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IDENTIFICATION OF LEAKAGE SYNDROME TOWARDS THE SUSTAINABILITY OF RESIDENTIAL BUILDINGS IN MALAYSIA

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ABSTRACT

Tropical nature of Malaysian region suggests that building of this region should be capabled enough to resist the humidity and condensation. The high proportion of annual rain fall in the region makes its building vulnerable to dampness and affects its sustainability. Water leakage problems in most buildings have always been an issue in the daily activities. Until today, continuous remedial works are done to solve this problem. The leakage syndrome is like uncontrollable disease, once it occurs in building at post occupational stage it is almost impossible to get rid of it. The resulting leakage types and its various forms attack the buildings from all sides i.e. from roof to bottom of building and its different form within building envelope and its enclosure. Residential buildings are among major affected building by this syndrome and consume bulk of exchanger on the maintenance of defects caused by building leakage. Unfortunately, the building with such conditions always emerges as the financial burden on the state or quarters concerned. Even in some cases in Malaysia, the maintenance cost of such building reaches at the level of total construction cost. The purpose of this paper is to identify the leakage types, causes of leakage and the affected leakage areas in high rise residential buildings as an earliest action for maintaining the building sustainability.

Keywords: *leakage syndrome, sustainability, dampness, maintenance, residential buildings*

INTRODUCTION

Building design and its architecture varies form region to region and most important factors which always influence the design is regional considerations. Regional consideration ranges from local customs, sociology, climatic conditions and availability of materials and local building techniques. In this regard, it could be mentioned that building design requires an expert assessment of all design consideration before moving the design scheme towards building process. Functional design is the only way to prevent the building form getting defective or failure at post occupational stage.

Leakage syndrome happened not only in old building but also new building. There are various type of leakage such as rising damp, condensation, water penetration and water entrapment. Water seepage results mainly from poor construction design, inferior materials, poor workmanship and deterioration of building materials. The misuse of sanitary fittings and improper maintenance of sewer piping system may result in water seepage. It is more the failings in the frame of systems that control their activities rather than the individual that to blame for the defects. Poor construction practices of the contractor like the use of damaged formwork and its early removal, failure to remove entrapped water and poor execution of waterproof membranes could cause defects in the completed building. Due to all the factors, water leakage will happen and caused dampness to the building (Keith, 1982).

Generally, leakage in building is cause by few possible factors; it can be seen from different angles, such as the environment factor, non-suitable design, poor workmanship and lacking of maintenance. Even though there are plenty of factors which will cause leak in a building, the main factors which always contribute to leak is faulty design, poor workmanship and natural factor. Non-standard specification is also known as one kind of faulty design (Briffett, 1985).

Leak is created from accidental hole or crack or fissure that can allow water to enter or escape from the spaces of a building in any way (The American Heritage® Dictionary of the English Language, 2000). Leaks in building can be caused by dampness, water spillage and leaks, condensation, water entrapment, water

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penetration and rising dampness. The following lists are the common spaces in a building affected by these kinds of leakage; basement, garden, toilets, kitchens, bathrooms, shop lots, offices, work spaces and others. The buildings structures commonly have to deal with water leaks are from below to the top of the concrete ground slabs, walls (including the openings' frames such as doors and windows), ceilings and the roof structures (Richardson, 1995).

Walls leak because water passes through them from the outside to the inside in a manner determined to be potentially damaging to the fabric or the contents, or that impacts the comfort of the occupants. For a leak to occur, three conditions must be in place: water at the exterior surface, a motive force top moves it through the wall, and sufficient time to transport the fluid. Most water enters the building through joints between materials or at junctures of change in geometry. Small streams indicate two things: water coming through cracks or holes or spills through the openings of the wall head (Samuel, 2001).

Research done by Mendell.et.al (2006) stressed that excessive moisture in building is caused by water leaks in the building envelope, plumbing, inadequate controlling of humidity in the outdoor air brought in by the HVAC systems or infiltration of water vapor through building fabric. Chew and DeSilva (2003) studied the building maintenance problems with high-rise residential buildings in Singapore. They found that leakage was the most significant problem, accounting for a full 46.59 percent where ceiling leakage (36.20 percent) and service pipe leakage with corrosion (10.39 percent) of all (nine) problems identified.

In case of Malaysia, these residential buildings present the conditions which suggest that ample consideration has not been given to regional factors at design stage. In failure of such, results in the form of accumulating dampness and other leakage types within the building envelope and its enclosure. The purpose of this study is to identify the causes and affected area of leakage syndrome in high rise residential buildings as an earliest action before planning for it maintenance.

Even though leakage defects will also affect the indoor air quality and causing illness among its users, the scope of this study will only focuses on the physical of the building which affected by leakage syndrome. Therefore, methods of investigation and survey will be restricted to the physical of the buildings, internally and externally.

MATERIALS AND METHODS

This discussion focuses on the appropriate survey instruments, data to be collected and the methods used in analyzing the causes and other constraint factor of the investigation. Primary and secondary approaches which involved literature review, questionnaire survey and field observation were selected to be conducted, based on the limitation such as constraint of time, cost, confidentiality and sensitivity of the investigations.

Survey Investigation

This survey is conducted for obtaining primary information from the selected residential building which includes observation, visual inspection, note-taking and photographs. Information obtained from the visual inspection will determines whether there is a need for further comprehensive investigation using more sophisticated testing technique. This study had surveyed the building floor to floor. Measuring equipments were used for diagnosing purposes such as to check humidity, moisture content and identify defect sizes. There are two types of residential building will be counted as case studies, the high-rise and low rise building. Ten buildings were chosen for the research are over five years of building age. From all ten buildings, seven units of the high-rise building were chosen as the sampling for this research.

Interviews and Questionnaire

The use of semi structured interview is necessary to strengthen and achieve the objectives of the research. The questionnaire is designed to the respondent of the case study building mainly to find out leakage syndrome through the present of leakage defect in the form of leakage type, leakage causes and leakage areas. A set of 200 questionnaire forms were distributed to the managerial and sub-managerial of the maintenance management team of the selected case study buildings and 156 questionnaires were returned.

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Data Analysis Technique

The collected data was tabulated and analyzed by using the descriptive analysis. The descriptive analysis refers to the transformation of data in raw format, which will make it easier for interpretation. The statistical package for the social science (SPSS) software for windows version 12.0 is used to analyzing the data. The raw data were edited by means of frequency and percentage distribution for making the data readable and reliable.

RESULTS AND DISCUSSION

Leakage syndrome is the most important variable to be identified and analyzed in this study. The ultimate objective of study is to determine the lead sources of moisture or liquid movement through materials. Total of 156 questionnaire of leakage syndrome which consider the leakage types, causes of leakage and the leakage areas will be analyzed. The obtained results which based on frequency is recorded and complied to discuss concerning all case studies.

Leakage Type

There are generally four types of leakage in a high rise residential building which are dampness, water penetration, water entrapment, and condensation. From table 1.0 and figure 1.0, a frequency of 72 leakage syndrome is defined as dampness by respondents. The seconds highest is water penetration which is 47, followed by water entrapment with a frequency of 29 and condensation with 6 leakage syndrome. However, some of the respondents have an opinion that the burst pipe is another type of leaking problem which only with the frequency of 2 leakage syndrome.

Table 1.0: Distribution of Leakage Type

		Frequency	Percentage	Cumulative Percent
Valid	**Dampness**	**72**	**46.2**	46.2
	Water Penetration	47	30.1	76.3
	Water Entrapment	29	18.6	94.9
	Condensation	6	3.8	98.7
	Others	2	1.3	100.0
	Total	156	100.0	

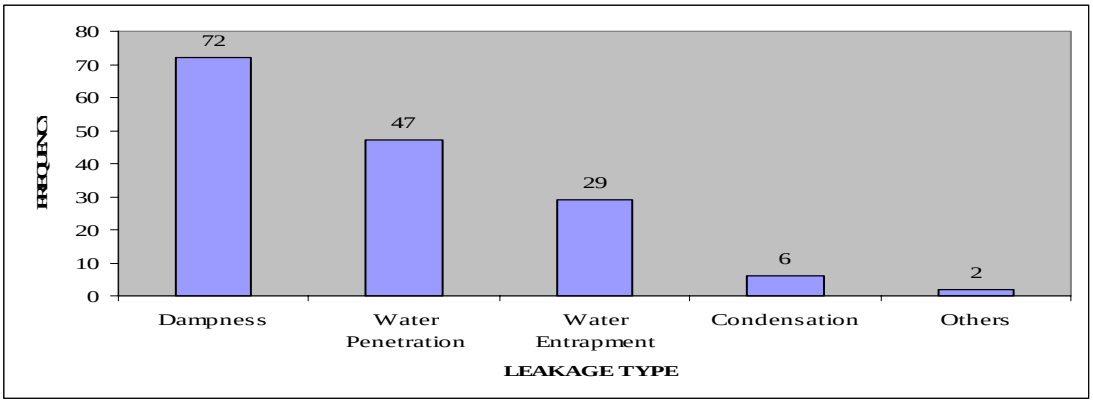

Figure 1.0: Analysis on Leakage Type

Causes of Leakage

The causes of leakage can be categorized in five major causes which are design fault, construction fault, poor maintenance performance, environment influence and the usage pattern. However, each of the causes is specific to their sub-causes. The analysis is considered base on these sub-causes. Result from Table 1.1 and Fig 1.1 shows that for the design fault, it consists of the total frequency of 46 leakage syndrome which 22 are caused by

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selection of material, 8 caused by design detailing, and 16 caused by design consideration. For the construction fault, the total frequency is 45 leakage syndromes. 7 leakage syndromes are caused by construction supervision problem and 38 are caused by workmanship problem. Poor maintenance performance follows with a total of 20 leakage syndromes. This frequency come with the sub-causes of poor outsource services which contribute 2 leakage syndromes, inadequate budget allocation with 7, the poor quality of material with 9, and 2 leakage syndromes caused by other poor maintenance performance. The other cause is environment influence with a total of 41 leakage syndromes which contributed by the sub-causes of climatic condition with 28 and external force with 13 leakage syndromes. Lastly, the usage pattern with only 4 leakage syndromes, which contributed with the sub-causes of overload with 2 leakage syndromes and misused problem which is also with 2 leakage syndromes.

Table 1.1: *Distribution of Leakage Causes*

		Frequency	Percentage	Cumulative Percent
Valid	**Design fault (DM) - select of material**	**22**	**14.1**	14.1
	Design fault-detailing	8	5.1	19.2
	Design fault-design consideration	16	10.3	29.5
	Construction fault-supervision	7	4.5	34.0
	Construction fault(CF) - workmanship	**38**	**24.4**	58.3
	Poor maintenance(PM) - outsource services	2	1.3	59.6
	Poor maintenance-budget allocation	7	4.5	64.1
	Poor maintenance-material quality	9	5.8	69.9
	Poor maintenance- others	2	1.3	71.2
	Environment influence(EI) - climatic condition	**28**	**17.9**	89.1
	Environment influence-external forces	13	8.3	97.4
	Usage pattern(UP)-overload	2	1.3	98.7
	Usage pattern-misuse	2	1.3	100.0
	Total	156	100.0	

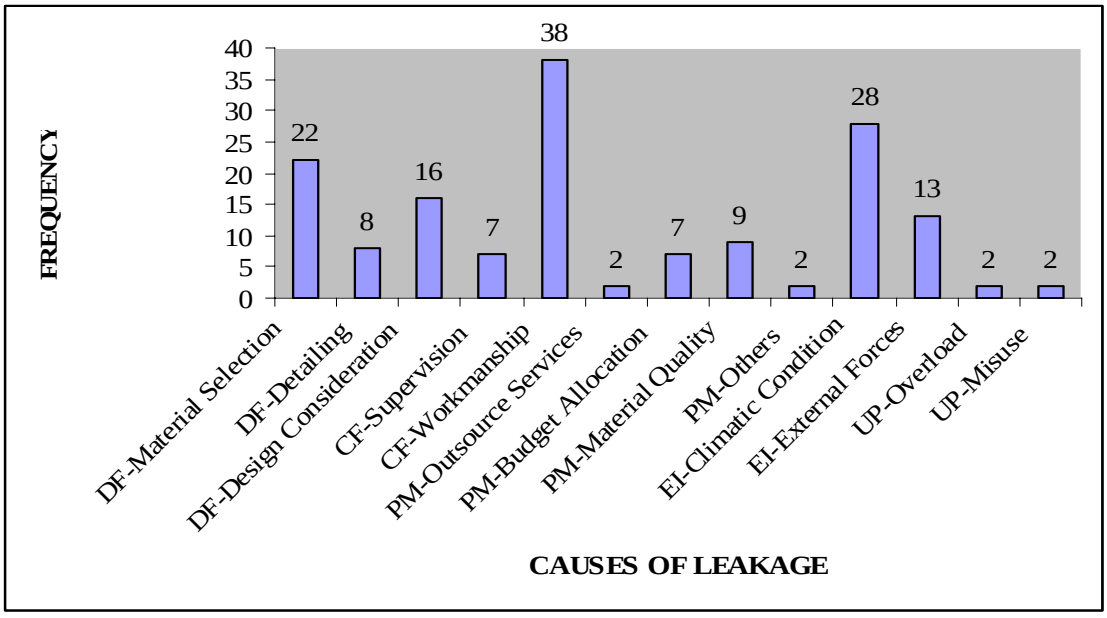

Figure 1.1: *Analysis of Leakage Causes*

Leakage Area

The analysis of leakage syndrome is firstly conducted by the leakage area. The areas which are face the leakage problem in the chosen building included the roof area, wall, floor (especially the toilet area), gutter and down pipe, window and door, plumbing services, water tank, and joints. Obviously, from the Table 1.2 and Fig. 1.2

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shows the dominant leakage area of the residential building is the toilet floor area. It shows frequency of 40 from the total 156 leakage syndrome. The second highest frequency of leakage area is at the pitched-roof area which shows the number of 28 leakage syndrome. This followed by the area of external wall with 22 leakage syndrome; rain water down-pipe with 12 leakage syndrome; internal wall with 10 leakage syndrome; other type of wall with 7 leakage syndrome; roof area with combination type and plumbing services and water tank each shows the number of 6 leakage syndrome; flat roof with 4 leakage syndrome; and lastly the basement wall, window and door, and joints which each show only one leakage syndrome.

Table 1.2: *Distribution of Leakage Area*

		Frequency	Percentage	Cumulative Percent
Valid	**Roof-pitched**	**28**	**17.9**	17.9
	Roof-flat	4	2.6	20.5
	Roof-combination	6	3.8	24.4
	Wall-external	**22**	**14.1**	38.5
	Wall-internal	10	6.4	44.9
	Wall-others	7	4.5	49.4
	Floor-toilet	**40**	**25.6**	75.0
	Floor-basement	1	0.6	75.6
	Rain water-gutter	10	6.4	82.1
	Rain water-down pipe	12	7.7	89.7
	Rain water-others	2	1.3	91.0
	Window and doors	1	0.6	91.7
	Plumbing	6	3.8	95.5
	Water tank	6	3.8	99.4
	Joints	1	0.6	100.0
	Total	156	100.0	

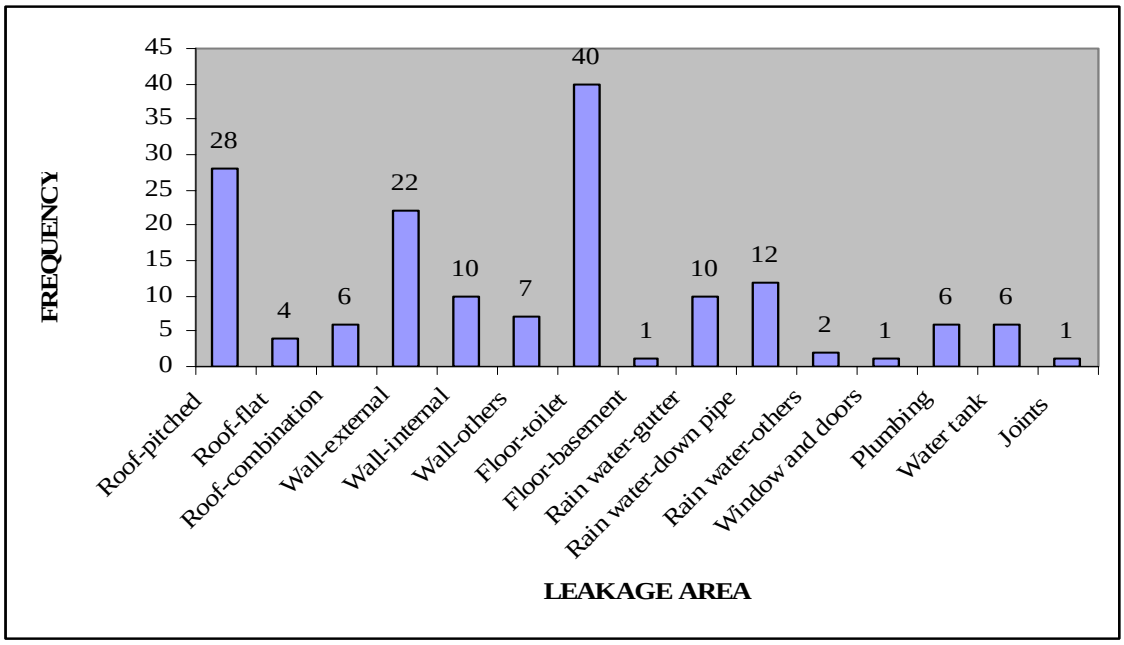

Figure 1.2: *Analysis of Leakage Area*

CONCLUSION

Overall, this paper has successfully achieved the objectives, where the significant of leakage type, leakage causes and leakage areas were identified. Furthermore, dominant causes attributed to leakage syndrome in high rise residential building were also been recognized. As can be seen from the analysis, the dominant leakage type

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found in the residential building is dampness.

The dominant factor allowed leakage syndrome in the high rise residential building is caused by construction fault which normally faced workmanship problem during construction stage. This is due to the use of semi-skilled and un-skilled labour. The most affected area caused by dampness was found at roof area. This shows that the climatic condition is the most significant factor to cause dampness in residential building.

However, toilet floor area was found as the most common area for leakage syndrome to occur among other leakage elements in the residential building. This is because toilet is the dampest area in the residential buildings. As a consequences, occupant at the lower floor may suffer with dripped water when leakage occurred on the floor area. The building elements such as roof, ceiling and floor area which lack of damp proof element may caused a lot of problem that has resulted damp patches and fungus attack on the area.

The building owner can get the ideas and understand more deeply about the leakage syndrome in the residential buildings. Besides, by focus on the long-term needs, hopefully this study can solve the leakage problem on residential building and gain more advantages, such as cost-effective reductions in leakage, operational cost savings and improved regulatory reporting.

Here, building maintenance takes an important place for the building life cycle and sustainability. The durability and longevity of a building is related to proper maintenance besides building design and construction method. Sometimes, there is no absolute solution to avoid building from being deteriorated by leaking problem because it is daily exposed to the nature; e.g. rainwater, underground water and etc, so the only solution are building's repair and remedial works to ensure the building is in good condition and can be use longer is by doing periodical maintenance to prevent leakage problem.

Therefore, according to Brian (2003), sustainable care is about more than the care of a sustainable building; it is also about caring for any or all buildings in a sustainable manner. Determinants of sustainable care could include low maintenance, high durability, design attuned to use of building, adaptability, reusability and the use of appropriate technologies.

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