Passive fire protection in high density village (case study, Bustaman Semarang)

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Abstract. Fire hazard is the disaster that always has an unpredictable process of coming. When it comes, its level scope and the magnitude of the effects cannot be predicted. Dense settlements especially in big cities, among others Bustaman Kampong Semarang never escape from physical problems such as flooding and wildfire. If both are compared in dense settlements scope, so that, wild fire is the most potentially catastrophic. It is necessary to do a research on passive fire protection in a village of high density city such as Bustaman. Qualitative research was conducted using descriptive method to conduct observations and interviews in the Bustaman.

Bustaman as a high density village, with narrow roads and dense rows of houses. The terraced buildings are also encountered, and found many buildings use combustible material. That environmental conditions can facilitate the propagation of flames in case of fire.

To improve the established Bustaman’s environment, in terms of the application of passive fire protection systems, it is recommended to utilize the road as the dividing buildings. Need to build the separation wall fireproof in every each series in several units of too long buildings and attempted open space procurement that separates rows of buildings that are too long, and also the replacement of combustible material with a material that is more incombustible.

Keywords: passive fire protection, dense settlement

1. Introduction
Fire hazard is the risk that needs to be watched, especially in dense settlements. Firewild will always be harmful. Flame and firewild occurred involves several elements. Therefore fires can be prevented by controlling the causing elements of the fire. Fire-fighting effort usually done with active and passive protection systems. Active protection system is a system of fire protection from the inside of buildings and the environment itself, and pursued by the owners themselves, such as installing utilities prevention of fire hazards. Furthermore, in the prevention and management of fire, the building design and the environment must be considered passive fire protection, such as flame-retardant material selection, compartmentalization, the spacing of the room / building, design footprint of the building which is accessible to fire engines [1].

Fire danger in dense settlements which has been described above it is important to be studied, in order to avoid casualties and great losses in case of fire. Not only within the scope of one building, the dense settlement also closely involving the environment around the building units. So, we need a thorough review within the scope of the building and the environment.

There are some items that should be considered in planning efforts secure building against fire: (1) Prevention of sources of ignition and spread of wider fire. (2) Fire protection to the building structure. (3) Smoke detection and path planning of emergency. It can be used as background knowledge in the conduct of research [2].
Building and environment structures as a condition of physical / spatial built-environment which are in that area found the facts forms-physical / spatial manmade form of buildings (facilities and environmental infrastructure), directly adjacent to the facts physical form / natural spatial [3].

Based on Minister of Public Works Regulation No. 26/PRT/M/2008 on Technical Requirements for Fire Protection System in Buildings and Environment. That any required environmental areas have the safeguards against fire, either passive or active.

Bustaman is densely populated settlements in the core city of Semarang. A village covering an area of 0.6 hectares consisting of 2 RT (neighborhood association), those are RT 04 and RT 05. Villages with a population of 366 people or 114 households. Bustaman is categorized as a very high population density because it reaches 610 inhabitants / ha [4].

Besides to the condition of a dense population, with the condition that only the residential area of 0.6 hectares, also found that the neighborhood Bustaman only have a narrow neighborhood street, with lots of terraced houses, especially the installation of biogas potential sources of ignition. The purpose of fire protection systems, especially passive system, among others, (1) Protecting the building from collapsing simultaneously due to fire, (2) Minimizing the intensity of the fire in case (that flashover does not occur), (3) Giving time for occupants to save themselves, (4) to ensure continuity of the function of the building, but still safe, (5) Protecting the safety of firefighters when fire-fight rescue operation occurred [5]. These things support the importance of passive fire protection assessment in Bustaman so can reach the objectives mentioned above.

2. Methods
Assessment of passive fire protection in Bustaman using qualitative descriptive method by describing the data in the field and analyze the corresponding variables passive fire protection qualitatively with reference to rules / regulations applied. After conducting a qualitative analysis, conclusions are drawn regarding the application of passive fire protection system in Bustaman, and formulated recommendations in terms of the implementation of passive protection system.

3. Discussion
Bustaman widely known as a producer of processed goats meat such as Bustaman goat curry. Bustaman location as a locus of research can be seen in Figure 1.

3.1. Fires Potential
Bustaman never experienced a fire in the era of the 60s. This event was caused by citizens cooking activity, who at that time was located at gedong 10. From the description of Mrs. Siti Haliman (67), it happened because of tinder burning in the kitchen processing curry goat. Tinder wood shavings is a powder that is used to prefix burn firewood. The fire quickly spread because the building material are made of wooden planks. Looking at the Bustaman’s history which has ever experienced a fire, it is fitting to be more vigilant in the next period, one of them is implementing a system of passive fire in Bustaman.

Before studying the fire protection variables, keep in mind the potential causes of the fire in Bustaman are the source of fire and electrical networks.

3.1.1. Fire Source
Some fire sources in Bustaman which potentially cause a fire:
- Citizens’ kitchen are located at the front of the house which is directly adjacent to the road can be seen in figure 2. The presence of the kitchen at the front of the room in the house due to the house has narrow rooms and it is not possible to put a kitchen in it. In terms of fire protection, kitchen is outside the house has a positive side that easily to reach the source of the fire in case of fire from the kitchen, fire-fights efforts easier to do. But there is also a downside, namely in case of fire arising from the kitchen outside the house, and did not immediately extinguished, the fire would easily spread to the other house or building around them.
- Kitchen stalls and goat curry processing.
The existence of the kitchen at the stalls and goat curry processing are also the sources of fire to watch. The existence of stalls outside the home is also possible to allow the fire to spread into surrounding buildings. In contrast to the kitchen stalls, goat curry processing that is in the house has a tighter guard due to being inside the building and usually use incombustible wall (incombustible material).

- The house and the installation of biogas
  One of the Bustaman’s advantages compared to other settlements is the installation of biogas from sewage / human waste. The collected organic waste from public toilets processed into biogas. MCK (toilet) using anaerobic treatment system consisting of bio register as a tank, septic tank as a sedimentation basin, the baffle reactor to reduce Chemical Oxygen Demand (COD) by 80%, and anaerobic filter as a residence and the development of anaerobic bacteria [6]. Houses and biogas installations are also a source of fire that really needs to be watched out. Biogas is a fuel that is very effective, so the presence of the biogas installation can always be monitored. Biogas home and MCK (toilet) as storage of waste can be seen in Figure 3.
3.1.2. Electric network/ electric grid.

Electrical installations in Bustaman include electrical fuse to prevent short circuiting. However, prevention of surge is not enough just to use a fuse, it is observed there is still electrical wiring in some homes that do not use the services of certified Electrical Engineering Bureau (BTL). In fact, some are undertaken solely by home owners. The type and quality of existing electrical wiring, not all in accordance with the capacity of electric current through the cable. It is very vulnerable because it can lead to short-circuits. For regions that are very dense, very important to have an electrical network certificate that is always monitored by PLN (State Electricity Company). The conditions and the situation of electric network system environment also need to be recked, the compliance community to equip his home with electrical installations using BTL (Electrical Engineering Bureau) legitimate services which is equipped with electrical installation plan made by BTL.

3.2. Variable of Passive Fire Protection

Preventive variable for passive fire hazards that exist among others: the road conditions, the building layout arrangement, buildings rows, and material use. It also includes attention to sources of ignition such as building and environment’s electrical networks which has been described previously.

3.2.1. The width of the road

The road environment in Bustaman have widths from 1 to 2.5 meters, it does not meet SNI 03-1736-2000 on procedures for planning passive protection system for fire protection in houses and buildings which is requiring that a minimum road width is 6 meters [7]. With a width of that roadway, Bustaman difficult to be accessed by emergency vehicles such as fire trucks. The narrowness of the road, coupled with the dense buildings in Bustaman, will hamper the circulation and evacuation in case of fire in Bustaman. A fire truck can only be stopped by the roadside MT. Haryono, and burnout done with hoses that are required to have a range of up fires. With this kind of cramped conditions, efforts outages can also be done from within Bustaman is by spraying water from a nearby water source. Existing condition in the road representing Bustaman can be seen in Figure 4.

3.2.2. The Height of Building

The height element of the building is also a passive fire protection variable of a settlement. The higher a building, fire evacuation efforts would be more difficult because the location is more difficult to reach. Bustaman existing condition in the village consists of several terraced buildings / has two floors. With a narrow road conditions, the presence of 2-storey building needs to be watched out, because in case of fire on the upper floors, allowing for burning building debris collapsed onto the road so it can propagate the fire. The existence tritisan (sun shading) almost connect between buildings also makes a fire easily spread. Therefore this kind of situation should be changed by eliminating the building’s tritisan. Conditions which is representing building height can be seen in Figure 4.
3.2.3. The distance between the Building (dilatation)

Dilation or the distance between the buildings also affects the passive fire protection in a dense settlement. It is also regulated in the classification of buildings SNI 03-1736-2000 Type C is required a separated-fire wall or walls within which limits a single dwelling unit or separate units adjacent. The conditions in Bustaman, not all houses have dilatation, but already all have walls in each. Some houses which have dilatation can be used as lengkong (side entrance) or an alternative access to enter the house when the main access cannot be bypassed (eg. being held an event).

3.2.4. Building materials

The building materials used in houses in villages largely use permanent material that is reinforced concrete frame construction with brick masonry wall barrier. The use of these materials can inhibit the propagation of flames in case of fire. But still there are buildings that use semi-permanent materials such as walls and columns of wood. This material is not fireproof material, making it easily spread fire in case of fire (combustible material). Semi-permanent building can be seen in Figure 5.

3.2.5. Water sources

In Bustaman, water sources are found in the form of wells located in toilets or public toilets. These wells are managed by the citizen for the common good. There are also private citizens’ wells and the water is piped into the bathroom or to the front of citizens’ house. However, it is commonly used for fire protection is jointly owned wells located at MCK / Common toilet, so the operation be more accessible and not disturb the privacy of people's wells. Wells that are ready to be used to extinguish fires are at the center and in the east of Bustaman. Location of the wells can be seen in Figure 6.
Given the narrowness of the access in the village Bustaman, the distribution wells are assessed as insufficient. Wells should be increased again in the southern area of Bustaman towards Jl. Petudungan.

3.2.6. Society Anticipation

Passive fire protection here is not only in the context of the physical environment, but also required the participation of society as a preventive. Public awareness about the importance of fire prevention is necessary because a man with all the instruments (technology and organization) determines a good or bad environment [8]. Humans as a social component in the use of technology / organizing things will be a major impact on the natural components and cause symptoms / consequences such as fire. Some efforts should be made public to prevent fire hazards, among others:

- Passive fire protection, in the first line is determined by the detection system symptoms of the fire, which is carried out by people day and night could be in the form of patrolling.
- Flammable materials around the center of the symptoms of the fire should be broken / removed so that flame propagation is hindered. Initial extinguishing actions can be done by citizens before the fire tank car come.
- Extinguish the fire starting point in a simple way: for example, flush with water from nearby sources (wells, etc.). So that the procurement wells evenly in Bustaman environment is also a fire hazard prevention protection efforts passively.

The passive fire protection efforts will give a positive impact on the physical environment. The physical condition of a good environment will contribute to the increasing of social economic aspects [9]. So that the improvement of environmental conditions will provide benefits back to humans.

4. Conclusion

4.1. Conclusion

After analyzing the data in Bustaman, it can be concluded that Bustaman is still not implementing passive fire protection systems. This was concluded because:

a. The layout of the Bustaman’s majority building is directly coincide. The layout of the building is a risky factor for the propagation of fire if any one of the buildings in the area on fire. The separation walls between the buildings are very easily carry on the flame by conduction on the building side, in addition, the temperature transmitting by convection can also spread fire to the surrounding buildings.

b. If the two-storey buildings on the dense settlements as Bustaman are burnt, the combustible material will easily fall into another building because of the narrow dividing road.

c. There are still contiguous buildings made of a-high-value combustible material or very easily-flammable.

d. The narrow neighborhood streets are also made the fire truck difficult to get in. Up to think that to make all buildings are covered by a jet of water from a hose of the fire extinguisher tank, the position of the car is on a highway.

4.2. Suggestions

It has been concluded that the Bustamanis still very lack of attention in the passive fire protection systems, so that, it needs adjustments again to prevent a fire hazard. Some suggestions / recommendations from this research results include:
a. Utilization of the road as the dividing of building must be implemented properly. Separation between buildings are aligned to contribute towards the prevention of fire propagation to surrounding buildings in case of fire.

b. Separation of the building also needs to be done into one side. The use of the building dilatation as lengkong (side entrance) of the building, be an alternative to inhibit the propagation of flame laterally. If not possible, can be applied fireproof walls between the buildings.

c. It also sought the procurement of open space that separates rows of buildings that are too long. Grouping of buildings in a certain amount by dividing a road, open space, the dividing wall is very useful to prevent the propagation of fire to surrounding homes until the arrival of firefighters.

d. Water resources construction in the southern area of Bustaman as an effort to provide the firefighters which is built in with the neighborhood.

e. Considering that the street in Bustaman is very narrow, road corridors should not be used to place the equipment and built/installed the shade like tritisan (tent) that are allowing to spread fire into front buildings.

f. Replacement of combustible material with an incombustible material, which is one of them by rejuvenating house buildings with wood / bamboo materials.

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