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FIRE AFTER EARTHQUAKE RISK MANAGEMENT

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Snímek 2

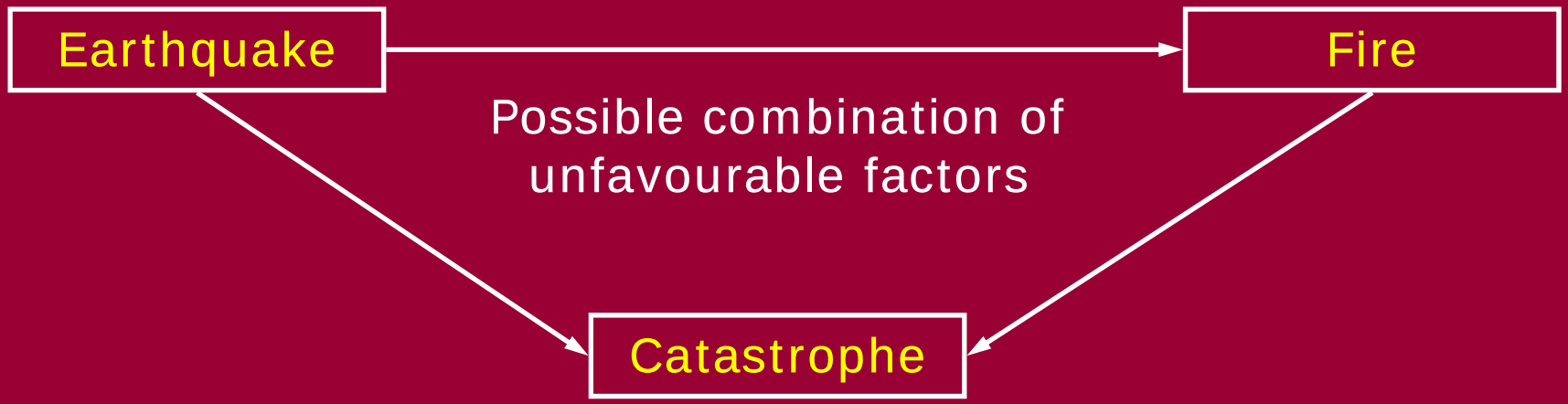
ME1 In ogni diapositiva inserisci una o più immagini di un incedndio catastrofico post terremoto

Matteo Esposto; 10.10.2008

The Fire After Earthquake hazard

General

One of the most concerning earthquake-related hazards in urban areas



In some cases the damage due to Fire Following Earthquake is larger than the one due to the earthquake itself

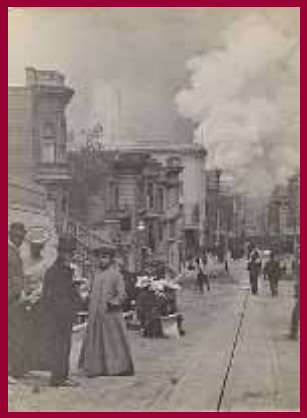
The Fire After Earthquake hazard

Main historical records (in the last Century)

Fire after 1906 San Francisco Earthquake

(Courtesy of The San Francisco Museum of Modern Art)

(The Bancroft Library)



The estimated fire-induced loss is 10 times larger than the one directly induced by the ground motion

The Fire After Earthquake hazard

Main historical records (in the last Century)

Fire after 1923 Tokyo Earthquake

(www.asc1996.com)

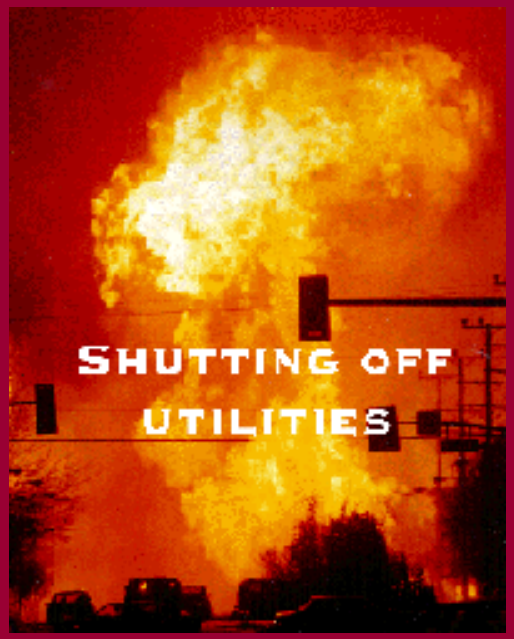
Three quarters of the lost buildings were destroyed by fires

(www.sosakuhanga.net)

The Fire After Earthquake hazard

Main historical records (in the last Century)

Fire after 1994 Northridge Earthquake



(Courtesy of Gene Blevins Action Photography (818) 787-7572)

The Fire After Earthquake hazard

Main historical records (in the last Century)

Fire after 1995 Kobe Earthquake

Almost 7000 buildings were destroyed by fire alone

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The FAE risk management

The Fire After Earthquake problem

Multi-sequential multi-situational components → Complex problem → Multi-disciplinary approach

Many subjects are involved in the risk management activity

- ✓ fire service
- ✓ local authorities
- ✓ utility organizations
- ✓ hazard informative services
- ✓ ...

The FAE risk management

How to face up the FAE hazard?

Usual way (past years): Response-based process

- Occurrence of earthquake + fire
- Intervention of specially trained disaster managers
- Coordination of the relief measures

New felt way (future?): Risk management process

- Preventive risk analysis and acceptability evaluation
- Identification of problems before their occurrence
- Set up of a systematic decision-making process for the identification of solutions to natural hazard-related issues (AS/NZS Risk Management Standard)

The FAE risk management

The main Risk Factors

In large urban areas prone to earthquakes

Direct earthquake effects	Damage, displacement of dangerous contents, fracturing of gas and/or electric connections…
Sources of ignition	Open fires, hot surfaces, boilers, short circuits from structural damage…
Establishment of fire	Fuel, failure of active suppression systems within buildings (like sprinklers)…
Spread of fire	High density of buildings, wind direction and velocity, damage to passive measures…
Detection/extinguishment	Uncertainty of fire location, impairment of fire brigade response, loss of water pressure…

The risk management approach

A two-scales approach

Regional scale

Building scale

(www.capurromrc.it)

The risk management approach

Building scale

Performance-Based approach

Code prescriptive requirements? → No (or not only) → Demonstration, by calculation, of the building capability to achieve the required safety performance

Possible main design objectives

- ✓ life safety of the occupants
- ✓ non-injury of the occupants
- ✓ life safety of fire fighters
- ✓ non-injury of fire fighters
- ✓ prevention of damage to contents
- ✓ avoidance of damage to process
- ✓ prevention of damage to building
- ✓ prevention of collapse of building

The risk management approach

Regional scale

Geographic Information Service (GIS)-Based approach

Decision support tool for assigning and routing optimization of emergency vehicles after earthquake

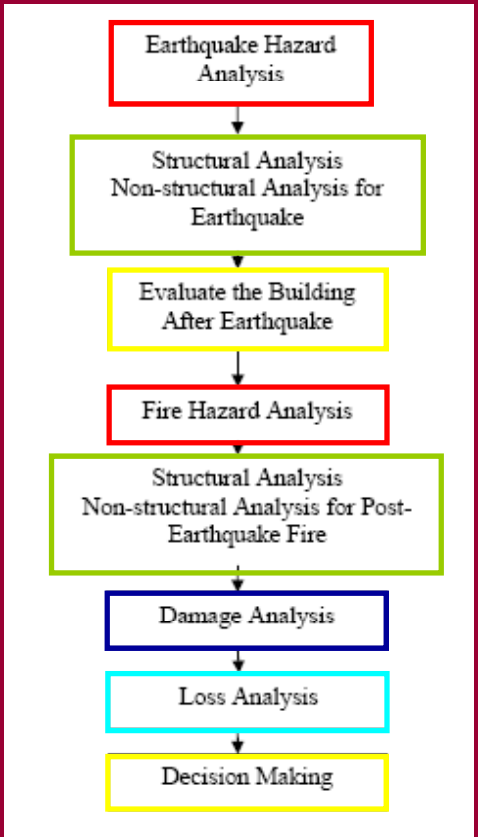
...taking into account:

- ✓ geographic distribution of ignited fires and injuries
- ✓ locations of emergency response facilities
- ✓ earthquake damage to the facilities
- ✓ earthquake damage to the transportation system

Examples of application

Building scale: PBD applied to single buildings

Chen et al. (2004)



FOUR MAIN PHASES:

1. Hazard analysis
2. Structural and non-structural analysis (repeated after the fire)
3. Damage analysis
4. Loss analysis

Examples of application

Building scale: PBD applied to single buildings

Johann et al. (2006)

Proposal of a framework for the integration of structural fire safety into the design of structures

Flowcharts

↓

Identification and organization of fire performance expertise

Five main activities:

1. Structural design for gravity and lateral loads
2. Consideration of member protection and events that change the structural configuration and details
3. Definition of design fire conditions within the building
4. Analysis of structural response to the design fire conditions
5. Evaluation of the acceptability of the predicted performance

Examples of application

Regional scale: risk management guidelines

AS/NZS 4360 (1999)

Outline of the risk management process

Main aspects:

1. Establishment of the strategic, organizational and risk management context
2. Risk identification
3. Risk analysis
4. Risk evaluation
5. Risk treatment
6. Monitor and review
7. Communication and consulting

Conclusive remarks

- ✓ An overview on the fire after earthquake risk assessment is shown
- ✓ The importance of a multi-disciplinary approach is underlined
- ✓ The necessity of considering both a regional and a building scale is pointed out
- ✓ The usefulness of the PBD approach for integrating the fire design in the structural one is stressed

Further developments

- ✓ With regard to the PBD approaches for single buildings, the suitable definition of performance criteria and design procedures has to be consolidated
- ✓ With regard to the GIS based regional approaches, the prediction of PGA-fire occurrence correlations should be refined

Main references

- ✓ Bennetts, I.D. and Thomas, I.R. (2002). Design of steel structures under fire conditions. *Progress in Structural Engineering Materials*, 4, 6-17.
- ✓ Chen, S., Lee, G.C. and Shinozuka, M. (2004). Hazard Mitigation for Earthquake and Subsequent Fire. *2004 ANCER Annual Meeting: Networking of Young Earthquake Engineering Researchers and Professionals*, Honolulu, Hawaii.
- ✓ Johann, M.A., Albano, L.D., Fitzgerald, R.W. and Meacham, B.J. (2006). Performance-based structural fire safety. *ASCE Journal of performance of constructed facilities*, 20:1, 45-53.
- ✓ Scawthorn, C., Eidinger, J.M. and Schiff, A.J. (2005). Fire following earthquake. *ASCE Publications*. ISBN: 0784407398.
- ✓Standards Australia and Standards New Zealand (1999). Risk Management AS/NZS3460, Sydney and Wellington.
- ✓Wellington Lifelines Group (2002). Fire Following Earthquake: identifying key issues for New Zealand.

Thank you for your kind attention…