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Design And Analysis Of One Bed Isolation Unit

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Abstract— The spread of pandemic needs to tackled throught all departments of science. Civil engineering department can be helpful in tackeling the isolation space problem. In this paper the author has iniated a design process for one bed isolation unit. This isolation unit can be installed at the airports. Manufactering of these units can be done by modular construction technique.

Index Terms— Isolatio unit, one bed isolation unit, airport isolation unit.

1 INTRODUCTION

THIS As shown in the above figure this isolation unit has one bed only, hence it is called one bed compartment. There are two entry gates for this unit. The entry on the right side is for patients called as patient's pathway and on the left it is called as medical personal pathway. Main reason for providing two separate entries is that, as soon as the passenger has landed on the airport they will enter from passenger pathway. In this ways the number of people coming in contact with the arrived passenger will be less.

Sanitization sprayer will be installed on both the entrances. This will ensure complete sanitation of person leaving or entering the isolation unit. Observation screen is provided to observe the passenger arrived. Proper observation can be carried out from this observation screen. The size of this isolation is kept as 6m X 3m X 5m height. This sizes will be sufficient for a single person.

2 DESIGN PROCESS

2.1 Material used

Detailed For Roof:- For roofing material G.I sheet of 26 gauge with 0.8mm thickness is used. The weight of the roofing material used is 4.11 kg/sq.m. In this case the weight for 18 sqaure meter, the total weight of the material will be 725.74-N or 0.725-KN.Vertical members: - This members will proved and form the outer frame. The material selected for vertical section is 49.5mm X 49.5mm X 4.5mm. The mentioned material is selected from Indian standard code IS 4923: 1997. The weight of this section is 5.96 kg/m. This is a hollow square section.Beam member: - The section used as beam in this unit is 60mm X 40mm X 3mm. This is a slotted hollow steel section. Main purpose for selecting this slotted section is that, the wall panels used in this unit can be sided into this hollow section. By sliding in the wall panel there will be less joints and speed of installation can be increased. The thickness of wall panel and section will be same so that it can easily slide in. This technique of connection is called as tounge and grove joining system. This will help in transporting and assembling of the wall panels. Doors,windows,and wall panel will be manufactering part of modular technique

2.2 Manual design

For manual design following is the floor plan. This plan is suitable for one bed and one person

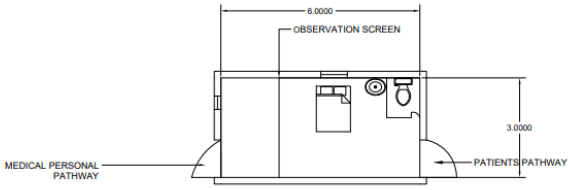

Fig. 1. One Bed Isolation unit

Roof Section:- Material used :- Coloured G.I Sheets. Thickness = 0.8mm Weight = 4.11 kg/sq.m = for 18 meter square = 725.74-N= 0.725- KNThe G.I sheet will be welded to the supporting vertical member.Bottom of GI sheet will be welded to the vertical member with the help of a plate.
Size of plate :- Width = 160mm.Thickness = 20 mm.

Design of welded connection:- f_u = 410 N/mm^{2}Load to be carried = 725.74 N. Assuming size of weld = S= 18.5 mm. Design shear strength of weld:-

$$f_{wd} = f_u / \sqrt{3} \div \gamma \quad (1)$$

$$= 236.71 \text{ N.}$$

Strength of weld = fwd X Thickness of weld = 3065.265 N. The length of weld will be calculated as load carried divided by strength of weld which is 240mm. Therefore,the size of weld will be 250mm and 95mm respectively.

2.3 Design of Tension member:-

The section will act as a beam. Therefore design process is as follows.

The density of load acting on this section is = 0.752 KN
Therefore, Factored UDL density = 0.725 X 1.5 = 1.087 KN.
Max shear force = V = (1.087 X 32) ÷ (8)
V = 1.6305 KN.
Maximum bending moment = $(WL^2) / 8$ (2)

Bending moment = 1.22 KN-m.

After using the refrence of classification of section from IS 800 the section was classified as plastic. So the next step followed is determining the shear strength,which his determined as follows.

$V_d = (f_{yw} X A_w) ÷ (\sqrt{3} X 1.10)$ (3)
= 3.149 KN > V ……Hence safe.
$Md = (\beta_b X Z_p X f_y) / \gamma_{mo} > M$…….Hence safe.

2.4 Wind Load Calculations :-

For the calulations of wind load ,there are some parameters which are pre defined in the indian standar is code. The is code used for wind calculation is IS 1893:2002. Following are the values of parameters which are obtained from calsues of the code which are furture used for caluculations.

K_1 = Probability Factor Or Risk Coefficient, Cl-5.3.3, Table 1
= 1
K_2 = Terrain Roughness and Height Factor, Cl.5.3.2, Table 2
= 0.8
K_3 = Topography factor, Cl.5.3.3, Cl.5.3.3.1
= 1.0

The structure is located in pune, therefore the design wind speed will be calculated as,

Design wind speed (Vz) = $Vb \times K_1 \times K_2 \times K_3$ (4)
= 31.2 m/s
Wind pressure = $0.6 V_z^2$ (5)
= 584.06 N/m

Wind load = F = $(C_{pe} - C_{pi}) \times P_d$ (6)
= 0.9 ×584 .06
= 0.525 KN/m^2

The values of $(C_{pe} - C_{pi})$ are taken from table 6 and cl.6.2.2 respectively.

2.5 Design of compression member :-

Total Wight to be carried by = Wind load + Load of roof material + Load of slotted section
= 0.525 + 725.74 + 205.05
= 930.09 N.

From IS code 4923: 1997 which is the Indian standard code for hollow sections , the properties of the section are as follows:

- 49.5 mm X 49.5 mm X 4.5 mm
- D = 49.5 mm
- T = 4.5 mm
- W = 5.95 kg /m
- A = 7580 mm^2
- R = 180 mm

Effective length = 5000mm
Selnderness ratio = (KL)/R = (5000) / (180) = 27.77
From IS code 800 – 2007 table 9 for buckling class b , by interpolation, the value of f_{cd} = 218.3 Mpa.

Therefore, Design compressive strength will be calculated as,

$P_d = A X f_{cd}$ (7)
= 7580 X (218.3)
= 1654.71 KN

As P_d > Total weight to be carried. Hence the section selected is safe.

2.6 Design of Beam to column connection :-

The UDL density = 0.725 KN/m
Span = 3m
Web = 49.5 mm
Using M20 bolts.
Strenght of M20 bolts in double shear
$= Fub/\sqrt{3} X 1/ \gamma_{mo} X (1+0.78) X (\pi/4) X (20)^2$
= 103.314 KN

Providing edge distance = e= 40 mm
P = 60 mm

We find K_b which is the minimum of
(40/66) : ((60)/66) – 0.25 ; (400/410); 1
K_b = 0.606.
T= 4.5 mm

Strength in bearing = 2.5 X Kb dt X fu X $1/(\gamma_{mo})$
= 2.5 X 0.606 X 20 X 410 X 0.8
= 9938.4 N
= 99.38 KN
Bolt Value = 99.38 KN.
End reaction = 50 X 1.5 = 75 KN
Factored reaction = 1.5 X 75 = 112.5 KN.
Number of bolts required = (112.5) / (99.38) = 1.13 say 2
Connection of angle to web:-
Thickness = 4.5 mm
Strength of bolt in single shear
$= Fub/\sqrt{3} X 1/ (1.25) X (0.78) X (\pi/4) X (20)^2$
= 45.27 KN.

Number of bolts required = (112.5) / (45.27) = 2.48 say 3
Therefore provide 3 bolts on each side for connection of section to web.

2.6 Seismic Load Design :-

Design parameter :-
Building in zone V
From IS 1893-2002 ,Table no-2
Z = 0.36
Importance factor = I = 1.5 from table 6
Response reduction factor = 5.0
Calculations of time period:-
From clause 7.6 of IS code 1893-2002 , for steel building.
$Ta = 0.085h^{(0.75)}$
= 0.526 secs.

Since building is symmetrical in plane and both are in same direction, for medium stiff soil ,Ta = 0.526secs
From clause 6.4.6, Sa / g = (1.36) /(0.526) = 2.5
Calculating of design horizontal seismic coefficient , clause 6.4.2
$Ah = (z/2) X (I/R) X (sa/g)$ (8)
= 0.18 X 0.3 X 2.5
Ah = 0.135.
Calculation of seismic weight:-
Floor area = 18 meter sq.
Dead load = 1.22 Kn
Live load = 3 Kn per meter sq.
From table 8 considering only 25% of the load, LL = 0.75 KN/m2
Seismic load on floor = 18 X 1.229 = 22.122 kn
Seismic live load = 18 X 0.75 = 12.5 kn
Total seismic weight = 35.633 KN.
Design of base shear according to clause 7.5.3,

Vb = Ah X w
= 48.08 KN

3 SOFTWARE OUTCOME

The software used for analyzing the sectins was stadpro. The software allows us to determine weather the section exposed to the loading are safe or unsafe. From analyzing the members used in the unit they were declared safe.

TABLE 1
SESMIC LOAD CALCULATIONS

Floor	Wi (KN)	$Wihi^2$	$Wihi^2/\sum wihi^2$	$Q = Vb \times wihi/\sum wihi_2$
ground	35.622	890.55	890.55	42.79KN

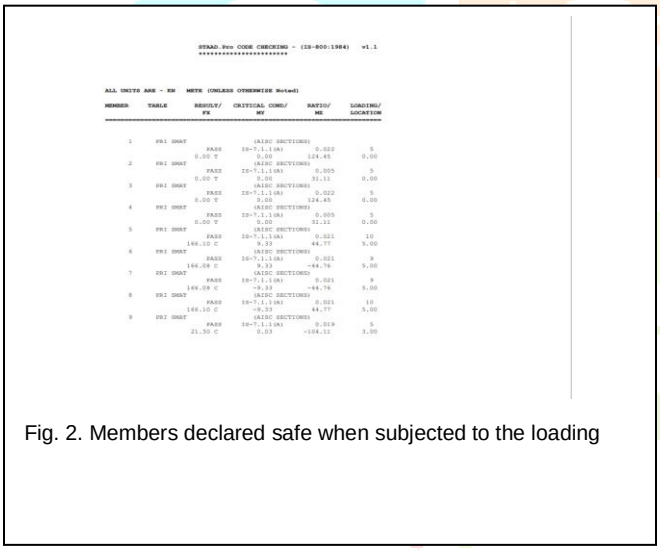

Fig. 2. Members declared safe when subjected to the loading

4 CONCLUSION.

From the above work it can be expected that at the end of the project we will have an isolation compartment for the people to isolate. The compartment will have one beds. Inside the compartment all guidelines which are required to be followed for isolation will be followed. The whole structure will be checked for static and dynamic forces. Thus it is expected it will carry all the forces which will act upon it.

It is also expected to boost this technique not only in field of medical but also in other fields of emergency. By designing such structures we might be able to tackle the current situation. It will also make us prepared for the future out comings.

The material selected for roofing purpose, G.I sheet is good enough material and durable material to serve the purpose. The easy availability of material and easy installation can speed up the construction period or installation period. These G.I sheets are easy to transport and can withstand forces impacted on it.

The vertical members ,which are acting as compression members are safe to use. The selected member is 49.5 mm X 49.5mm X 4.5 mm. This section was selected from IS 4923:1997. The design compressive strength of the member was found more than the weight which will be imposed upon it. This was checked by software analysis which gave the same result.

By introducing a slotted steel section has elemental many joints to stabilize the wall. By selecting Hollow square steel slotted section it will be very easy to slide in the walls. By this wall erection time will take very less time. The thickness of wall section and slot size of the section is kept equivalent. By doing this the wall will remain firm and intact. The wall panels are of GFRG material. These are pre-fab wall panels made up of fiber strands and gypsum plaster. The strength of this wall can also be increased by using infill material into the cavities of the wall, if necessary.

In such a way if above mentioned materials and design is used we can built a quick isolation center for airports , which will help in stopping the spread of the virus.

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