

DAMAGE ASSESSMENT OF CONSTRUCTION COMPONENTS OF THE JAKARTA SION CHURCH BUILDING

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ABSTRACT

The Sion Church is one of the cultural heritage buildings that still needs to be maintained, given its condition to deteriorate. It is fitting that a cultural heritage building needs to be preserved, especially as a heritage asset in the capital that is more than three centuries old in dire need of conservation action. Meanwhile, routine monitoring and evaluation activities are one of the tools in preserving cultural heritage buildings. This activity aims to discover and collect data on maintaining a cultural heritage building so that any damage found in the cultural heritage building can be followed up. It is intended that cultural heritage buildings can be maintained and their existence is preserved because there are things that are valuable to human civilization, including religion, science, and culture. The conditions of ability and upkeep of the Sion Church Building were assessed based on weighting assessments, namely in design and upkeep work suitable, adjusted for Indonesia (humid tropical climate, based on BRE Digest 268). Based on the examination results, the ability quality of the Sion Church building was 33.90, which is categorized as the moderate damaged maintenance condition category.

KEYWORDS

Damage assessment, Building maintenance and ability, Jakarta Sion Church building

INTRODUCTION

Routine monitoring and evaluation activities are one of the tools in preserving cultural heritage buildings. This activity aims to discover and collect data on maintaining a cultural heritage building so that any damage found in the cultural heritage building can be followed up. It is done to intend that cultural heritage buildings be maintained and preserved because things are valuable to human civilization, including religion, science, and culture. [1][2][3]. The Indonesian government has regulated cultural heritage, which explains that objects, buildings, or structures can be declared as cultural conservation objects or cultural conservation buildings by fulfilling the requirements [4]:

- a) Have been aged 50 years or more;
- b) Shows a certain period of at least 50 years;
- c) There is a particular purpose in history, science, education, religion and culture;
- d) There are cultural values to strengthen national identity.

The Republic of Indonesia regulated cultural heritage as outlined in the form of a law in 2010. Community involvement in the management of cultural heritage must be increased. The cultural heritage management paradigm is no longer intended only for academic interests but must include ideological and economic interests. Therefore, synergy is needed to achieve these three interests between the government, academia, society, and the private sector [4]. Through the Ministry of Public Works and Public Housing of the Indonesian government regulated the preserved cultural heritage buildings in 2015 and explained that it is necessary to maintain, prevent and overcome cultural heritage buildings from failure and vandalism employing redemption, safekeeping, preservation, and restitution [5]. Besides, in the second part, article 8 explains that the reliability requirements of cultural heritage buildings consist of safety, health, convenience, and easiness [5][6].

Safeguarding the building can be interpreted as convenience with which a result can be maintained to ease next upkeep or cope with a changing surrounding environment. Maintenance of buildings is a part of the design characteristics (in architecture). Thus, the elements of building maintenance become design parameters (in architecture) related to the ease of maintenance of the building [7][8]. Thus, when designing a building, we must pay attention to a method to elongate a building's service time (save costs) by framing the structure adaptable. The service life depends on several elements, starting from how often the maintenance element is included in its design (architecture), the degree to which the owner/occupants perform caring obligations during the service life of the building, and estimated costs.

Building pathology is a systematic knowledge in building "disease" by understanding the causes, symptoms, and remedial treatment needed to overcome it. Building pathology both conceptually and as a whole requires a holistic approach from the anatomical conditions. Some of the detailed elements needed in this approach are building design, material selection, building, using, existing changes, and other mechanisms related to local environmental conditions [9][10]. The use of building pathology was known in the past few decades, but in the present, it seems unnecessary, as is the case with the current building. If there is a building with hundreds of service life years, it is considered good maintenance, robust construction, or good management. Buildings can have a long service time because someone works to solve all the problems in the building by caring for, loving, and paying attention to stay in top condition. From the design period until after the building was built, building pathology is still needed to be used for a long time [11]. The purpose of an environmentally sound building is to maximize its utilization and minimize damage [12]. Meanwhile, it was also explained that its service time could exceed 50 years [13].

The Sion Church in Jakarta, which became the research material, is one of the cultural heritage sites with the stipulation of the Governor's Decree No. 475 of 1993 [1] and DKI Jakarta Regulation No. 9 of 199 [14], as well as Ministerial Decree No.193/M/2017 [15]. The Sion Church consists of two buildings close to each other or is united, namely the main building (prayer room) and the consistory building. The architectural style of this church building is heavily influenced by ancient Roman architecture, with the architect H. Bruyn. A distinctive feature of the Romanesque style seen in the Church of Sion is the arch at the entrance to the church. Similar to the Romanesque style building, this church looks very big and sturdy, with very thick and solid walls to strengthen the structure [15]. Meanwhile, research on the Sion Church aims to obtain and collect data on the maintenance and condition of the construction components by identifying their maintenance.

MATERIALS AND METHOD

General conditions

The Sion Church Cultural Heritage Site in Jakarta is located at Jalan Pangeran Jayakarta, RT 009 RW 04, Pinangsia Village, Tamansari District West Jakarta. This church

building faces north, surrounded by a wall, but the eastern part has been demolished due to road widening. This church consists of the main building and additional buildings, with 6,750 m² and 768 m². The main building is rectangular. This church building has a Baroque-style interior. This church has Romanesque architectural features erected using 10,000 wooden posts from Ewout Verhagen from the Netherlands, with the architect, H. Bruyn [17]. Even when the eruption of Krakatoa caused the earthquake, this church was still strong. The Sion Church is divided into a worship room, balcony, and church offices.

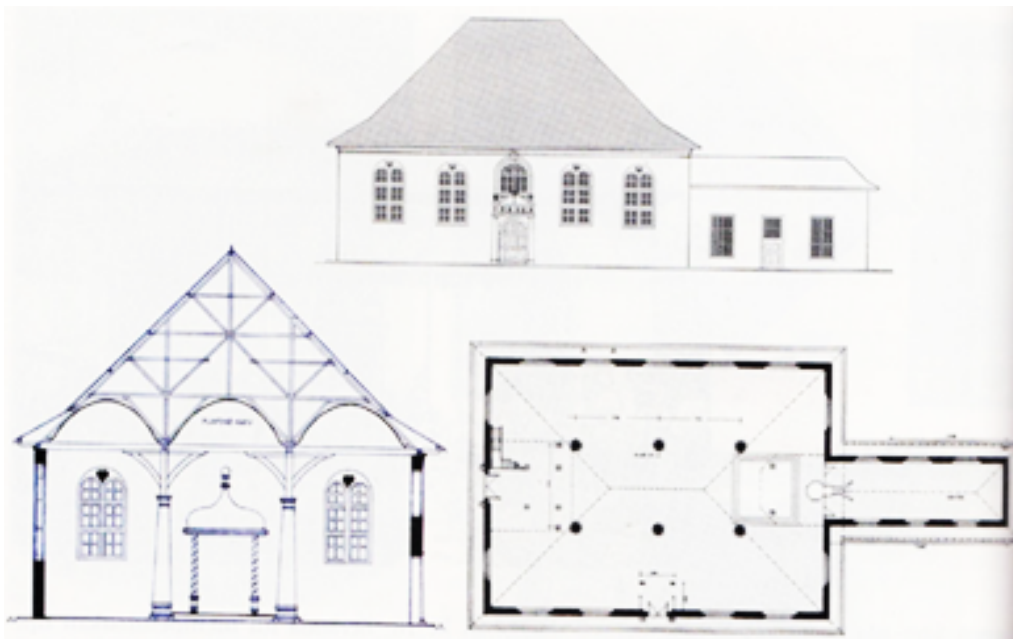


Fig. 1 - Sketch, facade, and a cross-sectional the Jakarta Sion Church (source: Heuken,2009)

In Sion Church, there are 2 entrances, the north and west, with a width of 2.6 m, semi-circular doorway with a height of 3.2 m. The door is made of 5 cm thick wooden planks. The northern entrance is still the original door, while the western entrance is an additional door. The church's interior is equipped with glass windows as many as 15 windows measuring 2.6 m and 5 m high, whose lintel is also semi-circular. This window is made of stained-glass panels. In the northern front yard of the church, there is a cast iron bell. This bell was made in 1675. The bell is hung on the wall to the left of the church door.

On the courtyard to the west side of the church door, several large gravestones typical of the Dutch era. The tombstones are made of stone materials imported from India (the Coromandel Coast area). They are ancient tombs of several important figures such as government officials and other prominent people (17th century to 18th century). Some of these graves are the tombs of the husband and wife of the Bengali Mardijkers (slaves), namely: Ragel Titis (died 1701) and Tities Anthonijse (died 1720). Besides, there is also the tomb of Governor-General Hendrik Zwaardcroon (died 1728) and others. Only 11 ancient tombs are left in Sion Church at the church's west entrance.

The drawing plan of the Sion Church building is the material in this research. In this research, some of the tools used are water level gauges, digital meters, digital cameras, drones to record the roof images of the Sion Church, laptops/computers, stationery, and forms to record damage or other data.

Research Method

The procedure of the research stages in the main building by:

- Noting the state of the building structure (upper structure), both indoors and outdoors area;
- Determining damaged area by recognizing the type of damage, in terms of both design and maintenance organizations; and
- Investigation of repairs that have been made of the repaired construction components.

Data Analysis and Instruments

- a) The first stage performs ratings for each construction element of the building. It is to specify the degree of the primacy of the building elements of the Sion Church building based on BRE Digest 268 [9]. The method used in BRE Digest 268 is for general building construction damage in traditional low-rise housing. The instruments used can be seen in Table 1.

Tab. 1: Architectural rating estimation for construction elements [9]

Construction Elements	Estimation of Connections with *										Total	Rate (%)
	1	2	3	4	10						
Outside wall												
Roof												
Doors and windows												
.....												
Etc.												
												100

* rate 3: tight connection, 2: moderate connection, 1: deficient connection

Estimation elements relate to (1) durability-reliability, (2) permanence toleration, (3) the influence meteorological conditions, (4) keeping, (5) fire avoidance, (6) deterrence against noise, (7) building construction method, (8) circulating air conditioning, (9) earth tremor endurance, (10) other causes

- b) The second phase is to verify the ability of the building with a scoring and rating system to achieve the ability of construction and building elements based on BRE Digest 268 [9]. The score of the condition of the construction is (1) heavily damaged, (2) moderate damaged, (3) minor damaged, (4) moderate, (5) suitable.

The building ability rate is achieved based on the equation:

$$\text{Building ability} = \frac{\text{Total Rate} \times \text{Value}}{500} \times 100 \quad (1)$$

Meantime, the upkeep circumstances of the building are acquired to the advanced calculated ability value. The category of building upkeep circumstances is estimated to the effect of building ability estimation [16], as shown in Table 2.

Tab. 2: Building ability values and keeping conditions [16].

Ability Value	Keeping Condition
81 – 100	good
61 – 80	moderate
41 – 60	lightly damaged
21 – 40	moderate damage
0 – 20	heavily damaged

RESULT AND DISCUSSION

Components Condition

The outer wall of the Sion Church building is painted white, but it looks peeling and dirty. There is a slightly yellowish stain in certain areas, which may be due to mold. In construction, the outer walls still look solid, so they need to be repaired and repainted. Some of the damage to the outer walls of the building was caused by weather (natural) and biological factors. It can be said that the construction of the walls of the Sion Church is excellent, but with a long age (325 years), of course, it requires continuous maintenance. The condition of the outer walls of Sion Church is in the category of medium damage.



Fig. 2 - Damage to the roof frame of the Jakarta Sion Church.

The roof covering of the Sion Church building is in the form of a trapezoid (shield), while the roof of the conservatory building (church court) is rectangular. The roof frame covering the Sion Church is made of clay tile, as shown in Figure 1. This clay tile was only used in the 20th century, so tile was only used when the Sion Church was restored in 1978. The roof supporting pillars of the Sion Church looks big and sturdy. Overall, the condition of the roof of the Sion Church building is in the medium damaged category. It can be seen from the shifting of the roof tiles because the roof truss has also begun to break down and there is weathering, causing leaks in the prayer room (church pulpit). The damage is caused by natural factors (weather and climate) and biological damage.

The wooden door's paint is faded, like the paint color on the windows and walls (visible from the outside). The bottom ends of the doors and windows were torn off. It is not definite that the door and window materials of this Sion Church are made of certain types of wood. Perhaps because it was restored in 1920 and 1978, material that was used was possibly traded wood, for example, camphor wood. In general, the conditions of damage to the doors and windows of the Sion Church are categorized as severely damaged. This damage occurred because the doors and windows in the Sion Church were without a canopy or gurgling to shelter rainwater

and sunshine. It indicates that the doors and windows of the Sion Church should be replaced with better wood materials and make a canopy to protect them from rain and sunshine.



Fig. 3 - Door and window of the Jakarta Sion Church

The floors in this building are from marble and natural stone materials. Meanwhile, the material on the balcony floor is made of teak wood. The damages of the floor of the prayer room and balcony are due to the life and age of the floor coverings used. It also resulted in the floor surface not having a water pass. The condition of the damage to the floor is included in the category of minor damage. The utility element observed in this building is the air conditioner (AC) device. The outdoor AC unit (compressor) is located on the outside of this building. This air conditioning device is an addition to modern equipment to support the comfort of worshipping the congregation. Generally, the damage to these utility elements is caused by service life and the joints in the gutter plate and pipelines. The condition of the damage experienced by the utility element component is a medium damage.



Fig. 4 - Cracked wall pairs (left) and damaged ceiling (right).

The foundation uses 10,000 wooden posts (round wooden blocks), Ewout Verhagen, from the Netherlands. When checking the damage to the foundation, it cannot be seen directly,

but there is a distance between a wall and a door/window, indicating a settlement in the foundation. The decrease in the foundation was caused by land subsidence [18]. From the lowering of the wall, the damage to the Sion Church foundation categorizes as medium damage. Wall pairs in the Sion Church were found to be quite cracked. It is due to the condition of the foundation subsidence that occurs during the life of the building. The cracks that occur significantly affect the condition of the building. From the examination results on the wall pairs, the damage condition has reached the medium damaged category.

The ceiling material for this building is made of white plasterboard and supported by six dark brown teak wood poles. Meanwhile, many damaged ceilings were found. The damage occurred due to the ceiling damp condition due to rainwater seepage on the roof. Damage to the ceiling is included in the medium damage category. The interior walls are still visible in their original state, in shape, material, and size. The maintenance carried out was inadequate, so the quality of walls in the Sion Church building looked quite apprehensive. Damage conditions to the inner walls and upholstery are in the heavy category. The Sion Church stairs condition is quite alarming, as well as the staircase railing. Stairway and stair railings at Sion Church are made of good quality wood. However, with long service life, weathering has occurred, mainly due to biological factors (termites). The condition of the damage to the stairs and railings is in the medium damaged category. The building facilities referred to in this case are a consistory building and a church bell. The condition of the Sion Church's consistory building is in the category of moderate damage. The church bell is currently on the wooden tower beside the church's north entrance. The condition of the damage to the Sion Church bell is included in the medium damaged category.

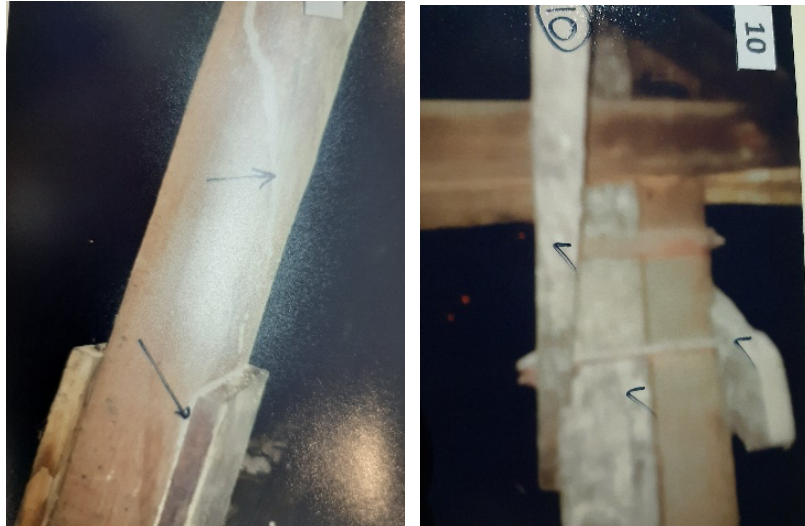


Fig. 5 - Condition of roof truss of the Jakarta Sion Church

In the structural frame system, there has been damage (weathering) to the roof truss. To maintain the roof frame of the Sion Church, people make wooden supports to hold the weight of the roof. Seeing the condition of the roof truss, of course, it needs immediate repairs, but until now, no repair work has been carried out. Meanwhile, with the occurrence of land subsidence, it is easier for rainwater to penetrate the slot surface of the building, which results in a decrease in the condition of the column (cracks). The damage that occurred in the framework system of the Sion Church structure was included in the medium damage category. Overstek in this building seems to have started to rot and dirty, caused by weather and biological factors. Besides, the roof cover (tile) can be seen without wooden battens on the overstek and only

visible wooden rafters. In this case, it is necessary to replace rotten rafters in the overstock to support the load of the roof tiles above. The condition of the supporting components of the Sion Church building is in the category of heavy damage and is in dire need of immediate repair.

The Ability of the Sion Church

The ability and keeping conditions of the Sion Church Building are elaborated based on a rating estimation of the architecture and upkeep work declared as a percentage. Architectural rating goals to achieve the connection among the building construction elements and the showing shown in the plan (design). The rating implementation indicated BRE Digest 268 [9], adjusted for Indonesia (wet/humid tropical climate). Meantime, the rating of upkeep work goals to achieve a connection among construction elements and the showing of the building since it was established 325 years ago (1695 - 2020).

Tab. 3: Rating assessment of elements of the Jakarta Sion Church building construction (based on design and upkeep condition)

No.	Construction Element	Rating (%)	
		Design	Upkeep
1	Outer wall	8.0	10,07
2	Roof	8.1	8.9
3	Doors and windows	7.4	6.9
4	Floor	7.3	6.3
5	Utility element	7.1	5.9
6	Foundation	6.8	6.9
7	Wall pairs	9.5	10.07
8	Ceiling	6.4	4.5
9	Inner wall (interior)	7.4	6.5
10	Inner wall cladding	6.1	6.9
11	Stairs	5.1	4.9
12	Placement of building facilities	6.7	6.9
13	Structural frame system (roof and column trusses)	8.2	8.9
14	Building construction elements (overstek)	5.9	6.3
		100	100

A study in the investigation at the Sion Church Building was implemented to achieve arrangements and modifications in the continuity of interest of construction elements undertake. An analysis of the connection matrix among the classifying of construction element work and its influence on its showing is building upkeep perform. Attempts or alterations are made to avoid contraction and failure to construction elements, degrade/depress substitution/ correction of construction elements, and indeed depress the upkeep of all construction elements [19][20]. It is necessary to check the condition of the building by the maintenance and repair department to obtain information about the condition of the main building and public zone: water pipes, electricity, structural systems, roofs, and windows. Establishing an inspection shall be shortly found out which refinement should be implemented soon to eliminate failure or accidents (danger), such as fixing bad electrical connections or damaged fixtures, or finding out what repairs can be delayed [21]. Due to changing building conditions, the maintenance and repair department must survey the condition of the building every three months [22].

In Table 3, it shall be visible that there is an alteration in the quality percentage of every construction element from an architectural perspective to the upkeep performance of the Sion Church building. Then, for assessing the condition of the construction components, it will be carried out in terms of architecture and upkeep performed by the Sion Church building. Meanwhile, the reliability of the construction components in the Sion Church building was obtained based on the results of examinations on the maintenance work of the construction components. It aims to see the condition of the Sion Church building based on its maintenance work. The maintenance conditions acquired will be supposed to be accomplished based on the architectural work. The examination of each construction component is obtained based on a scoring system magnified by the quality of every construction element [9]. Meanwhile, all construction components are in good condition (multiplied by a score of 5).

Tab. 4: The results of the inspection of upkeep work at the Jakarta Sion Church building

No.	Construction Component	Ability (%)		(Decrease)/ Increase (%)
		D*	U**	
1	Outer wall	40.00	20.14	(19.86)
2	Rooftop	40.50	17.80	(22.70)
3	Doors and windows	37.00	6.90	(30.10)
4	Floor	36.50	18.90	(18.10)
5	Utility element	35.50	11.80	(23.70)
6	Foundation	34.00	13.80	(20.20)
7	Wall pairs	47.50	10.07	(37.43)
8	Ceiling	32.00	9.00	(23.00)
9	Inner wall (interior)	37.00	6.50	(30.50)
10	Inner wall cladding	30.50	6.90	(23.60)
11	Stairs	25.50	9.80	(15.70)
12	Placement of building facilities	33.50	13.80	(19.70)
13	Structural frame system (roof and column trusses)	41.00	17.80	(23.20)
14	Building construction elements (overstek)	29.50	6.30	(23.20)
Total		500.00	169.51	-

D*: Architecture

U**: Upkeep

The results of ability checks of the Sion Church building construction components indicated an alleviation in the grade of every construction component, as in Table 4. The most significant decrease was found in wall pairs (37.43%), inner walls (30.50%), and doors and windows (30.10%). There was a decrease in the wall pairs quality due to a decrease in the Sion Church building foundation. As one of the oldest buildings in Southeast Asia, of course, the Sion Church, which is 325 years old, has experienced a deep decline in its foundation due to land subsidence. The settlement of this foundation resulted in the walls crack, both the outer walls and the inner walls of the Sion Church.

Meanwhile, generally, for doors and windows, the damage that occurs is due to weathering and the wood materials' age. The quality of the wood also used dramatically affects the service life of the wood material. The doors and windows components must be replaced periodically to overcome the problem.

Based on the results of the upkeep work in Table 4, it proved that the care work at Sion Church is very lacking. All construction components in the Sion Church building were damaged

(Table 5), and only the floor components were slightly damaged. Construction components of the outer walls, roofs, utility elements, foundations, ceilings, stairs, building facilities, and structural frame systems were medium damaged. Meanwhile, components of doors and windows, ceilings, inner walls, inner wall cladding, and building supports (overstek) were severely damaged. Based on the examination results, it was found that the reliability value of the Sion Church Building was 33.90, which was included in the moderate damaged maintenance condition category (see Table 2).

Forensic Factors Affecting Construction Components

Forensic factors that influenced the outer walls of the building, rooftop, floors, wall pairs, and placement of building facilities are sunlight and radiance, temperature, wind, aerial movement, rainfall, grit and ash, intense winds, and hurricane, earth tremor, and biological disturbers. Meanwhile, forensic factors that influence doors and windows are sunlight and radiance, temperature, wind and aerial movement, rainfall, grit and ash, intense winds and hurricane, and biological disturber. Forensic factors that influence the elements of utilities and stairs are grit and ash and a biological disturber.

Tab. 5: Forensic factors influence the Jakarta Sion Church building

No.	Construction Component	Condition	Forensic Factors
1	Outer wall	medium damage	a,b,c,d,e,f,g
2	Rooftop	medium damage	a,b,c,d,e,f,g
3	Doors and windows	heavily damage	a,b,c,d,e,g
4	Floor	minor damage	a,b,c,d,e,f,g
5	Utility element	medium damage	d,g
6	Foundation	medium damage	a,b,d,f,g
7	Wall pairs	medium damage	a,b,c,d,e,f,g
8	Ceiling	heavily damage	a,b,c,d,g
9	Inner wall (interior)	heavily damage	a,b,d,f
10	Inner wall cladding	heavily damage	a,b,d,f,g
11	Stairs	medium damage	d,g
12	Placement of building facilities	medium damage	a,b,c,d,e,f,g
13	Structural frame system (roof and column trusses)	medium damage	a,b,c,d,e,f,g
14	Building construction elements (overstek)	heavily damage	a,b,c,d,g

The inspected forensic factors are: (a) sunlight and radiance, (b) temperature, wind, and aerial movement, (c) rainfall, (d) grit and ash, (e) intense winds and hurricane, (f) earth tremor, (g) biological disturber

A biological disturber consists of fungi, termites, and beetles. Mold can cause stains on concrete walls, wood, floors, and others construction components. In addition, termites and beetles can cause weathering/porousness in wood materials. Generally, the damage to wood material is mainly caused by the availability of media for the development of termites, for example, damp wood due to frequent exposure to rainwater. Moist wood conditions are very popular with termites, especially subterranean termites. For more details, the forensic factors that influence every construction element can be seen in Table 5.

The Cost of Maintenance and Cleaning of the Sion Church

Although the Government of Indonesia has established the status as a national cultural heritage building, the management of the church is under the Sion authority. Daily management is carried out at the expense of the Sion's congregation. For example, donations and tithes during worship. This maintenance management includes cleanliness and building maintenance. It can be said that the costs for the maintenance of the Sion Church are only incidental, which of course, amount does not match the needs of the Sion Church maintenance.

The Sion Church is a cultural heritage building that still needs to be maintained. In 2001 and 2002, church walls and doorframes were painted. However, lately, this kind of treatment is rarely carried out, even though it requires ongoing costs to maintain cultural heritage buildings. Meanwhile, to get special treatment, the operational costs must be based on submitting funds needed to the Jakarta Provincial Government's Cultural Heritage Conservation Center, considering the large number of costs required.

Apart from the government, of course, the preservation of cultural heritage must include togetherness with the community. From the results of observations to the Sion Church, the condition is indeed very costly for its conservation. Uniquely, the maintenance or conservation measures taken should not use ordinary building materials. Furthermore, they must adjust to the existing building materials in the Zion Church. It is fitting that a cultural heritage building needs to be preserved, especially as a heritage asset in the capital city that is more than three centuries old and requires consistent conservation action.

CONCLUSION

The examination of the building construction components observed was in the category of minor to severe damage. The construction component, which is included in the minor damage category, is the floor. Damage to this floor can be caused by lowering the foundation, which results in a cracked part of the floor. Meanwhile, the construction components of the outer walls, roofs of buildings, utility elements, foundations, ceilings, stairs, placement of building facilities, and structural frame systems were moderately damaged.

Construction components of doors and windows, ceilings, inner walls, inner wall cladding, and building supports (overstek) were severely damaged. Damage to door and window components was caused by wood shrinkage by solar radiation, rainwater humidity, and biological destroyers (especially termites). Generally, the damage to the construction components in the Sion Church is caused by the age factor. Based on the examination of the condition of the Sion Church, it was found that the reliability value was 33.90 with moderate damaged maintenance conditions.

The most significant decrease was found in wall pairs (37.43%), inner walls (30.50%), and doors and windows (30.10%). It decreased the wall pairs quality due to a profound decrease in the foundation due to land subsidence. The settlement of this foundation also resulted in the cracks of the walls, the outer walls, and the Sion Church's inner walls. The quality of wood used in the doors and windows is greatly influenced by the lifetime of the wood material. As a problem solving, the components of doors and windows must be replaced periodically.

Currently, the care management at Sion Church only relies on the costs from the congregation of Sion Church. This maintenance management only includes cleanliness and building maintenance. It can be said that the costs for the maintenance of the Sion Church are only incidental, which of course, amount does not match the needs of the Sion Church maintenance. As a particular treatment, the operational costs must be based on submitting funds needed to the Jakarta Provincial Government's Cultural Heritage Conservation Center,

considering that the costs required are pretty significant. Besides, further research is needed on the Jakarta Sion Church, especially conserving this cultural heritage building.

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