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Risk Management in Intelligent Buildings
Case study: Faculty of Architecture, Shahid Beheshti University, Iran

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Abstract. Past experiences indicate that almost all of the universities in Iran are vulnerable to natural hazards, particularly earthquakes, and the occurrences of such disasters are inevitable. In this respect, planning and implementing a risk reduction program in order to mitigate the possible losses is an urgent task. Such programming would not only save lives, but could also prevent damage to universities' values and assets. Risk reduction strategies addressing non-structural elements are very flexible and can tailored to meet the changing needs of an incident. The present article was carried out in 2010 using qualitative and quantitative methods. The results show that strengthening the architectural, mechanical and electrical elements within the Faculty have a significant impact in reducing possible damage and human injuries after an earthquake.

This paper is set out in three sections. Firstly, it determines the related theoretical approaches by briefly reviewing the literature and establishing a conceptual framework; Secondly, it introduces the Faculty of Architecture and its physical vulnerabilities; Finally it recommends a number of non-structural solutions in order to reduce the possible risks in future.

Keywords: Faculty of Architecture, Risk reduction, non-structural elements, Iran.

1. Introduction

An intelligent building provides a sustainable, responsive, effective and supportive environment within which individuals and organizations can achieve their objectives. Technology is fundamental, but is an enabler rather than an end in itself. Although intelligent buildings are generally considered safe and healthy working environments, the indoor air quality problems, occupational illnesses and injuries, exposure to hazardous material and accidental falls requires architects, engineers and facility managers to design and maintain buildings and processes in order to ensure the safety and health of its occupants. Notably, building designs must focus on eliminating or preventing hazards to personnel, rather than relying on personal protective equipment and administrative or process procedures to prevent injuries.

Protecting the health, safety, and welfare (HSW) of building occupants has expanded beyond disease prevention and nuisance control to include the protection of mental health physical health and the ecological health through the creation of spaces that delight the occupants and enable them to realize their potential. Therefore, the design team must adopt an integrated approach, including work process analysis and hazard recognition to develop solutions that provide healthy built environments, having no undue physical stressors, as well as meeting other project requirements. In addition, consideration of HSW issues should be an integral part of all phases of a building's life cycle: planning, design, construction, operations and maintenance, renovation and final disposal.

The present paper aims to examine the effectiveness of buildings in terms of risk management and explores the wider context beyond theoretical foundations, linking practical solutions with sociological

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considerations. It is believed that there is no way to prevent the collapse of buildings following earthquakes. However, there are a number of non-structural solutions which may mitigate and reduce the effects of such a disaster. This paper introduce the risk reduction measures applied in order to strengthen the Faculty of Architecture and Urban planning, Shahid Beheshti University, situated in Tehran, Iran. The paper concludes that an integrated approach, of both software and hardware programming is required to reduce the possible damages following a disaster.

2. Study context

Intelligent buildings are ones in which the building fabric, space, services and information systems can respond in an effective manner to the demands of the owner, the occupier and the environment. Intelligent buildings are essentially about people, processes and systems. The interdisciplinary nature of the design and management processes is important, together with emerging methodologies and innovations such as smart materials, embedded systems and robotics. Evaluation tools are applied in an integrated and holistic manner. Lessons from natural and vernacular architecture will also feature. In this regards, a number of issues should be addressed such as, understanding how the built environment affects people's well-being, sustainable design and management, automation and innovative systems and approaches to design. The effort to cope with the complex nature of disasters such as earthquakes, its successes and failures encompasses lessons valuable both to Iranian and international bodies who have to deal with disastrous situations. To document and analyze the experience, an inter-disciplinary study has to be conducted which would take into account the pre- and post-earthquake periods, and would examine the existing strengths and persisting weaknesses in earthquake preparedness and mitigation in the Faculty of Architecture. The study should examine the following questions:

- How can we prepare an appropriate risk reduction strategy in the Faculty of Architecture?
- To what extent may strengthening policies increase risk reduction and disaster prevention capabilities?
- What sorts of risk reduction measures are required within the non-structural and management plan of the University?

FEMA (2005) studies risk reduction from the view of both organizational and non-structural elements [1]. In terms of the organizational approach, four are required to reduce the possible risk within buildings, including "organize resources, assess risks, develop a mitigation plan and implementation plan and monitor progress. Regarding non-structural elements, it argues that if such element were to be fixed and strengthened in their places, the possible damage arising from them would be significantly mitigated. Risk reduction of non-structural measures includes:

- Providing designs that eliminate or reduce hazards in the work place to prevent injuries and reducing reliance on personal protective equipment.
- Preventing occupational injuries and illnesses.
- Preventing falls from heights.
- Preventing slips, trips, and falls.
- Ensuring electrical safety from turn-over through Operations and Maintenance. Modifications must be in conformance with life safety codes and standards and be documented.
- Eliminating exposure to hazardous materials (e.g., volatile organic compounds (VOCs) and formaldehyde, and lead and asbestos in older buildings).
- Providing good indoor air quality (IAQ) and adequate ventilation.
- Analyzing work requirements and provide ergonomic work places to prevent work-related musculoskeletal disorders (WMSD).
- Performing proper building operations and maintenance.

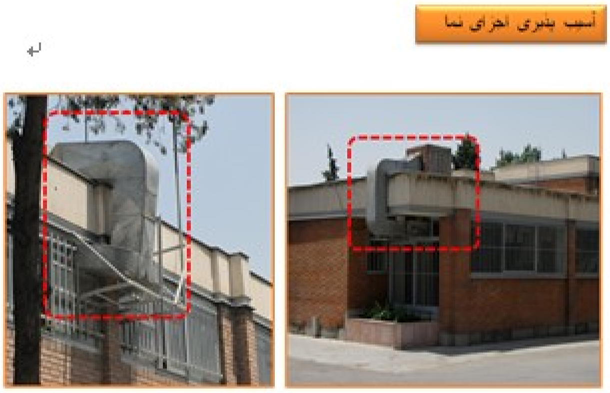
Supporting disaster response and recovery through improved situational awareness (SA) has recently been well documented [2]. It is claimed that a high level of situation awareness (SA) has the potential to enhance the first responder's performance and mange work demand resulting from the dynamic and chaotic situations which arise from a disaster in modern urban environments. The authors argue that an integration of information technology and civil engineering components is required. The authors conclude that SA is very relevant to ensuring how much a current disaster response system is effective cognitively and physically effective and also how well disaster response systems support risk reduction at both strategic and operational levels. In addition, the improved role of civil engineers and information technology components to collect, analyze and share information must not be underestimated.

3. Faculty of Architecture

Located in the north of Iran's Capital City of Tehran, the Shahid Beheshti University lies on *Albors* mountain range. Despite its unique location and landscape, one of the major seismic fault-lines passes close to the campuses. The Faculty of Architecture and Urban Planning is the oldest and one of the most important buildings in the university. A study in 2010 was undertaken by the author in order to develop a risk reduction plan against future earthquakes. A combination of qualitative and quantitative research methodology was applied to explore the possible risk reduction solutions. All together, there are some 280 undergraduate, 400 masters and 45 doctoral students in the Faculty. In addition, there are about 99 academic staff and some 45 in providing services and administrative duties. A closed ended questionnaire was designed to find out the viewpoints of all the mentioned people with the Faculty towards risk reduction. Furthermore, a number of in-depth interviews were conducted with the mangers of the Faculty including the head, deputies and all directors of post-graduate levels. Such interviews assisted the researcher to extent his insights towards developing a disaster plan.

3.1. Non-structural vulnerabilities

Due to the age of building, there are a number of physical vulnerabilities. The following photos illustrate that opening direction of exit doors, metal barriers on windows, locking on exit doors, physical weakness of facades, mechanical and electrical instability.



❑ تاسیساتی مانند کولرهای آبی به درستی به سازه متصل نشده اند و در هنگام زلزله ممکن است سقوط کنند.

❑ تاسیسات(تابلو برق، لوله های آب ، کانال کولر، رک کامپیوتر و ...) دیوکار و غیر استاندارد و آسیب پذیر در برابر سانحه .

4. Recommendations

- Provide designs in accordance with best practice as well as designs that comply with applicable building, fire, safety regulations and health codes.
- Conduct preliminary hazard analyses and design reviews to eliminate or mitigate hazards in the Faculty.
- Use registered design professionals and accredited safety professionals to ensure compliance with safety standards and codes.
- Provide and implement engineering controls rather than rely on personal protective equipment or administrative work procedures to prevent injury.
- Integrate safety mechanisms, such as built-in anchors or tie-off points into the building design, especially for large mechanical systems.
- Design a means for safely cleaning and maintaining interior spaces and building exteriors.

4.1 Prevent Falls from Heights, Slips, Trips and Ensure Electrical Safety

- Provide guardrails and barriers that will prevent falls from heights in both interior and exterior spaces.
- Provide fall protection for all maintenance personnel especially for roof-mounted equipment such as HVAC equipment and cooling towers.
- Provide certified tie-off points for fall arrest systems.
- Provide interior and exterior floor surfaces that do not pose slip or trip hazards.
- Select exterior walking surface materials that are not susceptible to changes in elevation as a result of freeze/thaw cycles.

- Provide adequate natural and artificial illumination for all interior and exterior areas [3].
- Provide adequate space for maintenance, repair and expansion in electrical rooms and closets.
- Provide adequate drainage and/or containment from areas with energized electrical equipment.
- Evaluate all areas where ground fault circuit interruption (GFI) and arc fault interruption (AFI) devices may be needed.
- Consider response of emergency personnel in cases of fires and natural disasters.
- Label all electrical control panels and circuits.
- Install non-conductive flooring at service locations for high voltage equipment. [4]

5. References

[1] FEMA, *Earthquake Hazard Mitigation for Non-structural Elements*. FEMA 74-FM / September 2005.

[2] J. Son, Z. Aziz, and F. P , Mora, Supporting disaster response and recovery through improved situation awareness, *Structural Survey*, *Emerald*, 2007, **36** (5), 411-425.

[3] WBDG Secure/Safe Committee, *Ensure Occupant Safety and Health,* 2010, ...

[4] P. I Kaneshiro and E.Villani, Modeling of Fire Protection Systems In *Intelligent Buildings*, ABCM Symposium Series in Mechatronics, 2006, **2** (1), 337-344.