Fire Evacuation Plan Based on Availability of Time in a Conservation Area

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Abstract—The preservation of buildings in a municipal conservation area is not sufficiently supported by the regulations imposed on the building when it is restored or converted. The immediate area surrounding the conservation building remains a freely constructed area. The existence of the new buildings can unwittingly threaten the continuity of the conserved buildings. Other forms of threat to the preservation of cultural heritage buildings other than demolition are fire hazards that may originate from buildings around preservation objects that may endanger the continuity of conserved buildings. When access to fire-fighting and human-saving assistance is only by dismantling old building, even conservancy building have to yield. Consideration to the classification of the conservation building, its location in the downtown area, the situation and the density of the surrounding area, adjacent building function and the architectural style of the conservation building is not enough. The readiness of new buildings in terms of response to the fire ignition, the preparedness of water facilities for fire suppression within 45 minutes, occupants rescue, accessibility of assistance, becomes a matter of concern when the building permit is issued.
The prediction of time egress for occupants by utilizing IES (Integrated Environmental Solutions) technology, applied to a design as an example can be used as the basis for designing rescue paths, determining the assembly points as a save destination, early in the design process. The results of this time calculation can also be used to prepare the post-occupation fire management in the future. The right action based on the available time to save the conservation area's inhabitants and its surroundings, will also save the conservation building. *Keywords: Preservation of buildings, evacuation time egress, accessibility*

1. Introduction

The act of preservation of historic buildings in the city of Bandung, raced between building demolition and legality of conservation object determination. Bandung city government divides the conservation area into 6 historic areas: downtown area, Chinatown, villas, defense and security, ethnic Sundanese and industry [1]. Each of these areas has different characteristics, especially the placement of building masses on its site.

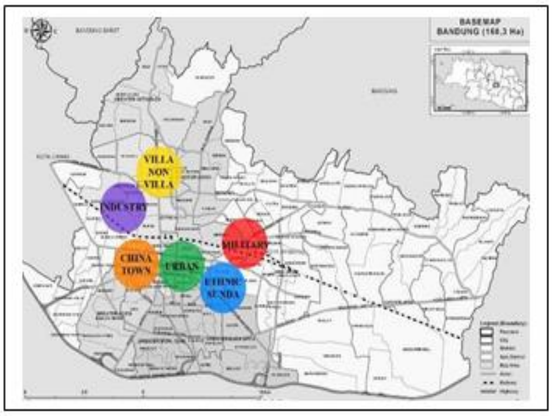

Figure 1. 6 Location of Heritage Area in Bandung
Source : Edited from Google 2017

Figyre 2. Single and Row Building at Conservation Area in Bandung

Preservation of old buildings in Bandung carried on a variety of buildings ranging from single-mass buildings to several building masses which form a row of mass. Conservation object in the form of a single building, in general has a fairly good building distance with parcel next to it. In contrast, a row of shop house objects such as those in Chinatown or "pecinan" region / trading area usually have no distance to the surrounding plots. Access comes only at the front of the building parcel.
Although a building has been declared to be preserved, ownership can be still over handed. Adaptive re-use is a design strategy in which new owners take to conserved buildings which located in the commercial area of the city. A new design of a hotel is a form of adaptive re-use which is quite a lot done in the city of Bandung. Without changing and dismantling the main building, hotels with many floors are built on the back or side of the plot.

Figure 3. Adaptive re-use of preservation of Historic Buildings in Bandung
Source : https://origin.pegipegi.com/jalan/images/pictL/Y0/Y967840/Y967840030.jpg

The technical planning of the restoration of the building is consulted to a team of expert on heritage building (Tim Ahli Bangunan Gedung Cagar Budaya**)** [2]. The threat of dismantling while the legality phase is still to be reached, conservation objects can also face post-hazard fire threats, especially on a conserved building which formed in a row mass, which have undergone adaptive re-use or addition of new building behind it . Preservation of historic buildings has also to be prepared for post occupancy threats, both against earthquakes and fire. Fire threats prevention can be well planned from the early stage of design and development. Either the threat of dismantling while the legality phase is still to be reached, conservation objects can face post-hazard fire threats, especially on conserved building which formed in a row mass, which have undergone adaptive re-use or addition of new building behind. Preservation of historic buildings should not stop at the execution. It has also to be prepared for post occupancy threats, both against earthquakes and fires. Fire threats prevention can be well planned from the early stage of design and development.

2. Literature review

2.1 Building Classification

The classification of buildings should be reviewed both from the classification under fire regulations and building conservation requirements. Classification based on [3] divides the building into 10 classes based on the activities inside it. This classification is closely related to the occupancy load. Another building classification divide buildings into 4 classes considered against duration of structural component resistance to exposure to the fire in order to give time to residents to save themselves in a fire [3]. According to Peraturan Daerah Kota Bandung No. 19 Tahun 2009, Pengelolaan Kawasan Dan Bangunan Cagar Budaya, the determination of the region and cultural heritage buildings are based on five criteria as follow : value history, architectural value, value of science, Social and cultural values, and age [4].

The classification area of cultural heritage building are divided into three catagories, as follow :

a) Class A (primary) are heritage buildings that meets four criterias
b) Class B (middle) is a heritage building that meets the three criterias
c) Class C (pratama) are heritage buildings that meets two criterias

2.2 Technical Requirements for Building and Environment

Preparation of sites and the environment for fire-fighting vehicles is calculated to the height of 4.5 m free space above the pavement layer with a width of min 6.00 m[3]. The provision of access roads for fire-fighting vechile is considered against the volume of buildings. The most influential buildings Technical provisions in building safety are the provisions on minimum width of the corridor 1.8 m, the distance of each point in the corridor to the nearest fire stair door maximum in a radius of 38.00 m and the dimensions of the fire stair [5]. The capacity of the exit means is determined by the occupancy burden per floor [3]. The fulfillment of these technical requirements is essential to provide sufficient space for residents to exit the building.

2.3 Terms of Building Utility

The source of water supply for fire hydrants shall be taken into account for at least 30 minutes of water supply [3]. This means that within 30 minutes the building must be able to defend itself with the available water supply blackouts. At the same time the occupants of the building have a chance to get out to a safe place. The ability of new building planning to last for 30 minutes, will also save the building of cultural heritage. In order to prevent fire not extends to the surrounding buildings, distance between buildings is set for buildings 14.00 m up to 40.00 m has a distance of 6.00 to 8.00 m from the adjacent buildings [3].

3 Method

The approach taken in this study is the analysis of a building design (hotel) by using software (IES-Simulex). From this analysis, the evacuation data of the occupants is recorded with every 5 seconds. By using some alternative obstacle positions in the form of a possible fire location, it can be recommended building design that is more accommodating the availability of evacuation time to fire disaster.

4 Case Study

The case study was taken on one of the sprawling parcels in the downtown area of Asia Afrika street Bandung. The building is located between Alkateri road and Banceuy street bordering China town area.

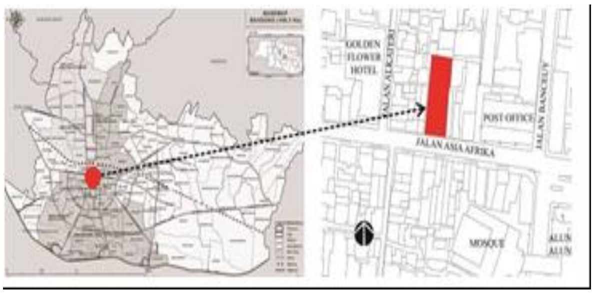

Figure 4. Location of Case Study. Source : Edited from Google 2017

Figure 5. Existing of DEZON N.V. building. Source : http://nyeduhteh.blogspot.co.id/2015/05/sekilas-cagar-budaya-bandung-1.html

A building in Art Deco architecture style known as DEZON N.V. consists of 2 floors was built in 1925. [6] [7]. DEZON V.N. serves as a department store. But with the passage of time, this building undergoes several changes to function until now planned residential function of a 10-storey hotel that can accommodate 128 units of rooms. DEZON V.N. is a class A historic building which should not be dismantled, then the main building is maintained by adding a new building on the back of the plot. The new building is planned on an area of 2,125 m^2 with a floor space of 906 m^2 and the total floor area of 6,353 m^2.

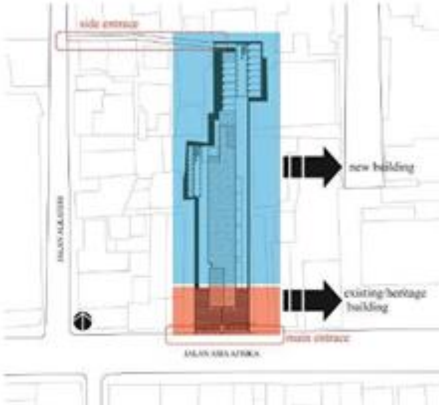

Figure 6. Siteplan Hotel Design
Source : PT. Estrella Sembilan, 2017, edited

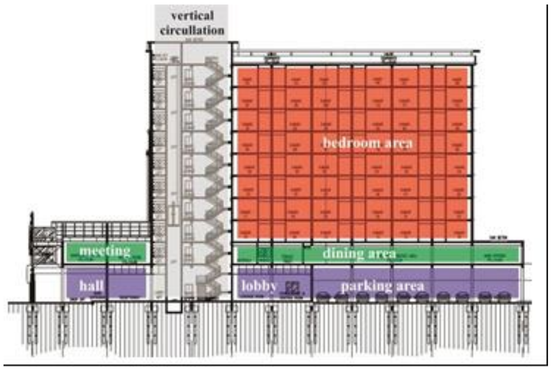

Figure 7. Building's Function Area
Source : PT. Estrella Sembilan, 2017, edited

Accessibility on the site plan is provided at two points, the main access being on the Asian-African road while the side access is a small corridor of 1.80 meters width connecting to the Alkateri road. New function on the existing building at the front, designed as public functions such as lobby, lounge, reception and vertical circulation. Behind the existing building stood a design of a new building with a parking function on the ground floor, meeting room on the 1st floor and bedroom on the 2nd - 8th floor. This new 10-storey building reaches 35 meters height. An art deco facade style of the new building is to adjust the existing building as a contextual response.

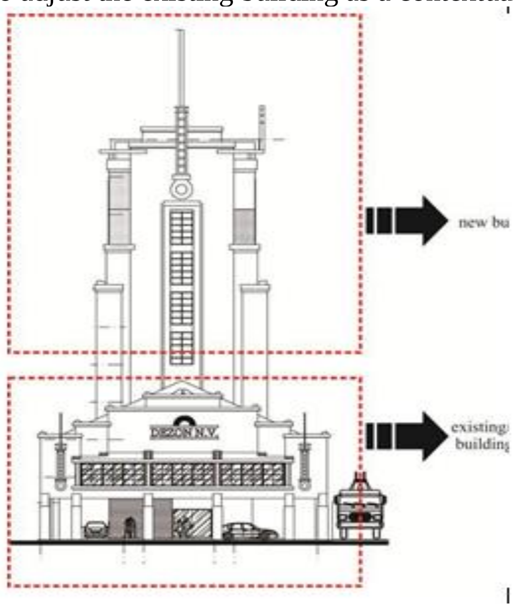
Figure 8. Building Fasade Design
Source : PT. Estrella Sembilan, 2017, edited

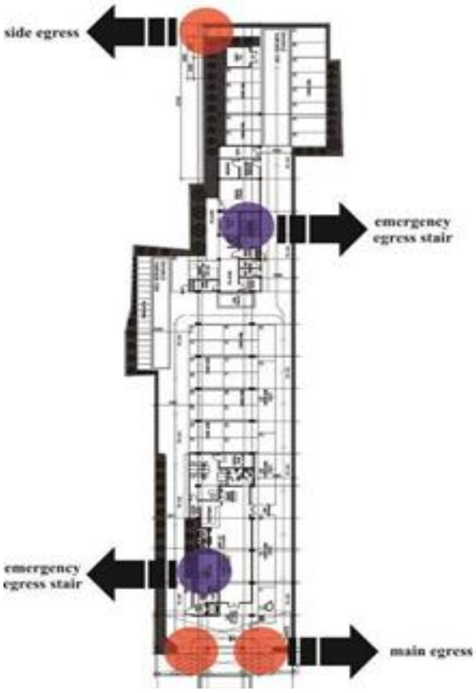

Figure 9. Emergency Egress Location
Source : PT. Estrella Sembilan, 2017, edited

This building provided 2 fire stairways in a distance of 53.00 meters against fire hazards. Both connect each floor as an access to discharge at the main entrance area and side entrance.

5 Result and Discussion

The facade of the new 10-storey building is in context to the old building and the surrounding art deco buildings in the historic area. The new building, facade ornaments use a geometry element with the tower emphasis in the middle.

Figure 10. Fasade of New Building's Design.
Source : http://i.imgbox.com/AnSXy56C.jpg

Figure 11. Radius Distance of The Floor Plan
Source : PT. Estrella Sembilan, 2017, edited

The mass of the new building has a volume of 20.547m^3, so the required access point is 1/6 x 157.663meters (the circumference of the building) = 26.16 meters [3]. This means that road pavement in front of the plot is enough to serve as a place for fire engines. The free distance required for the mass as high as 35.00 meters is 6.00 meters so that the fire cannot easily spread to other buildings. Typical floor designed in a double loaded system, separated by a corridor 1.75 m width with 2 units of exit. Exit distance is calculated against ½ x 68.347 m (diagonal distance of the floor plan) = 34.17 m.

Figure 12. Diagonal Distance of The Floor Plan.
Source : PT. Estrella Sembilan, 2017, edited.

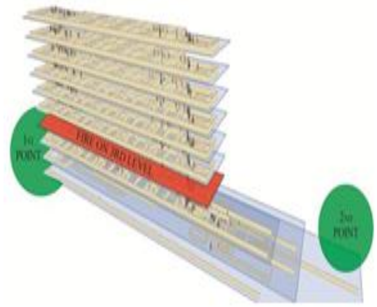

Figure 13. Simulation of first alternative

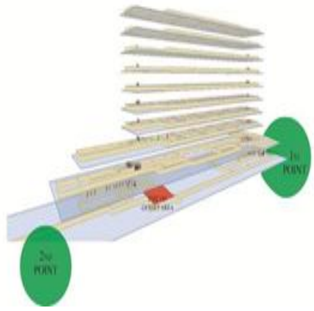

Figure 14. Simulation of second alternative

Evacuation process on case study is simulated on Simulex software. The simulation is done by taking some assumption on maximum number of occupants (371 persons). Add a number of persons with disability to get mixed inhabitant's condition. Change some position on the origin of fire as variables to put into the program as obstacle and the layout of the evacuation point (exit). Simulations conduct in 2 alternatives. On the First simulation, origin of fire took place on the 3rd floor corridors, while on the second simulation, origin of fire occurs on the ground floor in the generator room. Both simulations placed gathering point in two alternatives too. First gathering point alternative placed at the front of the building to the Asia Africa road. On second alternative two gathering points placed both at the front and the back towards Alkateri road.

Result of the simulation in details can be seen in the following table:

Table 1. Simulation of 2 alternatives

Fire	***1 Gathering***	***2 Gathering***	***occupants***

Location	*Point*	*Point*	
Corridor	6 minute 42 second	4 minute 38.1 second	371
Genset room	6 minute 43 second	3 minute 50.4 second	371

Referring the above table it can be concluded that the fire position has no significant effect in evacuation time, unless there is accumulation of fire location. The position of the gathering points spread in both directions (front and back of the site) is very helpful in the fast evacuation process. In addition two exits will provide other alternative evacuation if there are obstacles on one of the evacuation routes.

In more detailed simulation data, if only one point is used, the level of the fire stair density close to the assembly point (front staircase) is higher than that of the back stairs. At the fire stair which connects the first floor and ground floor, there is an evacuation density with a considerable time span, from the 20^{th} second to the 375^{th} second, with an average of 5 persons / second. The highest density occur in the 70^{th} second and 95th seconds, with 8 people / sec on the front fire stair from 1^{st} floor to the ground floor. Even this is influenced by the placement of function room on the 1st floor which only depends on the elevator as a means of vertical transportation at normal time. In contrast to the use of 2 points of gathering, Fire stair loads tend to be evenly distributed, with an average density for stairs on the ground floor 4 people / second. Maximum density occurs in the 30^{th} second to 45^{th} seconds on the back stairs connecting the 1st floor with the ground floor. This is also likely due to the evacuation of the function room and office manager.

6 Conclusion

The use of IES software is very dependent on the fulfillment of the completeness of facilities such as corridor width, the number of exits on the floor plan, space configuration, the fulfillment of active and passive security systems and field infrastructure in accordance with applicable regulations. Preserving a cultural heritage is an effort to be made in the development of a city. Construction of new buildings must really consider its existence. Fire emergency conditions should be predicted carefully, so that the interest of rescuing residents against the disaster does not clash with the existence of the cultural heritage. Based to the simulation of IES-Simulex to the case study it can be concluded:

a) The need of alternate gathering points close to the fire stair access.
b) A very important back-entrance evacuation path is designed for evacuation routes at the rear-end point, in addition to speeding up evacuation as well as to facilitate (not disturb) fire extinguishing access to just one, ie from the front of the building
c) Additional stair required, in addition to the existing fire stairs for access to public spaces that have a large capacity (function room)

Simulation results can be used as an evaluation of building design in the early stages of the design. Utilization of time calculations through IES software provides an alternative to consider in developing an evacuation strategy that should be tested in a fire drill exercise that should be done once a year. The availability of sufficient time to evacuate the occupants of the building before the water supply runs out and the arrival of assistance will preserve the preservation object from the demolition action.

6. Acknowledgment

We would like to thank PT. Estrella Sembilan Indonesia for the provided data of adaptive re-use Dezon N.V. Bandung.

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