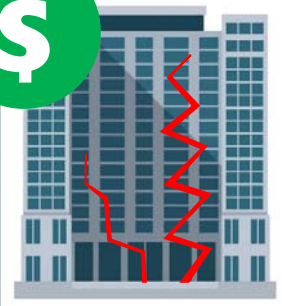




State of the art performance metrics





US Resiliency Council performance metrics

USRC BUILDING RATING SYSTEM	 	 	 
	SAFETY	DAMAGE	RECOVERY
★★★★★	Blocking exit paths unlikely	Minimal Damage (<5%)	Immediate to Days
★★★★★	Serious injuries unlikely	Moderate Damage (<10%)	Within days to weeks
★★★★	Loss of life unlikely	Significant Damage (<20%)	Within weeks to months
★★★	Isolated loss of life	Substantial Damage (<40%)	Within months to a year
★	Loss of life likely	Severe Damage (40%+)	More than a year

CODE BASED DESIGN

RESILIENCE BASED DESIGN



+0-5% Cost

Modern Codes



Case study: 4-story mixed-use office building



- **4-story, +/- 82,000 sf**
- **Civic office building with space for community college and retail**
- **Code-based design**

Safety ★★★★★

- Conditions unlikely to cause injuries or to keep people from exiting the building.

Damage ★★★★★

- The mean repair cost is less than 5% of building replacement cost.

Recovery ★★★★★

- The median recovery time to regain basic function is less than one week.

Case study: 9-story affordable housing



- **9-Stories**
- **Low income housing**
- **Reinforced concrete**
- **Rocking foundation**

Safety ★★★★★

- Conditions unlikely to cause injuries

Damage ★★★★★

- The mean repair cost is less than 10% of building replacement cost.

Recovery ★★★★★

- The median recovery time to regain basic function is less than one month.



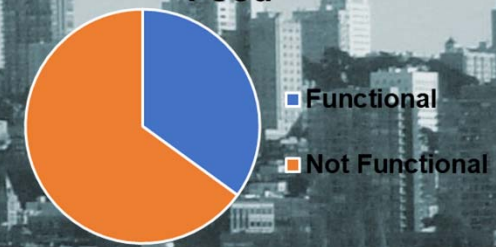
Community design guidelines



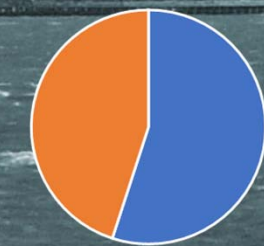
Housing



Food



Schools



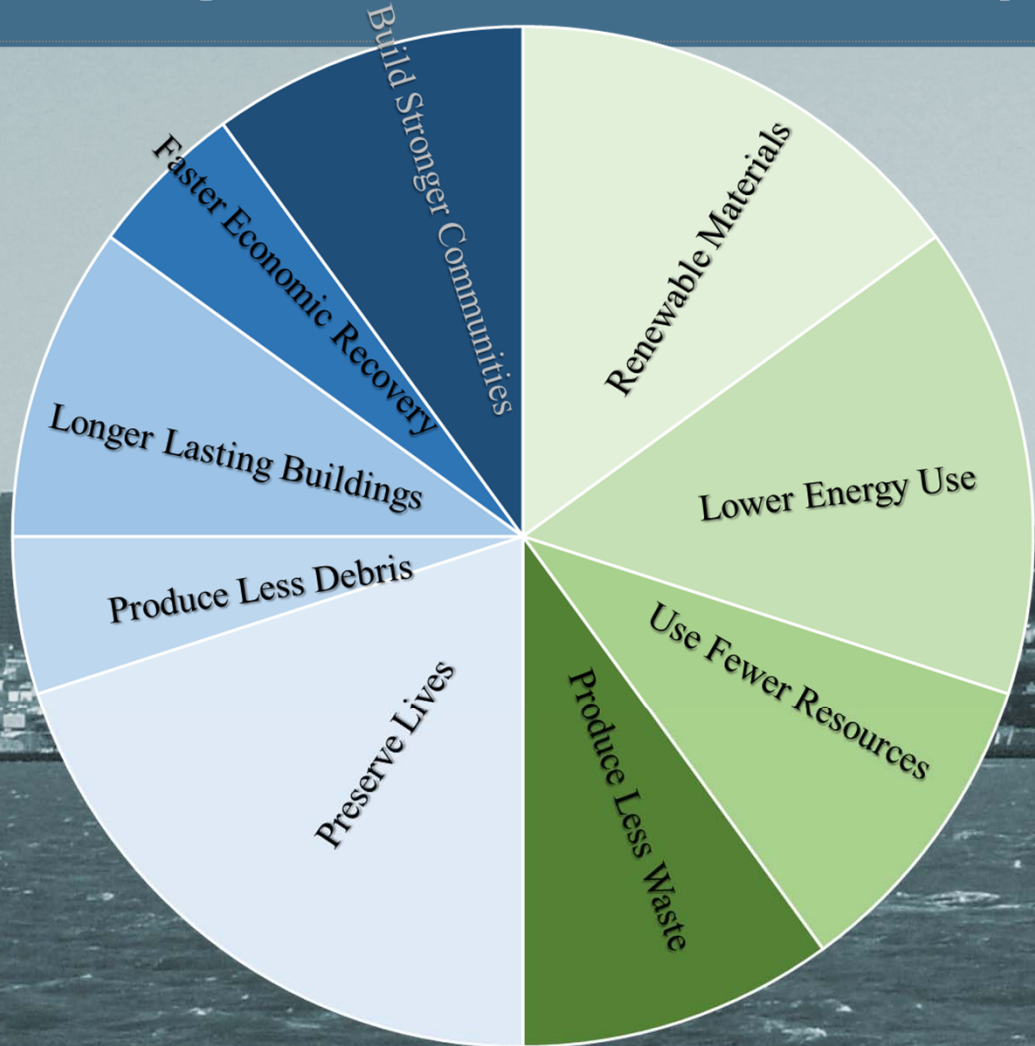
USRC collaborations



- *MIT Concrete Sustainability Hub - Planning More Resilient Cities*
- *Alliance For National and Community Resilience – Resilience Benchmarks*
- *USRC Members include: PCA, PCI, NRMCA, Cal Portland, CNCA, NCC/PNBRC, BASF, Clark Pacific, CMACN*
- *USRC - Concrete Industry Partners Committee*
- *Applied Technology Council Building Wildfire Rating System*
- *Pilot project with Fannie Mae on resilient mortgages for multi-family construction*



"Green" and resilient design - two sides of sustainability



Firing with both barrels – a strategy for resilience



- *Understand the place that buildings have in community, corporate and family resilience*
- *Quantify the social and economic returns of resilient design to all stakeholder groups*
- *Expand LCA to consider the reduction in Nat Cat impacts from resilient design*
- *Calculate expected building costs to achieve higher performance levels*



Thank You

www.usrc.org