Architecture & Urban Research Institute

auri research brief

No. 63

Kim, Eunhee
Research Fellow

Building Safety Risk Assessment and Management Tool

Despite the various efforts to prevent accidents related to building safety, structure collapse, fire, and other major construction-related accidents occur continuously. In the past 10 years, more than 25,000 cases out of the annual average of 40,000 fire incidents in buildings (over 60%) occurred, and this trend is continuing. Structure collapse has also increased rapidly since 2009, reaching an annual average of 344 cases. Recently, as remodeling of old buildings increases, accidents in the construction process are also increasing, directly or indirectly caused by neglected safety assessments or poor site management.

Due to abnormal climate conditions such as global warming, human and property damages are also increasing due to heavy rain, strong winds, and typhoons. In 2011, the cost of damage caused by torrential rain exceeded 500 billion won, and in 2012 this amounted exceeded 900 billion won as the frequency of typhoons increased as compared to previous years. Recently, the general public is in fear of more frequent earthquakes, and in 2018, energy use skyrocketed due to record heatwaves. These natural disasters may negatively impact accidents occurring in old buildings. In particular, buildings that have been rapidly developed to support economic growth, may be exposed to even graver danger as it faces various external risk factors in its deterioration.

Considering that buildings older than 20 and 30 years account for almost 85% and 35%, respectively, out of the whole 7.2 million building stock in South Korea as of 2019, there is a serious need to reconsider building safety in general. In particular, buildings that are older than 30 years were built before 1988, prior to the implementation of seismic design standards. Hence, the safety management of these buildings requires special attention. Also, 85% of the total number of buildings are small-scale buildings with less than 500㎡ area, which lack safety management systems, calling for an overall improvement of building safety. As such, old and small buildings, compared to medium to large buildings, are subject to poor safety management.

Fundamentally, building safety management needs to be implemented differently according to various building planning conditions and its construction process, building use, and management methods. Recent literature regarding a spatial and environmental safety management system argues for prioritizing high-risk facilities and its risk management, and applying differentiated measures corresponding to the facilities. Building safety management should also be differentiated by risk level from the initial design stage to the building use stage, and appropriate safety management measures need to be applied. In particular, the internal conditions related to building safety (e.g., building use, size, floors, structure, and building age), as well as external conditions of building users, local and surrounding environment need to be comprehensively considered in building safety management. Furthermore, the effic nt operation of management also needs to be considered in relation to the current building safety management system.

This study suggested the Risk Assessment and Safety Determining Tool (RAST) as an objective tool to diagnose the risk level of buildings and to offer safety management directions. The risk level of buildings was measured based on aspects that determine the building characteristics, such as building use and size, structure and finishes, the site environment, and building age. Based on the risk index and safety management index, RAST determines the safety management level and safety management index, and helps to establish a management plan according to the results.

[Table] The RAST Sheet and How to Use it

Risk level		Level 1	Level 2	Level 3	Level 4
		less than 40	more than 40 less than 50	more than 50 less than 60	more than 60
Safety management index	Residential	-	-	more than 60.25	66.25
	Non-residential	-	-	more than 67.84	more than 75.34

Main category		Subcategory	Safety performance using 7 point Likert scale (Safety performance low)						(Safety performance high)	Building A
			1	2	3	4	5	6	7	Score
Occupants (type, composition, circulation)		Main users (general, children, elderly, women, disabled persons, etc.)	0	0.97	1.93	**2.90**	3.87	4.83	5.80	**4.83**
		Resident density	0	0.77	1.53	**2.30**	3.07	3.83	4.60	**3.83**
		Mobility (mobile convenience)	0	0.85	1.70	**2.55**	3.40	4.25	5.10	**4.25**
Building structure		Structural type	0	0.85	1.70	**2.55**	3.40	4.25	5.10	**2.55**
		Seismic design adherence	0	0.83	1.67	**2.50**	3.33	4.17	5.10	**2.50**
		Changes including extension, major repair, etc. or its possibility	**0**	0.75	1.50	**2.25**	3.00	3.75	5.00	**0**
		Roof structure	0	0.62	1.23	**1.85**	2.47	3.08	4.50	**1.85**
Finishing material		Building interior finishes	0	0.98	1.97	**2.95**	3.93	4.92	5.90	**5.90**
		Building exterior finishes	0	0.83	1.67	**2.50**	3.33	4.17	5.00	**2.50**
		Roof finishes	0	0.68	1.37	**2.05**	2.73	3.42	4.10	**2.05**
Evacuation facilities and space	Evacuation facilities	Corridor (evacuation route)	0	0.20	0.40	**0.60**	0.80	1.00	1.20	**0.80**
		Installation of direct stairs	**0**	**0.22**	0.43	**0.65**	0.87	1.08	1.30	**0.22**
		Evacuation, special evacuation, installation of outdoor evacuation stairs	**0**	**0.23**	0.47	**0.70**	0.93	1.17	1.40	**0.23**
		Installation of exit to the outside of the building	**0**	**0.20**	0.40	**0.60**	0.80	1.00	1.20	**0.20**
		Installation of a rooftop, etc.	**0**	**0.17**	0.33	**0.50**	0.67	0.83	1.00	**0.17**
		Installation of fire compartments, fire doors, and fire sets	0	0.22	0.43	**0.65**	0.87	1.80	1.30	**1.08**
		Safe basement structure	0	0.18	0.37	**0.55**	0.73	0.92	1.10	**0.73**
		Evacuation safety area	0	0.20	0.40	**0.60**	0.80	1.00	1.20	**1.00**
		Living room ceiling height, lighting, and ventilation	**0**	**0.17**	**0.33**	**0.50**	0.67	0.83	1.00	**0.33**
		Emergency elevator installation, platform and structure	**0**	**0.18**	**0.37**	**0.55**	0.73	0.92	1.10	**0.37**
	Fireproof structure	Fireproof structure	0	0.85	1.70	**2.55**	3.40	4.25	5.10	**2.55**
		Firewall, etc.	0	0.37	0.73	**1.10**	1.47	1.83	2.20	**2.20**
	Building equipment	Installation of exhaust ventilation	0	0.77	1.53	**2.30**	3.07	3.83	4.60	**4.60**
		Installation of forced drainage system	0	0.30	0.60	**0.90**	1.20	1.50	1.80	**1.50**
Fire safety equipment	Fire safety facility	**Alarm system** (alarm type detector, fire detector, etc.)	**0**	**0.37**	0.73	**1.10**	1.47	1.83	2.20	**0.37**
		Fire extinguisher (sprinklers, outdoor fire hydrant, etc.)	**0**	**0.42**	0.83	**1.25**	1.67	2.06	2.50	**0.42**
		Water fire extinguisher and fire extinguishing facilities	0	0.33	0.67	**1.00**	1.33	1.67	2.00	**1.33**
		Evacuation instrument	0	0.33	0.67	**1.00**	1.33	1.67	2.00	**1.33**
		Lifesaving equipment	0	0.28	0.57	**0.85**	1.13	1.42	1.70	**0.85**
		Evacuation guidance lights, signage, emergency lights, portable emergency lights, etc.	**0**	**0.33**	0.67	**1.00**	1.33	1.67	2.00	**0.33**
Site and road		**Site and adjacent site grounds**	**0**	**0.73**	1.47	**2.20**	2.93	3.67	4.00	
		Unused areas within the site	0	0.72	1.43	**2.15**	2.87	3.58	4.30	
		Road and emergency routes	0	0.77	1.53	**2.30**	3.07	3.83	4.60	**2.30**
Sum										**54.47**

Comparison - insufficient

The risk index consists of 7 categories and 41 sub-categories that directly or indirectly impact safety levels, which was devised based on the current legal system, literature, and overseas case studies. The safety management index is a planning element that ensures the safety performance of buildings, and is an independent tool to prevent building-related danger, which has also been devised by considering related legislation, detailed standards, and overseas safety management components. The safety management index consists of 6 categories (i.e., occupants, building structure, external finishes, evacuation facilities and spaces, fire safety facilities, and site and roads) and 33 sub-categories.

In the case of risk level, the majority of buildings in South Korea are graded at levels 3 to 5. Hence, the initial risk level was limited to this category in this study. Based on a conducted risk simulation regarding the entire 440,000 buildings in Seoul, the study identified a significant result range to confirm the grading of 4 levels. The safety management index is the sum of the safety management index values according to its significance. The safety management index was devised by assigning weights to the 6 safety management categories and the opinions of experts. Different standards need to be applied for different risk levels. For the low-risk 1 and 2 facilities, the current system was deemed sufficien and thus, a separate safety management index was not given. For buildings of risk levels 3 and 4, the safety rate was applied, and a safety management index was given for over 60.25 and over 66.25, respectively, for residential buildings, and over 67.84 and over 75.34, respectively, for non-residential buildings.

If RAST is used, it is easy to intuitively judge the risk level and safety conditions of buildings and to identify the vulnerable elements. As a result, safety management efficiency and accuracy can improve based on the proper analysis of problems and help devise appropriate countermeasures. In particular, a building risk level can be easily determined by entering basic building information, and the results can be checked conveniently. Furthermore, as level 1 and level 2 buildings are excluded from safety management measures, a focused management on high-risk buildings is possible.

Keywords : RAST(Risk Assessment and Safety Determining Tool), Risk Level, Safety Management Index

(a u r i) Architecture & Urban Research Institute

Publishing Organization Architecture & Urban Research Institute
Publisher Park, Sohyun
Address #701, 194, Jeoljaero(Eojin-dong), Sejong, Republic of Korea
Tel +82-44-417-9600 **Fax** +82-44-417-9608 www.auri.re.kr