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PULCHOWK CAMPUS

A PROJECT REPORT

ON

FIREFIGHTING STANDPIPE AND SPRINKLER SYSTEM DESIGN

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1. INTRODUCTION

1.1 Background

1.1.1 Fire Protection Systems

A fire protection system is a crucial component of building safety measures designed to detect, suppress, and control fires, minimizing property damage and protecting lives. There are many types of fire protection systems available out of which two major types are: Sprinkler system and Hydrant system and combined system.

1.1.1.1 Sprinkler System

A sprinkler system is an active fire protection measure that consists of a network of pipes containing water under pressure and strategically placed sprinkler heads. These systems are designed to automatically discharge water onto a fire when triggered by heat, typically from a fire reaching a certain temperature threshold.

The various types of sprinkler system are:

- **Wet Pipe Sprinkler System:** A wet pipe sprinkler system is a fundamental and widely used method for fire protection in buildings. In this system, pipes are filled with water and kept under constant pressure, ready to be discharged when a heat-sensitive sprinkler head is activated by elevated temperatures indicative of a fire. The simplicity and reliability of wet pipe systems make them a preferred choice for various applications, such as residential, commercial, and industrial settings. The sprinkler heads are strategically placed throughout the facility, and upon detection of heat, an individual head releases water directly onto the fire, effectively suppressing it. Due to their immediate response capability, wet pipe systems are particularly suitable for environments where temperatures consistently remain above freezing. While they offer quick and efficient fire control, routine maintenance and inspection are crucial to ensuring the reliability of the system, as any malfunction could compromise its effectiveness in emergency situations.

- **Dry Pipe Sprinkler System:** A dry pipe sprinkler system is a specialized fire protection mechanism designed for environments where freezing temperatures pose a risk to water-filled pipes. Unlike wet pipe systems, which maintain water in the pipes at all times, dry pipe systems are filled with compressed air or nitrogen. The pipes are kept dry until a heat-sensitive sprinkler head is activated by a fire, causing a drop in air pressure. This drop opens a valve, allowing water to flow into the pipes and through the activated sprinkler head to suppress the fire. The delay in water discharge is a distinctive feature of dry pipe systems, intended to prevent pipe freezing in cold climates. These systems are commonly employed in unheated or outdoor areas, such as parking garages, attics, or freezer storage spaces, where maintaining a constant temperature is challenging. While the delayed response may pose a slight drawback, the inherent advantage of freeze protection makes dry pipe sprinkler systems a crucial component in fire protection strategies for a variety of facilities. Regular maintenance, including testing for proper valve operation and air pressure, is essential to ensure the reliability of these systems when needed.

1.1.1.2 Hydrant System

Fire hydrant systems are another type of fire protection infrastructure designed to provide a ready supply of water for firefighting operations. They consist of a network of underground pipes connected to strategically placed fire hydrants, allowing firefighters to quickly access water during emergencies. These systems play a crucial role in combating fires in both urban and rural areas, enabling efficient water distribution for extinguishing flames and preventing the spread of fire. The types of fire hydrant systems are:

- **Wet Barrel Fire Hydrant:** Wet barrel fire hydrants are the most common type used in areas where freezing temperatures are not a concern. In this system, the valve mechanism is located above ground and remains constantly filled with water, ready for immediate use. When activated, firefighters can attach hoses to the hydrant, open the valve, and access the pressurized water supply to extinguish fires.

- **Dry Barrel Fire Hydrant:** Dry barrel fire hydrants are employed in regions prone to freezing temperatures, where water left in the hydrant's barrel could freeze and cause damage. In this system, the valve mechanism is located below ground in a dry chamber, separate from the water supply. When the hydrant is activated, water flows into the barrel, pressurizing the system and allowing firefighters to access water for firefighting operations. After use, the water drains from the barrel, preventing freezing.

- **Pillar Fire Hydrant:** Pillar fire hydrants, also known as post hydrants or ground hydrants, are typically installed in areas with limited access to water mains or where underground piping is impractical. These hydrants consist of a vertical pipe or pillar with a valve mechanism and outlet nozzle at the top. Pillar hydrants are often found in rural areas, parks, and industrial facilities, providing a convenient water source for firefighting activities.

- **Dry Riser System:** Dry riser systems are a type of fire hydrant system commonly used in multi-story buildings and high-rise structures. These systems consist of vertical pipes installed within the building's stairwells or corridors, equipped with outlet connections on each floor. During a fire emergency, firefighters can connect hoses to the outlet connections to access water from the building's internal water supply or from external fire department connections located outside the building.

1.1.2 Regulatory Requirements

The National Fire Protection Association (NFPA) is a regulatory authority responsible for establishing a comprehensive set of standards and codes aimed at ensuring effective prevention and control of fire hazards. These standards cover diverse aspects of fire safety, encompassing the design and installation of fire protection systems, emergency response protocols, electrical safety, building construction, and the maintenance of fire safety equipment. NFPA categorizes fire hazards into various classes based on materials involved and associated potential risks. Here are some of the main types of fire hazards along with examples of where these hazards may occur:

- **Ordinary Hazard (Class I):** Ordinary hazards involve materials that are relatively easy to ignite and burn and are commonly found in everyday environments. Examples include offices, schools, retail stores, and residential buildings.

- **Light Hazard (Class II):** Light hazards typically involve materials that present a lower risk of fire and are found in environments where the quantity and combustibility of the materials are limited. Examples include libraries, museums, churches, and some office spaces.

- **Extra Hazard (Class III):** Extra hazards involve materials or processes that present a higher risk of fire due to their combustibility, quantity, or the presence of hazardous conditions. Examples include chemical processing plants and manufacturing facilities.

- **Special Hazard (Class IV):** Special hazards are environments where unique fire risks exist due to specific materials, processes, or conditions present. Examples include data centres, clean rooms and server rooms.

1.1.3 Hydraulic Design

The hydraulic design of fire sprinkler and fire hydrant systems is crucial for ensuring the effective distribution of water to suppress fires in buildings and outdoor areas. This design process involves determining the water demand, pressure requirements, pipe sizing, and layout to deliver an adequate supply of water for firefighting operations as per the regulatory requirements.

The major outputs of hydraulic design are listed below:

- Water demand for fire suppression based on occupancy classification and hazard analysis.
- Pressure requirements at sprinkler heads or hydrant outlets to achieve effective water distribution.
- Pipe sizes and layout to provide sufficient flow capacity and minimize pressure losses.

- Hydraulic calculations to verify the adequacy of the system design in meeting water demand and pressure requirements.
- Selection of system components and equipment to ensure reliable operation and compliance with fire protection codes and standards.

The frictional head loss per unit length can be determined using Hazen-William equation as,

$P = \frac{4.52 * Q^{1/85}}{C^{1.85} * d^{4.87}}$

Where, P= frictional pressure loss per unit length (psi/ft)

Q= flow rate (Gpm)

d= internal diamter of pipe (inches)

1.2 Objectives

1.2.1 Main Objectives

- To design a fire sprinkler system
- To design a fire hydrant standpipe system

1.2.2 Specific Objectives

- To determine the layout of a fire sprinkler system on building
- To perform hydraulic calculations of the sprinkler system
- To determine the layout of a fire hydrant standpipe system on building
- To perform hydraulic calculations of the hydrant standpipe system

2. DESIGN OF A FIRE SPRINKLER SYSTEM

2.1 NFPA requirements

According to NFPA-13, for an ordinary hazard (Group I), Occupancy

Area coverage by a sprinkler (A_s) =130 ft^2

Density = 0.15 gpm/ft^2

K-factor for a sprinkler = 5.6

Required distance between sprinkler = 6 to 14 ft

Min. residual pressure = 20 psi

C value for black steel schedule 40 pipe = 120

Maximum floor area per riser = 52000 ft^2

For the building considered, Total area of protection (A_t) = ft^2

Total no. of sprinkler required = $\frac{A_t}{A_s}$ = 1168.02/130 ≈ 9

Flow rate per sprinkler (Q) = Density * Area coverage per sprinkler =0.15*130 = 19.5 gpm

Residual pressure of sprinkler (P_r) = $\left(\frac{Q}{K}\right)^2 = \left(\frac{19.5}{5.6}\right)^2$ = 12.12531888 psi < 20 psi

So, taking residual pressure (P_r) = 20 psi

No. of riser = 1

Pipe size (")	**No. of sprinkler**1168.02
1	2
1.25	3
1.5	5
2	10
2.5	20
3	40
3.5	65
4	100
5	160
6	275

Table: Pipe size scheduling

2.2 Hydraulic Design & Calculations

The size of each pipe was determined according to the NFPA-13 pipe scheduling chart.

Pipe Sections	Pipe sizes
1-a, 2-a, a-b, 3-b, 4-c,5-d	1"
7-8,f-7,6-f	1"
b-c, c-d, e-f	1.25"
d-e	1. 5"

Table: Pipe sizes

The calculation for path 1-a is shown below:

Flow rate (Q) =19.5 gpm

Diameter (d) = 1”

Pipe length (L) =13.7 ft

Valves & fittings: 1 standard 90º elbow

Total length (Lt) = L + L(elbow)+ cross Tee = 13.7+5+ 2*2 =22.7 ft

Using Hazen-William equation,

$$P = \frac{4.52 * Q^{1/85}}{C^{1.85} * d^{4.87}} = \frac{4.52 * 19.5^{1/85}}{120^{1.85} * 1^{4.87}} = 0.16 \text{ psi/ft}$$

Frictional pressure loss in the path 1-2 = P* L_t = 0.16*22.7 = 3.48 psi

So, the pressure at node 2 is, P_2 = 20 + 3.48 = 23.48 psi

Similarly, other calculations were done for other paths as well.

In the case of the intersection of two or more pipes at the same point, the flow was balanced. The balancing of paths 5-a and 10-a is shown below.

For path 1-a, Flow rate = 19.5 gpm and Pressure at node a =23.48 psi

For path 2-a, Flow rate = 19.5 gpm and Pressure at node a = 22.42 psi

Balanced pressure at node a = maximum value of Pa = 23.48 psi
5.425 gpm

path	Q (gpm)	D(in)	Pipe Length (ft)	Fitting and Devices	N	Equivalence Length (ft)	Length (ft) Total	Friction loss (Psi/ft)	pressure friction (Psi)	P (psi)	Notes	
1-a	19.5	1	13.17	90° standard elbow	2	2	22.17	0.16	3.48	23.48	P1	23.48
				Tee or Cross 90°	1	5					k =	5.6
				NONE		0					Q2 =	27.13
2-a	19.50	1	8.417	Tee or Cross 90°	1	5	15.417	0.16	2.42	22.42	P2	22.42
				90° standard elbow	1	2					k =	5.6
				NONE		0					Q3 =	26.51
a-b	53.65	1	2.759	Tee or Cross 90°	1	5	7.759	1.02	7.91	53.80		
				NONE								
				NONE		0						
3-b	19.5	1	9.022	90° standard elbow	1	2	16.022	0.16	2.51	22.51	P3	22.51
				Tee or Cross 90°	1	5					k =	5.6
				NONE		0					Q5 =	26.57
b-c	80.22	1.25	6.464	Tee or Cross 90°	1	6	12.464	0.72	9.02	76.31		
				NONE		0						

				NONE		0						
4-c	19.50	1	3.802	Tee or Cross 90° 90° standard elbow NONE	1 1 	5 2 0	10.802	0.16	1.69	21.69	P6 = k = Q6 =	21.69 5.6 26.08
c-d	106.30	1.5	14.933	Tee or Cross 90° NONE NONE	1 	8 0 0	22.933	0.50	11.50	98.01		
5-d	19.5	1	3.517	Tee or Cross 90° 90° standard elbow NONE	1 1 	5 2 0	10.517	0.16	1.65	21.65	P8 = k = Q8 =	21.65 5.6 26.06
d-e	132.35	1.5	1.26	Tee or Cross 90° NONE NONE	1 	8 0 0	9.26	0.75	6.96	119.65		
7-8.	19.50	1	9.97	90° standard elbow NONE NONE	2 	5 0 0	19.97	0.16	3.13	23.13	P11 = k = Q11 =	23.13 5.6 26.93
f-7	46.43	1	8.94	90° standard elbow	1	2	15.94	0.78	12.44	35.57	P10 =	35.57

				Tee or Cross 90°	1	5					k =	5.6
				NONE		0					Q10 =	33.40
6-f	19.50	1	9.961	Tee or Cross 90°	1	10	21.961	0.16	3.44	23.44	P10 =	23.44
				90° standard elbow	1	2					k =	5.6
				NONE		0					Q10 =	27.11
e-f	106.94	1.25	6.686	Tee or Cross 90°	1	6	12.686	1.23	15.63	59.01		
				NONE		0						
				NONE		0					Qb =	137.82

Similarly, the balancing of other pipe intersections was also done.

The results of the hydraulic calculation are tabulated below:

Pressure in	**Psi**	**bar**	**feet of WC**
Frictional and Residual	178.64	12.32	410.66
Static	43.0	2.97	99
Total	**221.64**	**15.9**	**509.66**

Table: Hydraulic calculation results of sprinkler system

From the hydraulic calculation,

Pump pressure (P) = 15.9 bar

Total flow (Q) = 239.5 gpm =0.015 m^3/s

If pump efficiency (η) = 80 %

Pump power = $\frac{P*Q}{\eta}$ = **29.81 kW = 40Hp**

Hence, the total pumping power required is 29.81 kW or 40 Hp.

2.3 Final design and layout

The following picture shows all the nodal pressure values and the corresponding flow rates in the system.

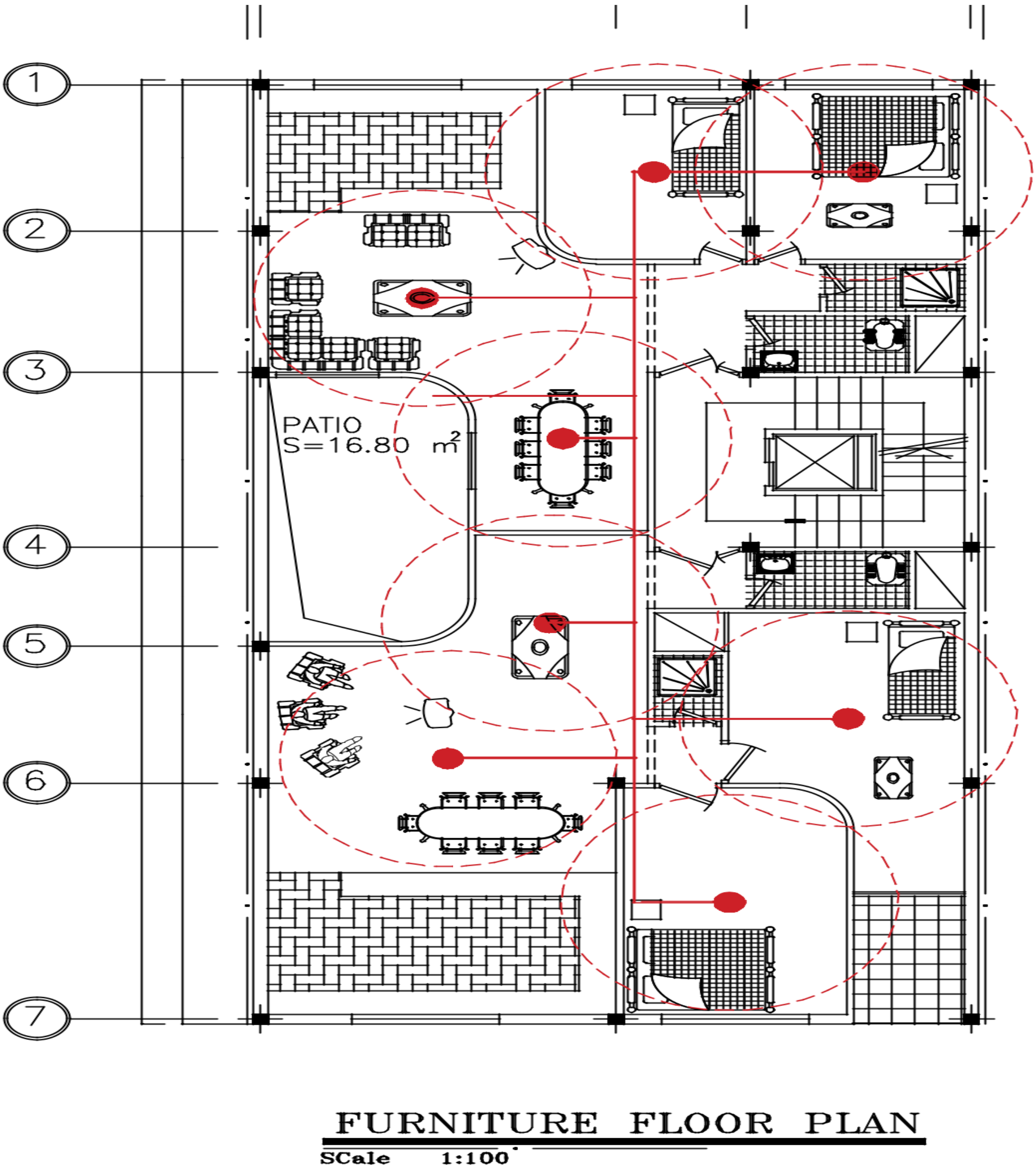

Figure: Final layout of the sprinkler system

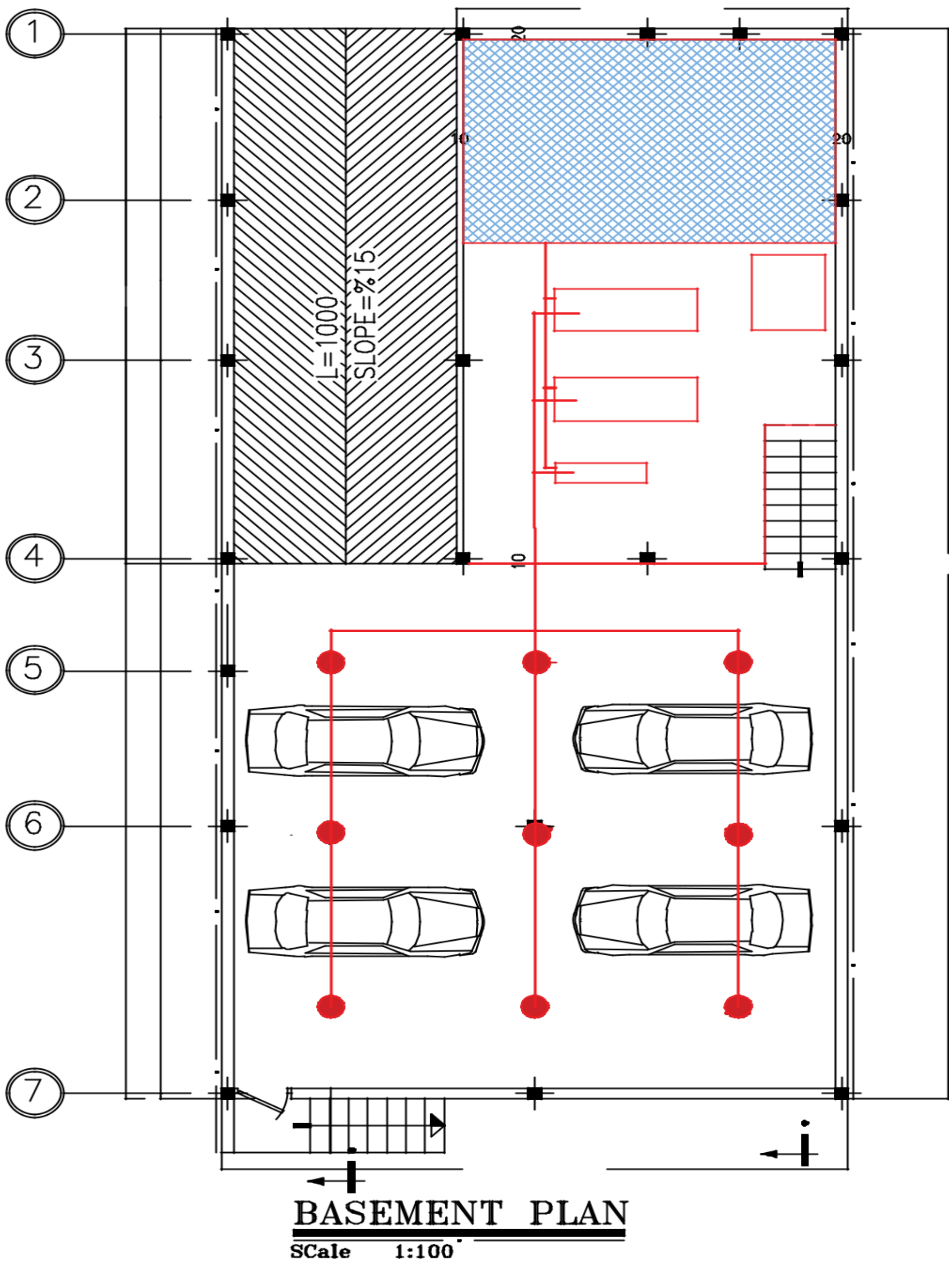

Figure: Final layout of the sprinkler system

3. DESIGN OF A FIRE HYDRANT STANDPIPE SYSTEM

The design of standpipe fire hydrant system was done for a 6-storey high rise building.

3.1 NFPA requirements

According to NFPA-14, for class-1 standpipe, the various requirements are listed below:

- 2½" hose connections
- Min. residual pressure: 100psi (6.9bar)
- Max. pressure at hose connection: 175psi (12.1bar)
- The maximum flow required from a 2% in. (65 mm) hose connection shall be 250gpm (946 L/min)
- Min. flow rate for the hydraulically most remote standpipe shall be 500gpm (1893 L/min)
- Where a horizontal standpipe system supplies three or more hose connections on any floor, the minimum flow rate for the hydraulically most demanding horizontal standpipe shall be 750gpm (2840 L/min)
- Min. flow rate for additional standpipes shall be 250gpm (946 L/min) per standpipe, for building not exceeding 80,000 ft^2 (7432 m^2) floor area
- Min. flow rate for additional standpipes shall be 500gpm (1893 L/min) for the second standpipe and 250gpm (946 L/min) for building exceeding 80,000 ft^2 (7432 m^2) floor area
- Max. flow rate shall be 1250gpm (4731 L/min) for non-sprinklered buildings
- If additional standpipes, Floor area 283'x283' 80,089sq-ft then standpipe-A flow to be 500gpm, Floor area 280'x280′ = 78,400sq-ft then standpipe -A flow to 250gpm

3.2 Hydraulic Design & Calculations

Hose diameter = 65mm / 2-1/2"

Diameter of pipe = 4”

Residual pressure = 100 psi

C value for the material of pipe black steel schedule 40 = 120

The calculation for path 0-1 is shown below:

Flow rate (Q) =250 gpm

Diameter (d) = 4”

Pipe length (L) =6.56 ft

Valves & fittings: 1 Tee 90°

Equivalent length of 1 Tee 90° 5

(Le) = 20 ft

Total length (Lt) = L + Le = 6.56+20 =26.56 ft

Using Hazen-William equation,

$P = \frac{4.52 * Q^{1.85}}{C^{1.85} * d^{4.87}} = \frac{4.52 * 250^{1/85}}{120^{1.85} * 4^{4.87}} = 0.02054$ psi/ft

Frictional pressure loss in the path 0-1 = P* L_t = 0.02054 *26.56= 0.54580 psi

We have, residual pressure = 100 psi

So, the pressure at node 1 is, P1 = 100+ 0.54580 = 100. 54580 psi

Similarly, other calculations were done for other paths as well.

path	Q (gpm)	D (in)	Pipe Length (ft)	Fitting and Devices	N	Eqv Length (ft)	Length (ft) Total	Friction loss (Psi/ft)	pressure friction (Psi)	P (psi)	Nodes	
0 to1	250	4	7	90 degree Tee	1	20	26.6	0.02		100.546	Node =	1
				NONE								
				NONE	0	0						
1 to 2	500	4	10	90 deg Tee	1	20	30.8	0.07		102.831	Node =	2
				gate valve 2.5"	1	1						
2 to 3	500	4	33	90 deg TEE	1	20	52.8	0.07		106.742	Node =	3
3to a	500	4	8	90 deg TEE	2	20	48.3	0.07		110.32	Node =	4
a to b	500	4	12	90 deg elbow	1	10	45.8	0.07		111.195	Node =	5
				gate valve 4"	1	2						
				Check valve 4"	1	22						

The results of the hydraulic calculation are tabulated below:

Pressure in	**Psi**	**bar**	**feet of WC**
Frictional and Residual	109.62	7.56	252
Static	25.26	1.74	58
Total	**134.88**	**9.3**	**310**

Table: Hydraulic calculation results of standpipe hydrant system

From the hydraulic calculation,

Pump pressure (P) = 7.56 bar

Total flow (Q) = 250 gpm

If pump efficiency (η) = 80 %

Pump power = $\frac{P*Q}{\eta}$ = **14.74 kw = 19 Hp**

Hence, the total pumping power required is 14.74 KW or 19 Hp.

3.3 Final design and layout

The following picture shows all the nodal pressure values and the corresponding flow rates in the system.

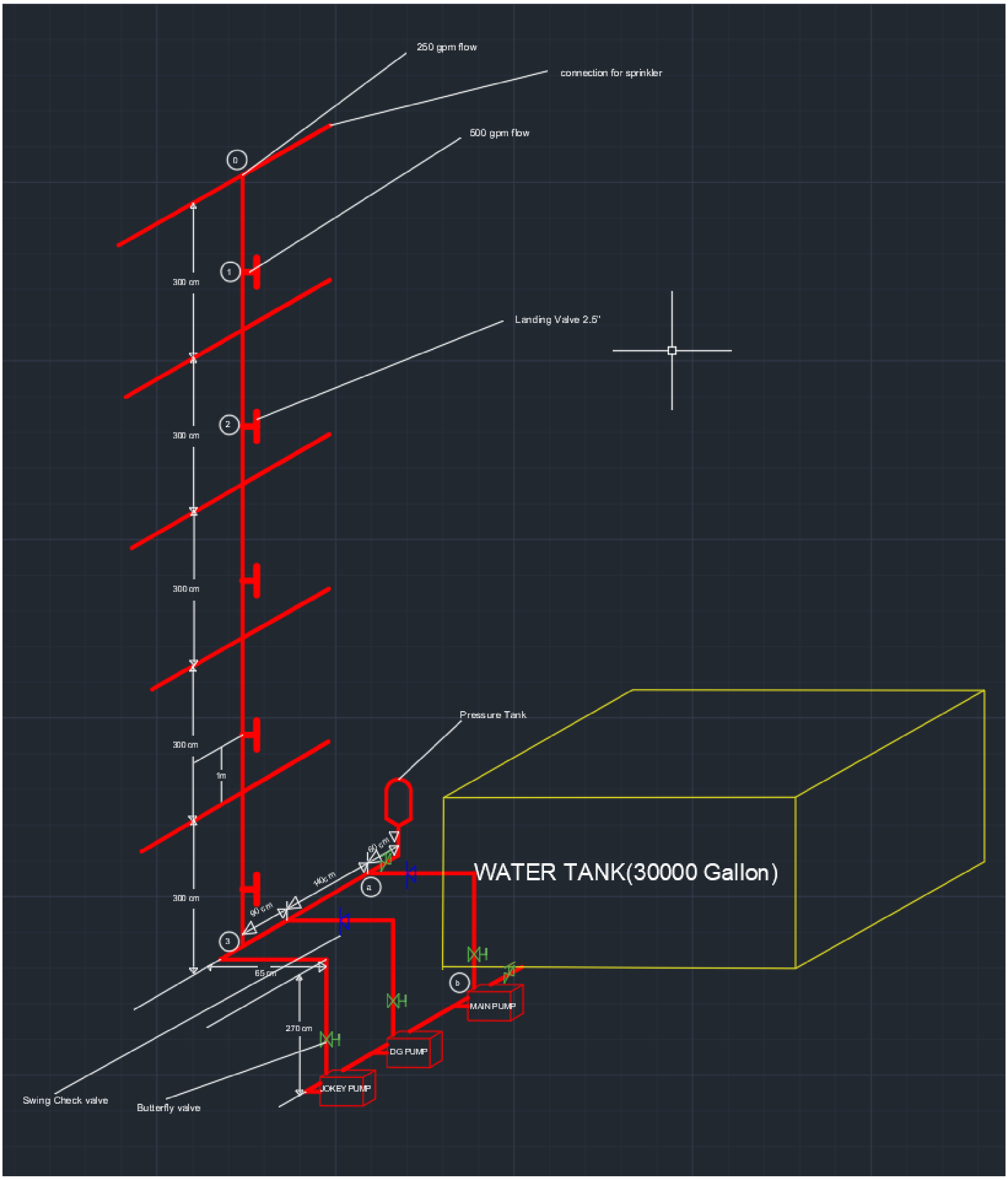

Figure: Final layout of the standpipe hydrant system

4. RESULTS

The result of the design can be summarized in the tables below:

For sprinkler system,

Floor Area	1168.02ft^2
Number of sprinklers used	9
Total flow rate required	239.5 gpm
Frictional and residual head	12.32 bar

Static head	2.97 bar
Total pressure head	15.29 bar
Total pump power	**29.81 kW**

Table: Results of the design of sprinkler system

For standpipe hydrant system,

Building Height	5 storey
No. of riser	1
Total flow rate required	250 gpm
Frictional and residual head	7.56 bar
Static head	1.74 bar
Total pressure head	9.3 bar
Total pump power	**14.74 kW**

Table: Results of the design of standpipe hydrant system

BILL OF QUANTITY:

Sl. No.	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.)
1.0 1	Supplying, installing, testing and commissioning of electric driven fire pump suitable for automatic operation consisting of the following				
a)	Fire pump with cast iron impeller horizontal split casing centrifugal suction type multistage having a capacity of 25 0GPM against a total head of 25 Bar so as to ensure a minimum pressure of 9 Bar at the highest and farthest outlet at the specified flow complete with necessary strainer on suction side and pressure gauge on the delivery side including by pass arrangement for periodical testing of the working of the pumping set with 50mm dia G.I. pipe upto 5mtr. length & control valve. The pump shall be provided with mechanical seals.				
b)	Squirrel cage type TEFC motor suitable for operation on 220-240V, 3 phases 50 Hz. system of suitable HP for the above pump with synchronous speed of 1500 RPM and flexible coupling with the pump motor should conform to IS: 325-1978.				
c)	Common bed plate fabricated from mild steel channel or cast iron type.				
d)	Suitable cement concrete pump foundation & vibration damping arrangement with cushy foot mounting as required.				
e)	All coupling of pump and motor should be covered with safety guard.	1	set	308347.10	308347.10
1.0 2	Supplying, installing, testing and commissioning of diesel engine driven fire pump suitable for automatic operation consisting of the following (as per specifications.)				
a)	Horizontal centrifugal type , fire pump with cast iron impeller complete for delivery of 50 GPM at a total head of 25 Bar so as to ensure a minimum pressure of 9 Bar. at the highest & farthest outlet at the specified flow, complete with necessary strainer on suction side and pressure				
	gauge on the delivery side etc. including by pass arrangement for periodical testing of the working of the pump set as required. The pump shall be provided with mechanical seals.				

b)	Water cooled cold starting type multi cylinder 4 stroke diesel engine, developing suitable minimum BHP at 1500 RPM for the above pump set with automatic starting mechanism, cooling system with radial cool engine, maintenance free batteries, battery charge unit, flexible coupling with the pump, fuel day tank with O/L level indicator. The tank should be cylinderical and horizontally fitted capacity 200 litres. Fuel piping and pump and vibration damping arrangement by cushy foot mounting as required complete in all respects.				
c)	Common bed plate fabricated from mild steel channel or cast iron type.				
d)	Suitable cement concrete pump foundation & vibration damping arrangement with cushy foot mounting as required.				
e)	Exhaust pipe with thermal insulation with 50mm thick Glass wool insulation and aluminium cliddding 24 SWG wire around upto external wall out side the pump room are directed both engineer incharge. Complete in all respects.				
f)	All coupling of pump and motor should be covered with safety guard.	1	set	447479.32	447479.32
1.0 3	Supplying, installation, testing and commissioning of electric motor driven automatic pressurization pump set consisting of the following (as per specification)				
a)	Centrifugal pump of 180 LPM capacity capable of building up pressure lost in any leakage in the system against a total head of 70 m approx. complete with necessary strainer on suction side and pressure gauge on delivery side etc. including by-pass arrangement for testing of the working of the pumping set and with mechanical seals as required .				
b)	Squirrel cage A.C. induction motor suitable for operation on 220-240 V, 3 phase 50 Hz. A.C. supply and of minimum 12.5 HP for the above pump with flexible coupling as per specification and conforming to IS: 325.				
c)	Common bed plate fabricated of mild steel channel or cast iron type.				
d)	Suitable cement concrete pump foundation with vibration damping arrangement with anti-vibration pad mounting as required.				
e)	All couplings of pump & motors should be covered with safety Guard.	1	set	82727.27	82727.27

1.04	Fabricating, supplying, erection, testing and commissioning of cubical type floor mounted control panel complete with suitable relays, contactor, indicating lamps, fuses, instrument isolator, automatic star delta type motor starter conforming to IS 1822 and auxiliary switch including connections complete as required for 1 nos. main pumps (one for wet riser and spare space for sprinkler pump and one diesel driven stand by) and 1 no. jockey pump and one spare space for jockey pump as per CPWD specification Part V-1985 and its amendments and Local Fire Department requirements.	1	each	195537.18	195537.18
1.05	Supplying, testing, installation & commissioning of pressure switches for pumps including necessary wiring upto the control panel.	4	each	3384.30	13537.20
1.06	Supplying and laying the PVC insulated and sheathed armoured cables of 1.1 K.V. aluminum conductor including supplying and making end termination with brass compression glands.				
1.07	Providing, fixing, jointing and testing of heavy gauge M.S. ERW black pipes schedue 40 with special accessories like tees, elbows, welded joints for pipe and fitting and flanged joints rubber insertion nuts & bolts, washers for valves including earth work excavating refilling compaction etc. and treating under ground pipe with two coats of anti corrosive paint and wrapping 4mm thick PYKOTE on pipe fitting etc. complete in all respects. Thrust blocks of cement concrete at bends, tees etc. 150mm thick around in 1:2:4 (1cement: 2 coarse sand: 4 stone ballast 20mm and down gauge).				
a)	100 mm dia - 5.4 mm thick	35	mtr	1654.55	57909.25
1.08	Providing and fixing single headed hydrants flanged inlet with 63 mm female instantaneous outlet of gunmetal with bolts, nuts, washers etc complete with male blank caps, chains conforming to IS:5290 type A with stainless steel orifice plate to keep the pressure not more than 9 bar at any point.	5	each	5640.50	28202.50
1.09	Providing 63mm (2 ½)" dia 15 m long canvas hose pipe complete with gunmetal male & female coupling copper wire wound with the pipe The pipe shall confirm to IS. 4927	5	each	6016.53	30082.65
1.10	Providing 63mm (2 ½)" dia 15 m long reinforced rubber lined hose pipe conforming to IS: 636-1992 Part-II with gunmetal male & female coupling copper wire wound with pipe as required.	5	each	3910.74	19553.70
1.11	Providing and fixing first aid hose reel full swinging type with 30 meter long 20mm dia rubber lined Maruty pipe with shut off nozzle of 5 mm dia. Conforming to IS:884-1969 complete/ Thermoplastic reinforced flexible hose ISI marked IS:12585 type-II. as required. Including 25 mm dia M.S. pipe connection from riser to hose reel with all sockets, nipples, elbows and 25 mm dia ball valve as required.	5	each	6994.21	34971.05

1.1 2	Providing and fixing standard short size gunmetal branch pipe with 20mm dia nozzle conforming to IS:903. Suitable for installation connections to hose coupling etc. as required.	5	each	1955.37	9776.85
1.1 3	Providing and fixing the four way fire brigade connection housed in steel cabinet fabricated from 1.5mm thick steel sheet having lockable arrangement, openable glazed door, including painting a coat of primer and two coats of postal red enamel, necessary supports for the cabinet etc. with 150 mm dia. non return and butterfly valve complete in all respects.	5	each	10152.89	50764.45
1.1 4	Providing and fixing set of "Siamese" quadruplet instantaneous fire brigade inlet connections comprising of two gunmetal instantaneous male inlet coupling 63mm dia with plug and cap, chain bends, tees etc. for inlet to the static tank.	1	each	7144.63	7144.63
1.1 5	Providing and fixing weather proof standard hose cabinet (900mm x 750 mm x 400 mm) out door type suitable for accommodating yard hydrants made of 1.5mm thick M.S. sheet having central opening glazed door including necessary locking arrangements, painting one coat of primer and two coats of postal red enamel paint and housing 2 Nos. canvas hose pipe and branch pipe as required. (The cabinet shall be floor mounted on suitable raised platform). The shutters are to be lockable type. The words “ hose cabinet” to be painted on the box.	5	each	8272.73	41363.65
1.1 6	Providing and fixing Fire hose cabinet glazed door shutter and frame with hold fasts (frame fabricated from 40 x 40 x 5mm and shutter from 35x35x5mm M.S. angle) 1500 mm high x 1000 mm wide with locking arrangement, 4mm thick glass with M.S. flats including all accessories, painting with one coat of steel primer and two coats of postal red enamel paint. The words “ hose cabinet” to be painted on the box.	1	each	8272.73	8272.73
1.1 7	Supplying and installing cylindrical type air vessel of 300mm dia, 1.0m high fabricated out of 8mm thick MS plate suitable for 7kg/sqcm. working pressure complete with 25mm gunmetal air release valve, safety valve, pressure gauge etc as required. The air vessel shall be continuous welded construction and painted with two coats of Postal red enamel outside over a coat of primer and Epoxy paint inside.	1	each	10152.89	10152.89
1.1 8	Supplying and installation of Fire pressure vessel of 450mm dia and 1m high fabricated from 8-10mm thick M.S. plate suitable for 25 bar. working pressure with accessories, painted with two coats of Postal red enamel outside over a coat of primer and epoxy paint inside for automatic operation of pump.	1	each	18801.65	18801.65

1.1 9	Providing and fixing cast iron body IS: 210 FG 220 and double flange simple operation type butterfly valve conforming to IS: 13095 with SS304 disc and shaft nitnile rubber replaceable seat of the following size complete with bolts, nuts, washers and rubber insertions as per specification.				
a)	80 mm dia	30	each	2857.85	85735.50
b)	100 mm dia	30	each	3609.92	108297.60
1.2 0	Providing and fixing 15 mm nominal bore quartzoid bulb type sprinkler of chromium plated, UL/FM approved (side wall or spray type) suitable for operating on 57/68 deg. C as per requirement of local fire services.				
a)	ceeling suspended type - 57/68^{0}C	53	each	248.18	13153.54
1.2 1	Supplying, fixing, testing and commissioning, installation control valves comprising of :				
	1 No. alarm motor & gong (hydraulically operated)				
	1 No. main stop valve				
	1 No. alarm valve.				
	Pressure gauges drain pipe.				
1.2 2	Providing and fixing self glowing Exit sign board size 350x200mm single side painted made of luminescent safely, rigid sheet in standard colour, phot luminescent sheet made of crystals consisting mainly sulphide in protective glass like sheet green and yellow crystal luminescent (glass in dark) by action of light.	5	each	1504.13	7520.65
1.2 6	Providing and fixing cast iron body IS: 210 FG 220 and double flange simple operation type butterfly valve conforming to IS: 13095 with SS304 disc and shaft nitnile rubber replaceable seat of the following size complete with bolts, nuts, washers and rubber insertions as per specification.				
a)	100	4	each	2857.85	11431.40
1.2 7	Providing and fixing non-return valve C.I. Body complete with bolts, nuts washer & rubber insertions as required conforming to IS:5312.				
a)	80 mm dia	4	each	3760.33	15041.32
1.2 8	Providing, fixing, welded joints and testing of heavy class M.S. ERW black pipes schedule 40 with special accessories tees, elbows, flanged joints, rubber insertion, nuts, bolts, washers or welded joint with flange joints on bends, including fixing the pipe with suitable flat iron strip clamps/brackets structural members dash fastner,civil breakage,making good the same etc. painting with a primer coat and two coats of postal red enamel etc. complete as required.				
a)	25 mm dia 6mm thickness	150	mtr	3158.68	473802.00
b)	32 mm dia 6mm thickness	40	mtr	2406.61	96264.40
c)	40 mm dia 5.4mm thickness	10	mtr	1654.55	16545.50
	Total			**Rs.**	**2192415.98**

5. CONCLUSION

In conclusion, the design of the fire sprinkler system considered various factors such as water demand, pressure requirements, pipe sizing, and layout to ensure effective fire suppression capabilities. Through hydraulic calculations and pipe scheduling, the system's performance parameters were determined, including flow rates, pressure heads, and pump power requirements.

Similarly, the design of the fire hydrant standpipe system adhered to NFPA requirements for class-1 standpipes, considering factors such as hose connections, residual pressure, flow rates, and pipe sizing. Hydraulic calculations were performed to determine pressure heads, flow rates, and pump power requirements, ensuring adequate water distribution for firefighting operations.

In summation, the designs presented in this report aim to enhance fire safety measures in high-rise buildings, mitigating the risk of fire-related emergencies and safeguarding lives and property.

6. REFERENCES

NFPA 14

https://www.youtube.com/watch?v=1bWNoRi1iUc

https://www.youtube.com/watch?v=fzKd4gEV6Lg