Estimation of Fire Load Calculation in College Library

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Abstract

In the library there are many valuable books stored. In case of a fire accident or any other short circuit, all these valuable books may get wasted. The valuable books will be useful to the students or other people to utilize them. From this, we take the library's are to be safe to protect valuable books. In the library to calculate the weight of the material and identify the calorific value of the material to know the range of fire. Fire is one of the major hazards which causes loss of people's property and environment. Fire is the exothermic process of releasing heat and light from the combustible materials. If the ignition of fire in the combustible material, the growth and full development of fire will burn out the materials and it will become useless ash. All the materials will be identified. The fire will be blanked out by using Carbon dioxide $gas(CO_2)$. The water cannot be used as a fire extinguisher agent. If we will use water, the remaining unburned books are also get wasted. So we use CO_2 gas to extinguish the fire. The fire will be cut off and presence the remaining valuable books in the library, and it can be utilized in the future.

Keywords: Calorific Value, Fire Load, Library, Types of fire, Source of ignition

1. Introduction

Fire load is basic data to the performance-based fire protection design regarding the overall development stage of fire as well as the intensity and duration of the fire. Knowledge of the statistical distribution of the fire load is essential for designing a library against fire. The fire load is calculated by the weight of the material to the multiple calorific values is divided by the total area of the library[24]. Identify the types of fire, and also find the combustible materials present in the library like paper, wood, etc. The weight of the material is calculated by both the inventory and direct weighing method[14]. The calorific value of the material is identified under the reference of fire loads in office buildings in the journal of structural engineering[22]. By the calorific value, if there is any triggering of fire like electrical short circuit etc. The paper can easily get fire within a short period. If there is a fire in one book, due to the heat of the fire in that book, every other book will catch fire and wasted. This can be avoided controlling the fire, or blanket the fire by using any type of fire extinguisher. Abdul Haqeem Alchyanic surveyed the fire load for 25 rooms and two different office rooms in the faculty of engineering, University Putra Malaysia. From the survey, they find the layouts which have a greater area will have the highest fire load energy density[1]. Eduardo E.C. Rodrigues [2] deals with the importance of fire safety methods and regulations to avoid death at industries due to the lack of failure of fire alarm in the industries. Pontip Stephen Nimlyat[3] deals about the fire safety measures in the high rise building of Nigeria. And found that fire detection system is not functioning properly due to the lack of regular tests and poor maintenance. Manish Nigram and N. Sures analysis the fire load calculation on hospital buildings[5] and also in Daria Daulet Bagh and Sri Ranganatha Swamy temple[9] they surveyed the buildings and calculate the fire load for every room and every floor of the buildings. Also, calculate the fire load for every movable and non-movable material. David Rohole[6] deals with the presence of smoke alarms to prevent injury and fatal rates from the fire. It also compares the fatal rates between working and without working on smoke alarms in the industry. Nam Kyun Kim[7] experimentally deals with the fire extinguishing and penetration performance in the wood cribs and wood floor. From this, they find the penetrating range of extinguisher to reduce the fire.

Ola Willstrand [8] deals with the fire scenarios in the sleeping and toilet compartment of the buses. Also surveyed were the smoke detector to place in the buses. M.J.spear [10] calculate the fire load in the car parking buildings. It also deals with the space specification of the respective vehicle to stop in the parking area. Negar Elhanic Khorasni[11] surveyed the fire load calculation in the office buildings and Mrs. Lilly grace Murali [12] surveyed the fire that occurred at AMRI hospital Kolkata, Krishna school building Kumbakonam and Caralton tower office building Bangalore Karnataka state. These case study deals about poor maintenance and not following the rules properly. Jack wook kwon [13] deals with the fire safety protective measures in the proscenium theatres as per the NFPA 80 standards. Wei Gao [17] conduct a fire load survey for hotel buildings in different cities in China. They classified the hotels into 3 ratings, low, middle and high ratings. From this fire load survey high rating hotel having a high fire load. Carmen C.S Fong [18] conduct a fire load density survey in 4 shopping malls in Hong Kong. They classified four malls into A, B, C and D. Mall A, B and C were provided a fire fighting system and mall D provided only portable extinguisher. The fire load of these above four malls, mall C has a very high fire load density. Antonio M. Claret [19] and w. K. Chow[20] surveyed the fire load density of historic buildings and 35 years old residential buildings respectively. In residential buildings, they stored more flammable liquids like kerosene and liquefied petroleum gas(LPG) in the living rooms. So it will get fire easily. E. Zalok [21], conduct the survey result of fire load in the Canadian cities of Ottawa and Gatineau of commercial premises like restaurants, travel agencies, pharmacies, shoes, food, alcohol and computer supplies. In these premises, the combustible materials are cloth, computer, food areas, grocery stores, pharmacies, restaurants, and travel agencies. The fire load of commercial premises buildings ranges from 17656 to 69843 megajoules(MJ) and also controls to spread the fire to the next compartment or next buildings. D. Cross[25] conduct a fire load density for office rooms and residential buildings. They also survey for both interior and movable combustible materials in the buildings. This paper will help us to know it fire occurs and what are all the measures taken to prevent the materials and buildings from fire. The objective of this present work deals with the methods of calculating the fire load.

2. Library

The library is the collection of books and sources of information made accessible to people for borrowing or reference purposes. The collection of libraries can include books, magazines, newspapers, films, audios, Digital versatile disc(DVD's), maps, manuscripts-books, and various other formats. The library is organized and maintained by the individual, institution or public body. Public and institutional libraries provide their collection of resources and services to people who need material they cannot otherwise have access to. Those who require help for their research can seek the same from the libraries are created as per the knowledge and interest of that person. A public library is open for all to cater to the interest and taste of all people and contains books on diverse subjects. An institutional library refers to a library that belongs to an establishment like school, college, university or a club,

etc. Such a library is open to the members of the community and caters to their needs and interest.

2.1 Uses of libraries

Libraries play a vital role in imparting knowledge. Libraries help with learning and expansion of knowledge. It develops the habit of reading and boosts the thirst for more and more knowledge. It adds to what an individual has already learned and leads to his personal growth and development in life. Libraries are especially essential for people who cannot afford costly books and resources for reading and acquiring information. They are the one who truly understand the value and importance of the library. Libraries do not only provide resources but also offer services by professional libraries who are experts at searching, organizing and interpreting information needs. Libraries provide a space for individual and group studies. They also facilitate access to digital resources and the internet. Modern libraries are extending services by providing material accessible by digital media. Librarians provide assistance in navigating and analyzing a large amount of information through digital resources. Such ambiance has a positive impact on the members of the family. It helps in developing reading habits in children and contributes to their growth and development. It broadens the outlook of the people.

3. Fire

The ancient greeks word believed that fire was one of the four basic elements that composed all things in the universe. Fire is the rapid oxidation of a material in the exothermic chemical process of combustion releasing heat and light.

3.1 Source of ignition

The ignition can come from a variety of sources, and understanding the processes involved is completely crucial in fire prevention and safety. A source of ignition is often described as, "an object, process or event capable of igniting or transmitting a medium to prompt combustion." Within this definition, a source of ignition could include open flames, hot surfaces, friction, sparks, and electricity.

3.2 Forms of fire

Fire can be classified into four types - flash fire occurs when a cloud of flammable gas and air is ignited. The spread of burning may be a function of the concentration of the flammable component within the cloud, and also the wind speed. Within a couple of seconds of ignition, the flame spreads both upwind and downwind of the ignition source. Initially, the flame is contained within the cloud thanks to the premixed burning of the regions within the flammable limits. A jet fire occurs when a flammable liquid or gas is ignited after its release from a pressurized, punctured vessel or pipe. The pressure of release generates an extended flame, which is stable under most conditions. A flash flame may take the shape of jet flame on reaching the spill point. Flame length increases directly with the flow rate. Typically a pressurized release of 8kilogram per second(kg/s) would have a length of 35 meters (m). The crosswinds also affect the flame length. A pool fire occurs on the ignition of an accumulation of liquid as a pool on the ground or on water or other liquid. A steadily burning fire is rapidly achieved as the flame vapor to sustain the fire is provided by evaporation of liquid by heat from the flames. The maximum burning rate may be a function of the internet heat of combustion and warmth required for its vaporization. The secondary fire involves the combustion of flammable materials that aren't directly concerned with the method, and sometimes present unnecessarily. For instance: Stored staple and products, including packaging materials, Combustible insulation of vessels, pipelines, and electrical cables, Combustible artifact and linings. Protection is elimination or segregation of combustible materials, use of incombustible materials of construction and insulation and control of ignition sources. careless or deliberate actions may defeat inbuilt precautions.

3.3 Stages of fire

Stages of fire can be followed by Ignition - Fuel, oxygen, and warmth join together during a sustained reaction. At this stage, the fire extinguisher can control the fire. Growth -With the initial flame as a heat source, additional fuel ignites. Convection and radiation ignite more surfaces. The size of the fire increases and the plume reaches the ceiling. Hot gases collecting at the ceiling transfer heat, allowing all fuels during a room to return closer to their ignition temperature at an equivalent time. Fully Developed - A Fire has spread over much if not all the available fuel, temperatures reach their peak, resulting in heat damage. Oxygen is consumed rapidly. Decay (Burn out) - The fire consumes available fuel, temperature decreases, the fire gets less intense.

4. METHODOLOGY

Fire load is the amount of heat in kilo-calorie which is liberated per square meter of the floor area of a compartment by the combustion of the contents of the building and any combustible parts of the building itself. The amount of heat is used as the basis for grading of occupancies. The fire load is determined by multiplying the weight of all combustible materials by their calorific values and divided by the floor area under covers.[14,15, 16]



	Table	1	Calorific	value
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Materials	Paper	Wood	Plastic	Computer	Printer	Steel
Calorific value in kcal/m ²	3224	3441	9554	117512	34871	1573

Fire load density was calculated for a library building in a college which is located at Tiruchengode. The library building consists of an entrance, student section, internet section, book section, and administrative office. The total area of the library is 1458 square meters (m²). The materials present in the library are as follows computers, printers, books, paper, steel, wood, and plastics. The various papers which present in the library are books, projects, and back volumes. The steel materials present in the library are bureau(large and small), staff table, S type chair, reading table, gate table, bookcase, book rack(large and small), steel stool, Compact disc rack, and journal rack. The various wood materials available in the library are reading table, counter table, gate table, bookcase, librarian table, wooden stool, compact disc rack, journal rack, and computer table. The plastic products in the library are chairs and stools.

The weight of the materials like a computer, printer, steel, and wood was calculated by the inventory method[14]. In the inventory method, the weight of the materials was calculated visually. The weight of paper and plastic were calculated by the direct method[14]. The indirect method weight of the books, project, and back volume was calculated by using the weighing machine. In the weight machine, the books got weighted and make a note to calculate the total weight of books available in the library. In the library, the fire load density is calculated by using equation 1.

S No	Name of Materials		No of	Approximate	Total	
				weight Per item	Weight	
				w (kg)	W (kg)
1		Computer		28	11	20
2		Printer	2	40	8	0
2	D	Books	102026		61951.23	60010 52
3	3 Paper	Project	3554	-	1777	69012.53
		Back volume	7549		5284.3	
4	Steel	Bureau-large	2	25	50	8738
		Bureau-small	5	10	50	
		Staff table	5	10	50	
		S-type chair	8	5	40	
		Reading table	12	10	120	
		Gate table	2	10	20	
		Book case	77	15	1155	
		Book rack - large	346	20	6920	
		Book rack-small	4	12	48	
		Steel stool	1	10	10	
		Compact disc rack	1	15	15	
		Journal rack	13	20	260	
5	Wood	Reading table	12	15	180	8528
		Counter table	1	80	80	
		Gate table	2	10	20	
	Book case	3	15	45		
	Librarian table	1	20	20		
	Wooden stool	1	8	8		
	Table- small	4	10	40		
		Compact disc rack	8	10	80	
		Journal rack	4	15	60	
		Computer table	5	15	75	
6	Plastic	Chair	252	2	504	529
		Stool	5	5	25	

 Table 2 List of materials and total weight

Both inventory and direct method, the weight of the materials get identified. The calorific value materials available in the library are known by the table1. From this weight and the calorific were multiplied to know the fire load of the materials in the library. Total fire load density is calculated by every fire load of materials present in the library is divided by the area occupied by the materials. From the analysis, we came to know that around 70 percent of the materials are in the form of papers and it is highly combustible. If a fire occurs it has a serious impact on the library. The fire load of every material is calculated and every fire load material is added to find the total fire load density in the library building.

5. Result and discussion

Grade	Time in Hours	Fire load and class of fire which the structural		
No	minimum	Element can withstand		
	resistance	Fire load in	Class of	
	against	Kcal/ m ²	Fire	
	standard fire			
1	6	1100000 and over	Very high	
2	4	500000 to 1100000	High	
3	2	275000 to 550000	Medium	
4	1	Less than 275000	Low	
5	1⁄2	_	Very low	

Table 3 Classification of Structural Components



Figure 1 Fire load of combustible materials

From the calculation of fire load in the library, the paper is the major part to get fire quickly and it turns to heavy fire in the library. The fire loads of materials such as paper, wood, plastic, computer, printer, and steel are 930979.04 Mega joules(MJ), 122803.2 MJ, 21160 MJ, 550928 MJ, 11672 MJ, 57496.04 MJ respectively. These fire loads were added to find the total fire load density of the library and it will be divided by the area of occupied

material in the library. Finally, the total fire load density of the library is 1114817.521 kilocalories per square meter(kcal/m²). From the figure(1) 55 percentage of paper has a high fire load. The plastic has a very low fire load in the library.

6. CONCLUSION

In a college library, the fire load is calculated by using the combination method. The combination method is defined as the combination of both inventory method, and direct weighing method. For non-movable materials like a reading table, counter table, etc, the weight of the material is calculated by the inventory method. For movable materials like books, newspapers, etc, the weight of the material is calculated by a direct weighing method. The weight of the materials and their total calorific values are taken from Tables 1 and 2. The calculated fire load is 1114817.521 kilocalories per square meter(kcal/m²), which is greater than 1100000 kcal/m². According to the grade of occupancies by fire load(table 3), the class of fire is distinguished as a very high fire. Therefore, the fire will exist for more than 6 hours. To save the books from the fire accident, the fire fighting system should be designed according to it.

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