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Rapid Construction of House Using Shipping Container and GFRG Panels

Haider Abdalsada Abdallah
Department of Civil Eng.
of Institiute Patil .Y.D .Dr
Pune ,technology

Mohammed Issa Ali
Department of Civil Eng.
of Institute Patil.Y.D .Dr
Pune,technology

Patil Laxmikant Diliprao
Department of Civil Eng.
of Institute Patil .Y.D.Dr
Pune ,technology

Prof. G.C. Sarode
Department of Civil Engineering
Dr. D.Y. Patil
Institute of Technology, Pimpri Pune.

Abstract
The aim of our project is to check reliability of container house using GFRG panel objective to study properties and strength of GFRG panel and container to determine sustainable approach of shipping container to develop construction facilities. Analysis of the residential building using Grog panel in the construction of container house.
India is having an nearly 200 tons per day of a gypsum waste generation from many industry like fertilizers so we can utilize the waste material and reduce the waste material generation.
In India providing affordable housing is a challenge as we have lot of population who don't have home by using the shipping container and grog panels it will be affordable We are unaware about what course the nature takes in future in a such scenario one of the prime needs is to provide shelter to the displaced an container homes are just the answer these homes easy to assemble can be a quick relief for those hit by calamity Container homes can be moved to different locations an advantage other housing concepts do not enjoy this is precisely the reason why they are popular made up of housing in the military this can be used for the military purpose As we know the world is changing towards the sustainable and eco-friendly things as these homes are also sustainable and eco-friendly that's why it will grow in the future.

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I. INTRODUCTION

Nowadays, more than 17 million retired shipping containers are stacked on the port worldwide. Huge expenses are required for their destruction transportation and their non- degradable materials occupy a large landfill space when they are not in use. Due to this reason, the concept of use of modular and prefabricated houses and components is becoming a prevailing trend. The modular architecture and the large accessible quantities with affordable cost are thus driving the rise in popularity of container homes. Shipping containers are stackable construction elements being able to reduce the construction time cost and waste. The exiting studies stated that the reduce of containers for buildings results into a significant decrease in embodied energy when compared with conventional building.

Properties and strength of GFRG panel and container.

GFRG is used as panels for construction of building at low cost. These panels are composite materials consisting of based gypsum plaster and glass fibers. When the cavities are filled with reinforcement, the composition is between the concrete and panel [1]. GFRG can be used wherever a light, strong and fire retardant material is required (casinos, hotels, theaters, residential, etc.)

They can be used for the construction of various building components like Lintels, roof slabs, stair case, tie beam and can be provided as openings for doors, windows etc. They are considered to be more economic than other conventional materials. Our main aim is to study the properties and strength of GFRG panels in an economic way in construction of various structures. Generally, conventional materials require high cost and strength is less when compared with GFRG panels

DATA COLLECTION

Objective We had planned general, affordable container house to be constructed to university area. We draw the plans by using AutoCAD software. Concept Below planning was based on functional design, environmental aspect and aesthetic sense

ANALYSIS AND DESIGN

The design of container house for affordable mass housing of Sq.ft. is given here, it is to
be designed for earthquake load as per IS 1893-2002. The structure is to be founded on black cotton soil. The plan of the room is shown in fig 5.1

6.1 LOAD CALCULATIONS
Live Load-2 KN/m² (15 875-2003 Part-3)
Capacity of water tank - 1000lit
Load of water tank - 15KN/m²
Floor finish-1KN/m

WIND LOAD
Basic wind speed (Vb)-44m/s
Risk coefficient (KI)-10
Terrain, height & structure factor (K2)-1.0
Topography factor (K3)-1.0
Design wind speed (Vz)-Vb.K1 K2 K3
Height of building-3m
Design wind pressure (Pd)-116KN/m2

SEISMIC LOAD

Zone 3
Zone factor (Z)-0.16.
Length of the building – 8.4m
Width of the building-6.4m
Height of the building=2.9m
Design horizontal seismic coefficient Ah=z1/2r(sa/g)
Importance factor (I)= 1.0
Response reduction factor (R)-3.0 (Table No. 7 of IS 1893 Part I 2002)
Tax=0.09*h/ √d=0.09*2.9 √8.4=0.095

$\frac{Sa}{g}$ = 1 + 15T (From IS 1893-2002 Part1)

= 1+ 15 × 0.095

= 2.43

Horizontal seismic coefficient,

$$Ah = \frac{0.160 \times 1 \times 2.43}{2 \times 3} = 0.065$$

Similarly for Y direction,

$$Tay = \frac{0.09h}{\sqrt{d}} = \frac{0.09 \times 2.90}{\sqrt{6.06}} = 0.10$$

$\frac{Sa}{g}$ = 2.50 (From IS 1893-2002 Part 1)

Horizontal Seismic coefficient,

$$Ah = \frac{0.16 \times 1 \times 2.50}{2 \times 3}$$

= 0.067

6.2 DESIGN OF FOUNDATION

Load Calculations,

For a 124mm thick GFRG panel of 2.90m height and length of 1m,

Load per running meter to be equal to

= 0.124×1× 2.90 × 0.45

= 0.16 KN/m

For empty 20ft container weight between 1.8-2.2 metric tonnes,

i.e. 21.57KN

We have three containers,

So the total wt. Of containers = 21.57×3

= 64.71 KN

Wt. Of container per meter length = $\frac{64.71}{6.06}$ = 10.67 KN/m

W = 315=10.67

= 325.67 KN

Wd = 1.5×325.67

= 488.50 KN

Assume 5% Wt. Of footing,

= 1.05×488.50

= 512.925 KN

Assume safe bearing capacity = 245 KN/m^2

Size of footing,

Width of footing (B) = $\frac{512.925}{245} = 2.09$m

Hence provide width of 2.2m

Tacking 10% of total load on self weight of footing and subtracting it from the total ultimate load,

Net downward load on soil = 512.925×0.9

= 461.63 KN/m

Net upward pressure (Po) = $\frac{W}{R} = \frac{461.63}{2.2}$

= 209.83 KN/m^2 Per meter length

BM CALCULATION:

In case of brick masonry wall, the critical section for max. Bending moment is taken at a section midway between the edges of the wall and centre of wall (clause 34.2.3.1) page No. 65 IS 456-2000

$$Mu = \frac{P0}{2}\left(\frac{B-b}{2} + \frac{b}{4}\right)^2$$

$$= \frac{209.83}{2}\left(\frac{2.2-0.23}{2} + \frac{0.23}{4}\right)^2$$

= 114.02KN per m

DEPTH OF FOOTING

For FE415,

Mulim = 0.138 Fck bd^2

$$d = \sqrt{\frac{Mu}{0.138.Fck.b}}$$

$$= \sqrt{\frac{114.02\times10^6}{0.138\times20\times1000}}$$

= 203.25 mm

= 210mm

Taking 50mm clear cover

(Clause 26.4.2.2 For footing min. cover shall be 50mm IS 456:2000)

Diameter of bars = 20mm

Overall depth (D) = 210+50+20/2

D = 270mm

Area of steel,

Mu = 0.87 Fy.Ast.d $(1-\frac{Fy.Ast}{Fck.bd})$

$114.02\times10^6 = 0.87\times415\times Ast\times210\times(1-\frac{415\times Ast}{20\times1000\times210})$

Ast = 1837mm^2

Using 20mm dia bars, Ad= 314.16

Spacing required $=\frac{314.16\times1000}{1837}$

= 171mm

Hence provide 20mm ø @ 170 mm c/c

Ast Provided $= \frac{314\times1000}{170}$

$=$ 1874.06mm^2

Pt% Steel $= \frac{Ast\ \times100}{bd}$

$= \frac{100\times1847}{1000\times210} =$ 0.88%

Min distribution steel required = 0.12/100×1000×270

= 324mm^2 $\leq$ 1827mm^2

Hence ok,

Using 10mm Dia. bars,

Spacing required = 150mm

Hence provide 10mm ø @ 150mm c/c in the longitudinal direction

CHECK FOR SHEAR (ONE WAY SHEAR)

Critical section for shear is at a distance (d) from the face of the wall

Vu = P0 $(\frac{B-b}{2} - d)$

= 209.83 $(\frac{2.2-0.23}{2} - 0.21)$

= 162.62 Kn/m

Tv = $\frac{Vu}{bd} = \frac{162.62\times10^{\wedge}3}{1000\times210}$

= 0.77 N/mm^2

Pt = 0.88, M20

Table 19, IS 456-2000

Tc= 0.59 N/mm^2

Tv ≥ Tc

Hence the footing is not safe in shear therefore revising its depth

$\frac{162.62\times10^{\wedge}3}{1000\times d}$ = 0.59

d = 275mm Appox. 280mm

D = 280+50+10 = 340mm

CHECK FOR DEVELOPMENT LENGTH

Ld = $\frac{0.87\ Fy\ \emptyset}{4\ T\text{bd}}$

M20, Tbd = 1.2×1.6 = 1.92 N/mm^2

= $\frac{0.87\times415\times20}{41,92}$

= 940.23mm

=0.94m

Provide, 50mm cover length of bar available

$= \frac{1}{2}(\frac{2.2-0.23}{2}$-0.50)

=1.205m ≥ 0.94m

Hence ok

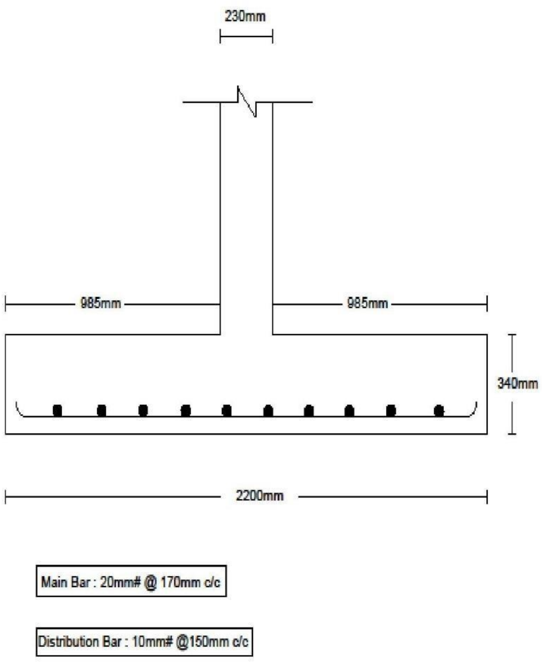

Fig. 6.1 Footing Detailing

Deign of floor slab for a room of interior dimension 4.63×3.0m using GFRG panel

Floor finish = 1.0KN/m^2

using M25 concrete & Fe 415 steel

Reinforced concrete micro beam are provided at every 750mm in the shorter direction together with 50mm screed concrete on top of the panel

Effective span: Effective depth assuming 12mm diameter bars

D= 124+ 50-15-8-12/2+ 145mm

Effective span as per clause 22.2 of IS 456:2000

I. Clear span + effective depth = 4.63+0.145 = 4.775
II. C/C of supports = 4.63+0.124 = 4.754

Min span = 4.754

LOADING -

Weight of empty GFRG panel = 0.44Kn/m^2

Weight of in filled concrete (every 3rd cavities filled) plus the 50mm screed concrete

= 0.05×25+(0.094×0.23×25/0.75)

=1.97KN/m^2

Floor finish = 1.0 KN/m^2

Live load as per IS 875 (part 2) 1987 = 2KN/m^2

Total service load , W = $1.5 \times 5.4 \times 4.7542^2/8$

= 22.88 KN-m/m

Design bending moment / rib mud =0.75×22.88

= 17.16 KN

Mu/bd^2 =$\frac{(17.16\times10^6)}{230\times145\char`^2}$ = 3.55 N/mm^2

From table 3 of SP-16 Design Aids to IS 456

Pt = 1.876

Ast = $(\frac{1.876}{100})$ ×230×145

= 625 mm^2

Provide $2\gamma 18$ + 1γ 14, giving an area of 662mm^2

Shear force Vu= 1.5×5.4×0.75×(2-0.145)

= 11.27 KN

Tu = $\frac{(11.27\times10^3)}{230\times145}$

= 0.34 N/mm^2 (From table 19 of IS 456)

For Pt= 0.914

Tc = 0.62 N/mm^2≥ 0.34 N/mm^2

Hence only nominal stirrups is required , minimum stirrups steel ,

Asv = 0.4bSv/0.87Fy

Max spacing, Svmax = 0.75×145

= 108 ≈ 100mm

Asvmin = $\frac{(0.4\times230\times100)}{0.87\times250}$

= 42.3 mm^2

Provide 6mm ø two legged mild steel stirrups @ 100c/c

Nominal steel for screed concrete = (0.12/100)×50×10^3 = 61.2 mm^2/m

Provide 10 Gauge welded mesh @ 100mm c/c on top

II. CONCLUSION

(1) GFRG Panels provides a new method of building construction in fast track, fully utilising the benefits of prefabricated, light weight large panels with modular cavities and time tested, conventional cast-in-situ constructional use of concrete and steel reinforcement.
(2) By this process, man power, cost and time of construction is reduced
(3) These of scarce natural resources like river sand, water and agricultural land• Fast delivery of mass dwelling/ housing is very critical for reducing huge urban housing
is significantly reduced.
(4) Rapid wall panels have reduced embodied energy and require less energy for thermoregulation of interiors. Rapid wall buildings thereby reduce burdening of the environment and help to reduce global warming.
(5) Rapid wall use also protects the lives and properties of people as these buildings will be resistant to natural disasters like earthquakes, cyclone, fire etc. This will also contribute to achieve the goal of much needed social inclusive development due to its various benefits and advantages with affordability for low income segments also.

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