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Sustainable Factors Of Wood Materials For Building In The Tropical Region

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Abstract
The implementation of the greenship rating is a measuring instrument qualitative the occurrence of a green building that environmental friendly since planning, development, until the operation and daily maintenance. At the stage of building maintenance occurs a decrease in function that is one of the cellulose materials can be measured in detail to find out the causes, symptoms and treatment improvements that need to be given to address them. The research that has been done is aimed at analyzing the condition of illness, greenship rating in quantitative (pathology building) as well as terrotechnology; i.e. see conditions afflicted of wood material infected by termites and economic losses as well as during their useful life due to termite attack. The result showed that the damage that occurs commonly in the apartment and hotel buildings in South Jakarta is the surface of crinkles and cracking hair on cellulose materials, while in college building in East Jakarta damage found were crinkles, the surface of cracked hair and loose/undone. Loss due to termite attacks on this did not damage the structure of the system but only made from cellulose as well as construction of comfort and loss factor in residence security quite significantly.

Keywords: greenship, pathology building, terrotechnology

Introduction

A system of greenship rating aids for the construction/ building industry, businessman, engineer, and other agents in applying best practices and reach a standard unmeasured that may be understood by the general public, especially tenant and users of the building. One factor that judgment is material resources and cycle (MRC) that deals with the maintenance of a building [2]. In the process of building maintenance, of course will found damages on the structural, mechanical, and electrical components; thus require the knowledge to know cause of damage [4]. Pathology building can be defined as of the systematic knowledge of building diseases, with the purpose to understand causes, symptoms, and treatment improvements need to be given to solve the problem. In the context of medical, someone be the subject of testing and investigation of which detailed considering time of service, time health and the manner of its treatment. Some element detail what needed in approach is the design of a building the election materials, the manner of constructing, utilization, changes in existing and other mechanism that associated with a local environment [8]. The deterioration and decreasing of condition and system of its building components need the knowledge of pathology building and it's diagnose.

The damages in construction because of termites attack starts happening on the construction of interior and exterior building. Meanwhile, termites are insects that always identified as pest crasher building, housing, filing, book, plants and so on. In fact, termites are insects which have as a cleaning trashes nature. But with the narrowness land that result against the narrowness life habitats termites, they begin to run human habitations to find food resources to keep their survival. Any of various termites crasher building namely *Coptotermes curvignathus* from Rhinotermitidae family inflict attack levels most terrible and capable of being struck up to 33rd floor at the high of building. Re-invasion of termites is capable of destructive element construction from one floor to floor subsequent; as ceiling from gypsum up to kitchen set made of wood in room in a building.

Materials and Method

Material used is master plan and pictures apartment buildings and hotels in the South Jakarta and visual data of Tower 1 (apartment), Tower 3 and Tower 4 (hotel) was attacked by termites as the data to represent of high-rise building. In addition as a basis for comparison is master plan, data visual, and lay-out of room were attacked by termites of college building in East Jakarta as the data to represent of three storey building.

Methods

The method used in system of *greenship* assessment rating is divided by 6 (six) categories, namely: (a) appropriate site development, maximal value 17 percents; (b) energy efficiency and conservation, maximal value 26 percents; (c) water conservation, maximal value 21 percents; (d) material resources and cycle, maximal value 14 percents; (e) indoor health and comfort, maximal value 10 percents and (f) building environmental management, maximal value 13 percents. An assessment system rating of greenship associated in this research is MRC-2, MRC-4, MRC-5 and MRC-6: certified wood (maximal value 10 percents) which included in (d) material resources and cycle in greenship rating system

In this research an observation is performed directly on the buildings, as well as on the basis of records researched report from management of maintenance building, includes:

i. To conduct observations on the condition of building construction floor by floor in accordance with termite

colony lives in the building construction in the interior areas.

ii. Investigation of damage location of the building construction and the cause of the attack as well as identify the kind of damage termites, either due to the design, construction, maintenance system, user carelessness, and also due to the utilization of the building materials. The next step is to categorize the conditions of building construction.

In this case utilization of material (wood materials) is a component of a building anatomist. Wood materials had benefits integrated with other material in a building. To know the quality standard of utilization related to the lifetime of the observed building. The observation data used in this research are data from 5 (five) years of damage to on component of wood materials and occurring by 3 (three) factors, namely (a) acceleration, acceleration of the damage that occurs due to election early draft of building; (b) mitigation, factors outside the building by termite attacks from the ground surface around the building; and (c) substitution, to change an old material damage by using the same material.

The efforts solved an incidence of damage regularly takes the concept of an integrated to produce a work of architecture by minimizing the risk of economic loss levels, security, and convenience for users. In this case, the management of building maintenance needs to have knowledge about conditions the building construction, utilities building has to do with the use of wood materials; in order to minimize damage happened [9].

Results And Discussion

Apartment and Hotel (High-rise Building) in South Jakarta

i. Building pathology

Data found visually on Tower 1 (30 floors), Tower 3 (33 floors) and Tower 4 (30 floors) found the path of a roaming ability until the top floor of buildings; suspected is a roaming path of *Coptotermes curvignathus* termites. Characteristics of vertically on cruising of termites in apartment buildings and hotels in South Jakarta begin from plumbing systems of clean water coming in through the basement floor which high moisture and coated with dark conditions (less lighting). The occurrence of condensation on cold water pipes or air conditioner, clean and dirty water pipes, clogged gutters water, leakage from gutter and some plants in terrace at every floor of building are all potential vehicles for termite colonies. Termite attack that occurred until to the top floor of the apartment and the hotel buildings show that the roaming ability of *Coptotermes curvignathus* termite are not affected by the force of gravity.

Observations of material damage occurred by 3 factors i.e. acceleration (acceleration), mitigation (by a factor of external damage) and substitution (substitution of materials with the same ingredients). A third factor such damage may occur again within 3 - 4 years, so it must be renovated. In this case the management of maintenance building need to have knowledge about the status of building structure, building utility and wood material more detail, in order to minimize happened damage [7]. The damage rate of wood material will be happened quickly, especially in the apartment building that have become a resident's property. These things happen, because management cannot directly to care of apartment units. On the hotel building, the coverage area for entire building includes the unit of hotel.

Common type of damage that occurs in Tower 1, Tower 3 and Tower 4 is the crinkles surface and cracking hairs found in cellulosed material. The losses direct were only caused by termite colony of *Coptotermes curvignatus*, and excludes loss indirect is to renovate around the occurred defects. By weighting damage material for cellulose of building construction that accounting is only about 8 (eight) to 10 (ten) percent of overall cost the building apartment.

On many modern structure, termites destructive not only material construction but also attack material in the room (interior) like wooden floor, panel dividing wall space, wallpaper, wallboard, furniture, and fibers at back of synthetic carpet [8]. These events also occur in every observed apartment unit/room on this research, so the indirect damage will add value of previous weights percentage and become larger.

ii. Terrotechnology

Terrotechnology is a discussion to analyze factors of technology and economic. The calculation of operational and maintenance at high-rise buildings is 25 percents from the total value of apartment and hotel room rates [5]. From the results of research showed the maintenance building of apartment and hotel in South Jakarta area include: consumption of electricity and water, maintenance of equipment, security and safety of building, environmental control, maintenance of cleanliness, and also landscaping works.

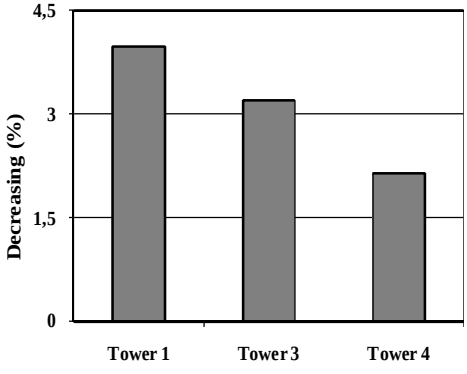

Fig.1. The Decreasing in Wood Materials at Apartment and Hotel in South Jakarta

To calculate the decreasing value of wood component in Tower 1, Tower 3 and Tower 4 buildings; the calculation shall be based on the condition index of building and also wood content in building at least 8

(eight) percent from the overall construction components of building. The calculation results of decreasing value of component based on condition index for Tower 1 was 3.98 percent; Tower 3 was 3.19 percent and Tower 4 was 2.14 percent respectively as seen in Figure 1 above.

The research ever done before shows the condition index of building for Tower 1 is 50.22; condition index of building for Tower 3 is 60.10 and for Tower 4 is 73.19. If the rate of decreasing calculated based on condition index of each tower (assuming the condition index will keep until 25 years), and wood components of at least 8 percent from overall building components and also based on decreasing percentage of building every five years [9], therefore the decreasing rate of Tower 1 is faster than Tower 3 and Tower 4 (Figure 2). Loss due to termite attacks on Tower 1, Tower 3 and Tower 4 did not damage the structure of the system but only the construction were made from wood material and loss of comfort and security factors of residence were significantly. The losses calculation caused by termite attacks equivalent with cost of roof cleaning and yard are 2 percent a month, so that same with a decreasing value of a building without maintenance.

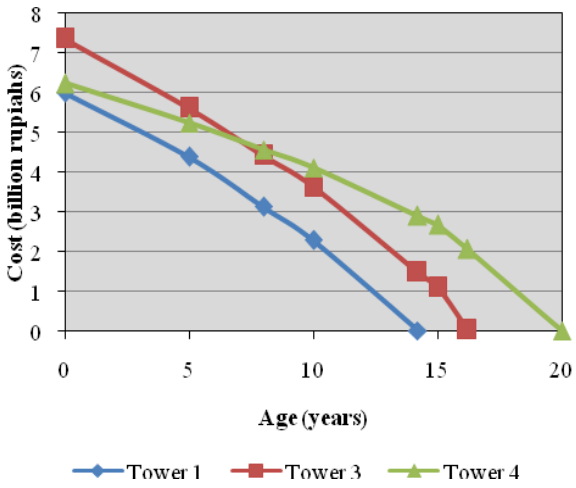

Fig.2. The Decreasing Rate of Wood Materials at Apartment and Hotel in South Jakarta

iii. Greenship value

Assessment rating greenship in this research is only done on a wood material that exists in the location of the customized research with scoring of conditions index. Thus, the assessment of the maximum rating from wood certified by 2 percent indicated that the condition of wood materials in buildings is 100 percent. When the condition index less than 100 percent, then it can be said that the cellulosed material has less or do not meet the criteria of greenship.

Based on the condition index of building for each Tower, obtained that Tower 1 has a greenship value 1.00, greenship value of Tower 3 is 1.20 and Tower 4 greenship value is 1.46. Generally the damage in solid wood caused by termite attack, so to repair should consider using non-solid wood; for example composites. Composites made from wood and other materials create enormous opportunities to match product performance to end-use requirements and also environmental friendly. Composites has combined wood and other raw materials, such as plastics, gypsum, and concrete, into products with unique properties and cost benefits [3]. Some of wood-nonwood composites like gypsum board cement board, wood fiber-thermoplastic composites, etc.

Table 1. Greenship Value for Apartment and Hotel in South Jakarta

Tower	Condition Index	Greenship	
		Score	Maximal
1	50.22	1.00	2
3	60.10	1.20	2
4	73.19	1.46	2

Greenship value is aimed to using of cellulosed materials can be accounted for its origins to protect the sustainability of forests. The measure of indicator was to using certified wood materials that its legal based on government regulation about the origin of wood and legitimate free from wood illegal trade. The next indicator was 30 percent use certified wood materials from Indonesia Ecolabel Institution. Other purposes of greenship scoring is to material not cellulosed materials that is considering environmental factors that includes building material reuse, environmental friendly process product, zero-ozone depleting potential, modular design and regional material.

Three Storey Building (College Building) in East Jakarta

i. Building pathology

The observations of *Coptotermes curvignathus* termite colony attacks this building this relate to some factor such as: structure system in the wall construction, floor construction and beam construction. All three of these factors have being access to be entrance media for termite colonies. The termite colonies are then expanded their habitat in the area this building from one floor to the next floor. This happens due to the ceiling, walls and floor (parquet) contains cellulosed materials and can be a source of food for the termite colonies. In addition, the use of cellulosed material in construction of wood composite panels (furniture) is also to be a medium life for termite colonies.

Termite colonies through of flattened tunnels network of land material that mixed with their saliva, roams vertically and horizontal from floor to next floor and from room to another room in each floor. The network conditions of the tunnel flattened always allegedly relate to the nest is on the ground (the main reproduction), especially around this building. On the conditions of the high building construction both vertical and horizontal directions, termite colonies only experienced relatively small obstacles when seeking food (attack), for allegedly reduced the natural enemy of termites in the building. This was confirmed with an explanation that the termite's nest predators or natural

enemy is ant where located in the ground, termite colonies so easily get food inside a building.

Common type of damage that occurs in this building is crinkles surface and at cellulosed materials for 1st floor; crinkles surface, cracking hairs and in 2nd floor; and unsteady/loose in 3rd floor were found in components cellulosed materials. Direct losses were only caused by termite colonies of *Coptotermes curvignatus* and excludes indirect losses to renovate around the damage occurred. Replacement of wooden materials in this building is usually done on a periodic basis; i.e. every 4 (four) years, and the last replacement made in October 2011. This can be taken to mean that decreasing value can occur in components of a cellulosed material in this building due to termite attack.

As long as the research progresses, seen that the 2nd floor level is used more, because there are also a lot more on the 2nd floor; so the level of usage is also higher. The higher use rates, then operational buildings using clean water through plumbing and due to air conditioner piping also getting high. Meanwhile the plumbing of clean water, dirty water, rainwater pipes and air conditioning pipe is a source of moisture are all potential for habitat of termites; so use more often than these building utilities also serves as the entrance of termites into the building and damaging components of wood materials. It explains, on the 2nd floor damage conditions of wood material higher than the 1st floor and 3rd floor.

ii. Terrotechnology

The value decreasing of building is calculation of age structure and calculation of value of buildings (in rupiahs) that influenced by factors treatment and depreciation [1]. The management of buildings maintenance need to take into account as a result of termites attack on components of wood material (4 percent of the total building component) in every the floor at this building with the lapse of time 3 - 4 years. So far the building maintenance includes: consumption of electricity and water, treatment equipment, building and work safety, environmental control, janitorial maintenance and landscaping works. Results of value decreasing calculation of the wood component based on the value of condition index for 1st floor is 0.68 percents, 2nd floor is 1.27 percents and 3rd floor is 0.88 percent as seen in Figure 3.

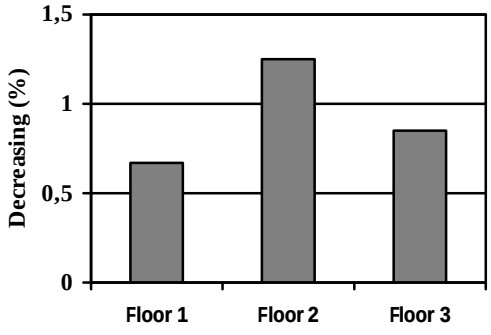

Fig.3. The Decreasing of Wood Materials at College Building in East Jakarta

Meanwhile, the result of previous study obtained an index condition for this three storey building is 77.36, consisting of: index conditions on the1st floor with a value of 83.18; the 2nd floor at a value of 68.82 and the 3rd floor with a value of 78.67. To calculate the value of the decreasing of wood material components at building, then these calculations based on an condition index of floor as well as the content of wood material is 4 percent of the overall construction component of this building (based on construction cost). The results showed a calculation of rate decrease in wood materials components are calculated based on condition index each floor (assuming the condition index will keep until 25 years) and based on the decreasing percentage of building every five years [9]; the decreasing rate of wood material components on the 2nd floor is faster compared to the 1st floor and 3rd floor (Figure 4).

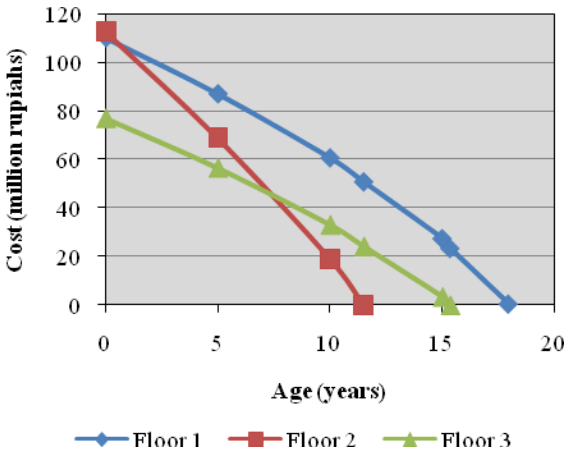

Fig.4. The Decreasing Rate of Wood Materials at College Building in East Jakarta.

iii. Greenship value

Just as in the discussion for the apartments and hotels that located in South Jakarta, then an assessment of greenship rating on this building is also only done for wood material. The research results obtained based on the conditions index of building pathology shows a greenship value for 1st floor is 1.66, 2nd floor is 1.38 and greenship value for 3rd floor is 1.57. Based on the assessment of the maximum rating from certified wood is 2 percent, shows the first floor nearly meet the greenship criteria (Table 2).

Greenship scoring is aimed to make use of the wood is in line with wood certification which guarantees that wood is not from wild logging. The existing of green building from green architecture concept identical with sustainable architecture. Sustainable architecture is conception offered by architecture science to minimize negative impact of building design to nature, environment and people [6]. In an element of green building is building material those materials product can be reused or

may be made recycled, just like wood and bamboo. To support this, wood materials need required greenship criteria; to use certified wood.

Table 2. Greenship Value for College Building in East Jakarta

Floor	Condition Index	Greenship	
		Score	Maximal
1st	83.18	1.66	2
2nd	68.82	1.38	2
3rd	78.67	1.57	2

Today, industrial of materials building have to do innovations to process wood from the plant industry forest equivalent its quality with wood from the nature forest. This innovation necessary to fulfill of the needs of construction wood in building development, for example by developed laminated wood, plywood, fiberboard, particles board and other processed wood products that have been certified. This is necessary in Indonesia to maintain its tropical forest, so there is no more illegal logging again.

Conclusion

Based on two factors (building pathology and terrotechnology), then obtained value greenship of Tower 1, Tower 3 and Tower 4 respectively are 1.00, 1.20 and 1.46. Greenship value of three buildings (Tower 1, 3 and 4) was less than 2.00 (two) which showed a tendency of wood material used for these buildings not certified. Meanwhile, based on the results of this research for college building, obtained a greenship value for 1st floor is 1.66, 2nd floor is 1.38, and 3rd floor is 1.57.

The greenship assessment shows conditions in floor of college building in East Jakarta is better than three tower buildings which were located in South Jakarta. It is allegedly because college building has already been built since 30 years ago using wood quality of a 1st class, although at that time system of greenship rating in Indonesia has not been applied yet. The application of greenship rating in another country of wood is certified began in the last 20 years, this caused by chopping down of wood harvesting in a forest is not controlled. Thus, college building (located in East Jakarta) from 30 years ago was using wood that relatively high quality so that wood quality which is nearly equivalent to a wood with greenship certified.

References

[1] Abioso, W.S., Daur Hidup Gedung dalam Sistem Arsitektur, Dimensi Teknik Arsitektur Vol. 35, No. 2: 128-135, Jakarta, 2007.
[2] Anonymous, Greenship: Panduan Penerapan (Guidelines), Green Building Council Indonesia, Jakarta, 2010.
[3] Anonymous, Wood Handbook: Wood as An Engineering Material. Forest Products Laboratory, USA, 2013.
[4] Douglas, J. and B. Ransom, Understanding Building Failures, Routledge, New York, USA, 2013.
[5] Juwana, J.S., Panduan Sistem Bangunan Tinggi, Erlangga, Jakarta, 2005.
[6] Karyono, T.H., Green Architecture: Pengantar Pemahaman Arsitektur Hijau di Indonesia, Rajawali Press, Jakarta, 2010.
[7] Randall, M., Environmental Science in Building, Palgrave, New York, USA, 2012.
[8] Watt, D.S., Building Pathology: Principles and Practice, Blackwell Sciences Ltd., Oxfor, UK, 2007.
[9] Wood, B.J.B., Building Maintenance, Blackwell Publishing Ltd., Oxford, UK, 2009.