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STRUCTURAL DESIGN OF ALUMINIUM FORMWORK STRUCTURE OVER FRAMED STRUCTURE

N.KALITHASAN[1] , K.SHANTHI[2] , B.JOSE RAVINDRARAJ[3] , R.VIJAYASARATHY[4]
PG STUDENT[1], M.Tech Structural Engineering, PRIST UNIVERSITY
ASSISTANT PROFESSOR[2] , Department of Civil Engineering, PRIST UNIVERSITY
ASSISTANT PROFESSOR[3] , Department of Civil Engineering, PRIST UNIVERSITY
ASSISTANT PROFESSOR[4] , Department of Civil Engineering, PRIST UNIVERSITY

ABSTRACT

The aluminium formwork construction method is 25 year older methods in Europe countries. But this method of construction is new type in India. This method is fastest construction compare another type.Our project is to compare than design, construction period and estimation. In Aluminium formwork all members are constructed using concrete, which consist of only walls and slab. Framed structure is beam, column, and slab. The wall is 250mm thick brickwork. This project selects same plan of structure and compare structural design, estimation and project duration in aluminium formwork and conventional method.

INTRODUCTION

In every year the construction industry provides new techniques up to date. The aluminium formwork construction technique is a new technique in the construction industry. This type of construction provides speed, high strength and quality of the structure. Aluminium formwork another name is Mivan technology.

This type of construction is a successful construction in East Asia and Europe countries. This type construction used in part of Burj Kalifa in Dubai. Aluminium formwork construction is a load bearing structure and wall is construction of reinforced cement concrete.

Aluminium formwork consists of high strength RCC wall. The load carried by RCC wall. This is more earthquake resistance compare framed structure. Aluminum is a high strength material and long life compares wood and plywood. Aluminium formwork is no need wall plastering. Framed structure need wall plastering.

SCOPE

Our project compares the design, estimation, construction duration and advantages and limits in the same plan of structure by mivan technology and conventional method.Mivan technology structure design by manual. Framed structure design by STADD PRO software. Mivan technology is consisting of walls and slabs. Framed structure is consisting of beam, column and slab.

STRUCTURAL DESIGN OF ALUMINIUM FORMWORK STRUCTURE

Assume wall thickness = 200mm

$L_e = 0.65L = 0.65x4000 = 2600mm$

Slenderness of wall

$L_e = 2600/200 = 13>12<40$

Minimum accidental eccentricity

$e_x = t/20 = 10mm$

Minimum provide

$e_x = 20mm$

Additional eccentricity as in R.C. column

$e_a = L_e^2 / 2000t = 2600^2/ 2000x200 = 17mm$

$P_u = \alpha (t-1.2 e_x - 2e_a)f_{ck}$

$= 0.3(200-1.2x20-2x17)20$

= **852** N/mm

For one meter length = 852x1000 = 852 KN

Axial strength of wall = 852 KN

Factored moment = Pe

$e = e_x + e_a = 20+17 = 37mm$

= 852 x 37/100 = 31.52KNm

Steel from interaction diagram

d' = 40+ dia of rod/2

= 40 +10/2

= 45mm

d' / D = 45/200 = 0.225

$P/f_{ck} b D = 852x10^6/20x200x1000 = 0.213$

$M/ f_{ck} bD^2 = 31.52x10^6/200x1000x200^2 = 0.039$

$P/f_{ck} = 0.02$

P = 0.02x20 = 0.4

$P = 0.4x200x1000/100 = 800mm^2$

Provide 10mm dia

$S_v = 78.54x1000/400 = 200mm$

Provide 10mm dia bar @ spacing 200 mm c/c

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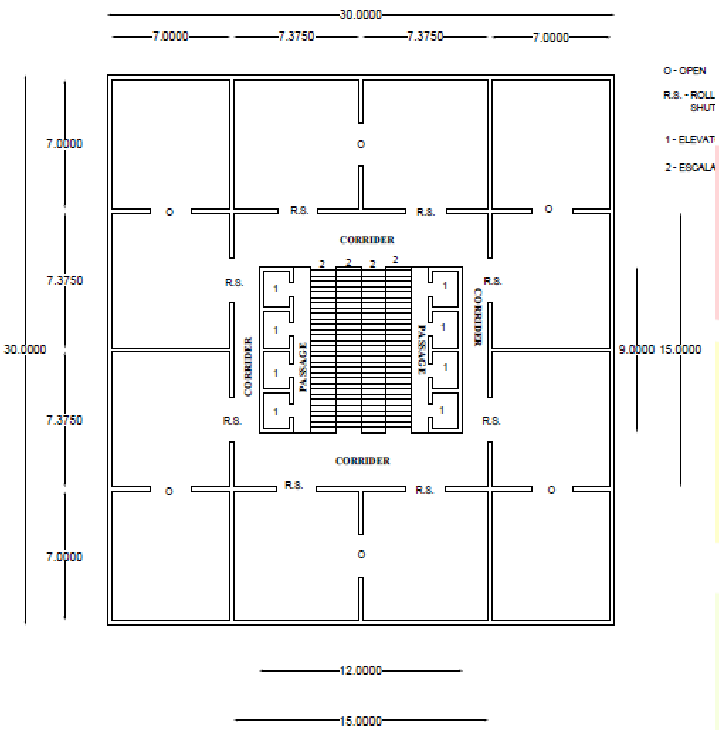

Figure-1 – First Floor To 9th Floor Plan

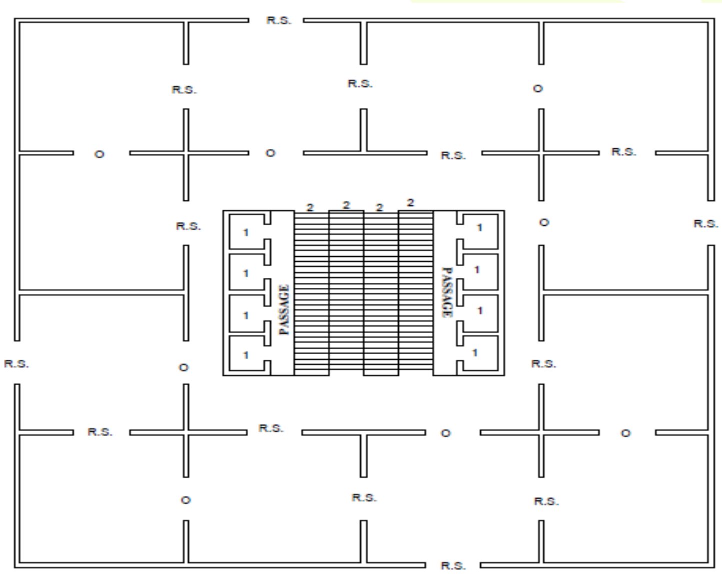

Figure-2 – Ground Floor Plan

Slaslab design

Effective depth = clear span / basic value modification factor

Basic value of continuous slab = 26

Assume percentage of steel = 0.3%

Modification factor = 1.5

d=7000/26x1.5 = 180mm

Provide cover 20mm

D=d+d' = 180+20 = 200mm

Self-weight = 0.2x25 = 5KN/m²

Live load = 4 KN/m²

Floor finish = 1 KN/m²

Total load = **10** KN/m²

Factored load = 10 x 1.5 = 15 KN/m²

Effective span = clear span + effective depth = 7+0.2 =7.2m

$M_{ux} = \alpha_x W_u L_x^2 = 0.047 \times 15 \times 7.2^2 = 36.55$ KNm

$M_{uy} = \alpha_y W_u L_x^2 = 0.047 \times 15 \times 7.5^2 = 36.55$ KNm

Check for depth

Required depth = √Mu/Qu b d = √36.55 x 10^6/0.138x20x1000 = 115 mm

d<required depth. hence is safe.

Mu = 0.87 x fy x Ast x d (1- Ast x fy/b x d x fck)

36.55x10^6 = 0.87x415xAstx180(1-Astx415/1000x180x20)

Ast = 604.55mm²

Provide 12mm dia of bar

ast = 113.1 mm²

Sv = 113.1 x 1000/ 605 = 185mm

Provide 12mm dia of bar @ spacing 185mm c/c

Quantity

Aluminium formwork

Shuttering and centering = 24607.5 m²
Concrete wall = 1912.5 m³
Concrete slab = 1096m³

Framed structure

Shuttering and centering = 11169 m²
Concrete = 609.5 m³
Concrete slab = 1096 m³
Brickwork= 1898 m³
Plastering = 21200 m²

Estimation

Aluminium form work

Shuttering and centering	=Rs 36, 91,115
Concrete wall	= Rs3, 03, 70,500
Concrete slab	= Rs1, 74, 04,480
Total	= Rs5, 14, 66,105

Framed structure

Shuttering and centering	=Rs 24, 01,335
Concrete	=Rs 96, 78,860

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Concrete slab = Rs1, 74, 04,480
Brickwork = Rs1, 12,88,000
Plastering =Rs 68, 47,600
Total = Rs4,76,20,275

Aluminium formwork is more costly than framed structure

Figure 4 – centering and shuttering

Figure 3- staircase

Figure 5 – wall shuttering

Advantages

- Concrete wall consists transverse reinforcement. So, more seismic resistance compare the framed structure.
- Structure is more strength.
- Very faster construction.
- Less labour.
- Erection and remove of aluminium panel is easy.
- Structure easy analysis.
- Quantitative and estimation are easy.

Limitation

- Can't modify after hardening member.
- This type of structure, skilled labour is less.

Project cycle

Aluminium formwork

Bar bending and erection -2days
Aluminium formwork erection- 2days
Electrical and plumbing – 2 days
Concrete pouring – 1 day
After 7 days remove aluminium formwork -2 days

Construction time each floor – 15 days
Total construction time of structure – 6 months/ 10floors

Framed structure

Framed structure construction time approximately 10 to 12 months

Conclusion

Alumuinium formwork structural manual design and analysis is easy in multi storey buildings. But framed structure manual design is difficult and not accuracy in multi storey structure.so, framed structure design is analysis in computer aided programme of STADD PRO.
Aluminium formwork structure is more costly compare than framed structure. But project time is half of framed structure. So, consider reducing labour cost in aluminium structure. And another think Aluminium formwork structure ismore strength and earthquake resist compare than framed structure.

Reference

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Design following as per IS codes.