Research Progress in Mechanical and Manufacturing Engineering Vol. 2 No. 2 (2021) 678-684

RPMME

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/rpmme
e-ISSN : 2773-4765

Design of Fire Fighting Sprinkler System by Autodesk Revit

Kugkan Santha Kumar[1], Sri Yulis M Amin[1]*

[1]Faculty of Mechanical and Manufacturing Engineering,
University Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, Malaysia

*Corresponding Author Designation

DOI: https://doi.org/10.30880/rpmme.2021.02.02.074
Received 02 Aug. 2021; Accepted 27 Nov. 2021; Available online 25 December 2021

Abstract: This study is about active firefighting sprinkler system. Overall view of a fire fighting system has been studied. As a summary, Firefighting systems has been classified into two categories, which is active firefighting and passive firefighting. Active firefighting is a group that requires some amount of action or motion in order to work; it is divided to manual system and automatic system. Passive firefighting are known as building materials that are always present and available within the building, placed and located evenly every floors of the building. Besides that, the standards and codes for firefighting system has been studied, the standard which is needed to follow is NFPA 13 and UBBL 1984. While planning to design a fire sprinkler system, there is few major factors which are need to be considered. The first one is the type of sprinkler system according to the nature of building, the second one is the type of sprinkler head and lastly the regulations which is standardized by the government. The digital designing project is carried out using Autodesk Revit . After the research and study process, the sprinkler system for a light hazard category building was designed in comply following the standard of NFPA 13, the upright sprinkler head which covers 225 square feet per sprinkler is used. As the outcome for the requirement, a double storey clinic and the sprinkler system with the single chamber valve and storage tank was design using Autodesk Revit.

Keywords: NFPA 13, UBBL 1984, Active Fire Fighter System

1. Introduction

A fire sprinkler system is an active fire prevention mechanism that consists of a water supply system that supplies pressure and flow rate to a water distribution pipe system, which is connected to fire sprinklers. Systems for homes and small buildings are now accessible at a cost-effective price, despite the fact that they were formerly primarily utilised in factories and big commercial buildings. Sprinkler systems are widely utilised across the world. Over 96% of fires were extinguished by fire sprinklers alone in buildings totally protected by fire sprinkler systems.

Water sprinkler system is an automatic device that not only indicates the incipient fire, but as an active fire protection means it extinguishes fire in its early stage without the steps of human factor.

Corresponding author: yulis@uthm.edu.my

Respectively it keeps fire under control until the fire brigade arrives. It consists of distribution piping system that is permanently attached to building structures, valve station and sprinkler heads that are firmly attached to the distribution pipes in the protected area.

Pipeline network together with sprinkler heads are connected to a water source. In the case of fire, water flows out from the sprinkler heads and sprays the area where fire is present. Water extinguishes the given area during fire, cools building structures and the surrounding area and at higher temperatures it evaporates quickly, displacing oxygen and thus creates an inert atmosphere, which prevents the access of oxidant.

2. Materials and Methods

This case study is carried out to design an automatic water sprinkler for a low-rise clinic building. The automatic water sprinkler has few specifications and types, it is important to choose the correct type of sprinkler system. Besides the sprinkler system, types of sprinkler head are also important to be analyzed. The designing process will be conducted by using Building Information Modeling (BIM) software, Autodesk Revit.

The design of water distribution for Firefighting consists of the following main steps:

i. Preliminary Studies

ii. Design Phases

iii. Network Layout

iv. Hydraulic Analysis

Before beginning the actual design process, topographical investigations must be completed. Digital maps of current houses, streets, lots, and other features should be created. It's necessary to evaluate about where water sources and pumping stations are placed so that distribution reservoirs can be found quickly. Hazards classification: The system is based on the extent of the risk, as well as the fire's growth and spread potential. For the purposes of system design, the risk should be classified into the following types.

A. Light hazard
B. Ordinary hazard
C. Extra-ordinary hazard–1

Spacing between 2 sprinklers: This depends on the coverage area of the sprinkler. Spacing is kept according to the light hazard classification. There are mainly two types of spacing provided as per the design criteria Triangular spacing and Rectangular spacing. Table 1 shows the distribution of the sprinklers according to each of the hazard class.

Table 1: Distribution of sprinkler according to the hazard class

Hazard class	Maximum area Per sprinkler m^2	Maximum distances as shown, m		
		Standard layout	Staggered layout	
			S	D
Light	21.0	4.6	4.6	4.6
Ordinary	12.0	4.0	4.6	4.0
High	9.0	3.7	3.7	3.7

The architectural drawing is made in Auto Revit is a workflow and software solution that enables a wide range of professions, including designers, construction professionals, architects, and builders, to collaborate. Models of real-world structures and buildings may be created with the program. Revit is mostly used in the field of building information modeling (BIM).

3. Results and Discussion

Each space was drafted according to observation of basic clinic structure in Malaysia. This building consists of mostly check-up rooms, therefore the approximate size of a medical check-up room is between 200 square feet to 300 square feet (Table 2). The lobby, entrance and waiting area are optional depending to its capacity and expected patients. Figure 1 and 2 shows the layout for the first and second floor of the building respectively.

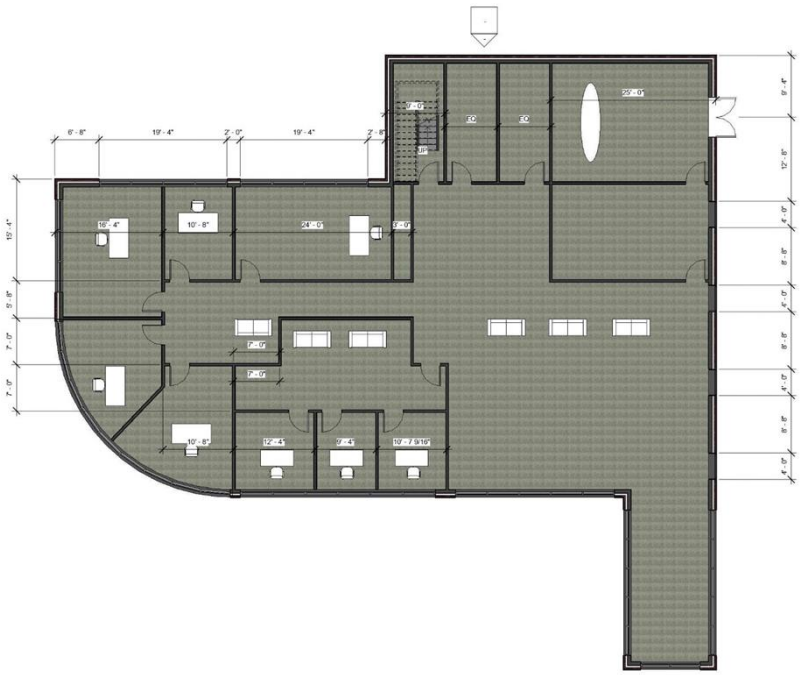

Figure 1: Layout of the first floor with dimensions

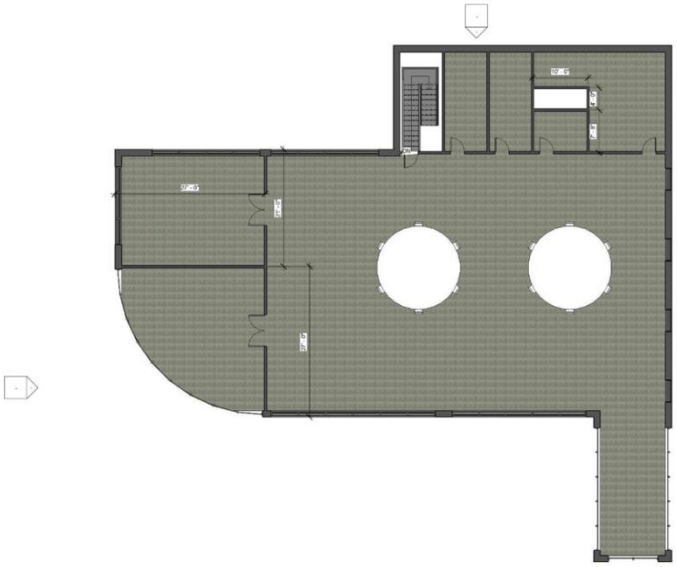

Figure 2: Layout of the second floor with dimensions

Table 2: Dimension of each space inside the building

Space	Dimension (square feet)
Entrance	422.82
Lobby	339.22
Waiting area	2223.39
Paediatric waiting area	347.44
Paediatric room 1	119.01
Paediatric room 2	103.92
Paediatric room 3	138.84
Room A	239.97
Room B	209.07
Room C	294.10
Room D	143.38
Minor surgery room	329.70
Cafeteria	3595.06
Head Dr office	519.60
Meeting room	503.60
File room	306.16

Based on dimension for each space, the number of sprinkler point is determined. Table 3 shows the number of sprinkler point according to the specific space.

Table 3: List of Spaces and Numbers of Upright Sprinkler

Space	No. of Upright Sprinkler
Entrance	2
Lobby	2
Waiting area	10
Paediatric waiting area	1
Paediatric room 1	1
Paediatric room 2	1
Paediatric room 3	1
Room A	1
Room B	1
Room C	1
Room D	1

Minor surgery room	1
Cafeteria	15
Head Dr office	2
Meeting room	2
File room	1

Figure 3: Realistic 3D of the elevated building

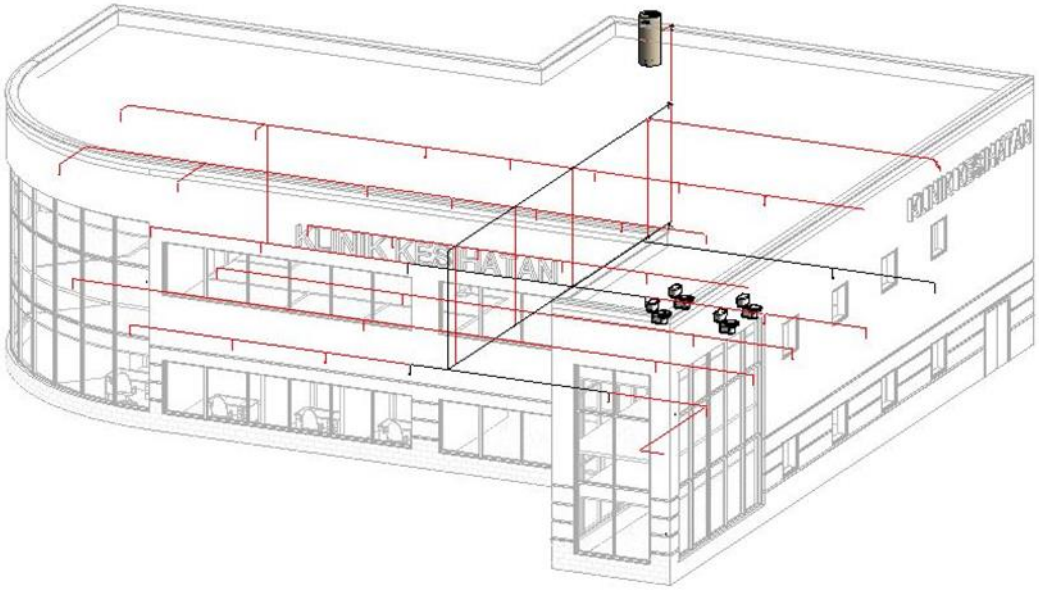

Figure 4: 3D Layout of Fire Fighting Sprinkler System

4. Conclusion

The objective is to study the active fire fighting system in a classified clinic. In order to achieve the first objective, research was done and studies were gathered about active fire fighting system. The second objective is to design a sprinkler system using Autodesk Revit software. The initial step to fulfil the requirement is to learn the basic interface of the software. In order to draw a complete and complex 2 storey clinic, constant practice and research was made to draw the architectural walls, reflected ceiling, architectural templates, piping dimensions and building elevation was theoretically and practically

Acknowledgement

The authors would like to thank the Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia for giving the opportunity to conduct this study.

References

[1] Evans, D. D. *et al.* (no date) *Federal Building and Fire Safety Investigation of the World Trade Center Disaster Active Fire Protection Systems*. doi: 10.6028/NIST.NCSTAR.1-4.

[2] Hicks, W. D. and Gorbett, G. (2016) 'Fire protection systems', in *The Comprehensive Handbook of School Safety*, pp. 149–159. doi: 10.1201/9781498710688-22

[3] L. Bass, P. Clements, and R. Kazman, Software Architecture in Practice, 2nd ed. Reading, MA: Addison Wesley, 2003. [E-book] Available: Safari e-book. (Example for e-books)

[4] Johansson, N. ; *et al.* (2012) *P O B o x 1 1 7 2 2 1 0 0 L u n d + 4 6 4 6-2 2 2 0 0 0 0 A Cost-Benefit Analysis of Fire Protection Systems Designed to Protect Against Exterior Arson Fires in Schools A Cost-Benefit Analysis of Fire Protection Systems Designed to Protect Against Exterior Arson Fires in Schools*.

[5] Korobeinichev, O. P. *et al.* (2012) 'Fire suppression by low-volatile chemically active fire suppressants using aerosol technology', *Fire Safety Journal*, 51, pp. 102–109. doi: 10.1016/j.firesaf.2012.04.003

[6] Lim, J. W. *et al.* (2019) 'Numerical analysis of performances of passive fire protections in processing facilities', *Journal of Loss Prevention in the Process Industries*, 62. doi: 10.1016/j.jlp.2019.103970.

[7] *List of NFPA Codes and Standards* (no date). Available at: https://www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/List-of-Codes-and-Standards (Accessed: 5 January 2021).

[8] Liu, Z. *et al.* (no date) *A Review of Water Mist Fire Suppression Systems&Mdash; Fundamental Studies*

[9] Nfpa (no date) *Sprinkler Design Requirements Based on Vulnerable Occupancy Facility Size and Sleeping Accommodations NFPA 13, 13R and 13D Sprinkler*

Design/Installation Comparison Chart [Based on National Fire Protection Association (NFPA) Source Document] System

[10] *NFPA 291 Hydrant Flow Testing Fire Flow Testing and Marking of Hydrants* (no date).

[11] Robin, M. L., Forssell, E. W. and Ginn, S. T. (no date) *A Comparison Of Fpetool Predictions To Experimental Results: Comparison Of Clean Agent And Sprinkler System Performance On In-Cabinet Fires*.

[12] Salleh, N. H. and Ahmad, A. G. (no date) *Fire Safety Management In Heritage Buildings: The Current Scenario In Malaysia*.

[13] Sam, I. and Hui, C. M. (2018) *Revit Fire Protection SBS5411 Building Information Modelling for BSE*. Available at: http://ibse.hk/SBS5411/ (Accessed: 13 January 2021).