COMPARATIVE STUDY BETWEEN NORMAL SLAB AND U BOOT BETON SLAB

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Abstract - *In this modern age different types of structure are been observed which are more efficient that the structures been made in past. In our project report we have been specifically focused on design and construction of slabs in R.C.C buildings and bridges eliminating the traditional method of slab construction by using hollow blocks and making a voided slab which has many advantages over the regular span and is more efficient too. The purpose of the study is to analyse the voided slab by using U-boot blocks and preparing a report mentioning how efficient the voided slab can be over and regular slab. Structural calculations and their outcomes are calculated in this paper comparing the traditional and u boot technology system*

Key Words: (efficient, U boot technology)

1.INTRODUCTION

In modern day construction there is always advancements and new technologies coming under use which helps the ease the work of construction in many ways. A voided slab may be a ferroconcrete slab during which voids reduce the slab's weight. In this slab, lightweight void formers are placed between the very best and thus rock bottom reinforcements before concrete casting to exchange concrete within the center of the slab. In our project we will the studying about the square beton blocks called U-boot blocks and will be comparing the voided slab to a normal slab and observe the differences between them.

1.1 OBJECTIVE

1. Identification of various structural models for project execution of low cost sanitation system which prevents to stand the cost, time and durability.

2. Proposal of innovation in construction methods and materials in the form of U-boot technology of casting and modular rebar sets in various repetations for effective low cost, manufacture time and maximum durability.

3. To compare the self-weight of conventional slab and self-weight of voided slab.

4. To be able to create slabs with larger span which can support large loads without beam.

5. Ability to build mushroom pillars due to absence of beam and reduce the number of columns.

6. Create higher number of floors creating more useable space for people.

7. Build an environmentally green and sustainable buildings.

1.2 NEED FOR U BOOT PROJECT

By using this technology we can save more concrete and steel by that structure is more economical for us. Less use of iron in the slabs, pillars and foundation up to a total of 15%. There are anti-seismic advantages connected to reduced building weight slimmer pillars and foundations, there are low chance of seismic effect on the buildings. Due to the fact, that the structural behaviour of this new kind of monolithic flat slab is the same as for solid slab, excluding slab-edge column connection, we surely can talk appropriateness of use and advantages of the new technology.

2. METHODOLOGY

We used Daliform official software to calculate and find the appropriate u boot beton size for calculations of slab by inputing the slab size, all types of load resulting in SAFE structure.
The inputs done resulted in using us H.10cm single U-Boot beton for slab

2.1 DESIGN OF NORMAL RCC SLAB

Design RCC slab of dimension 5.58 meter X 4.34 meter simply supported from all the four sides on beam with width 300MM

1) Assume =monolithic construction

   LL = 3 Kn/m^2

   FF =1 Kn/m^2

   FCK =20 Mpa

   FY =415 Mpa

2) Ly/ Lx = 5.58 /4.34 = 1.2857 < 2

   Hence two way slab

   Leff for monolithic slab

   Leff= 4340 - 300 /2- 300 /2 = 4040mm

3) Calculation of depth of slab

   Leff / dx = 20 x modification factor

4040 / dx = 20 X 1.4

Dx= 144.285 mm

Take clear cover = 30mm and Ø = 12mm

Therefore D = dx + clear cover + dia / 2

= 144.285 + 30 + 12 / 2

= 180.285mm

Take D = 200mm

Therefore dx= 200 - 30 - 6

= 164mm

Calculation of loads acting on slab

- dead load = 25 X 0.2 = 5 Kn/m^2
- LL = 3 Kn/m^2
- FF = 1 Kn/m^2

Total load = 9 Kn/m^2

Factored total load = 9 X 1.5 = 13.5

Consider 1 meter width of the slab

Wu = 13.5 / 1 = 13.5 Kn/m

4) Calculation for bending moment and shear force

Ly/lx	αx	αy
1.2	0.084	0.059
1.285	x	y
1.3	0.093	0.055

X=0.09165 Y=0.0556

MX = αx X w X lx^2

= 0.09165X13.5X 4.34^2

= 5.37225 Kn.m

My = αy X w X lx^2

= 0.0556 x 13.5 x 4.34

= 3.2591 Kn.m

Vx = αx X w X lx

= 0.09165 x 13.5 x 4.34

= 5.36977 KN

Vy = αy X w X lx

= 0.0556 x 13.5 x 4.34

=3.2576 KN

5) Check for flexure

Mx = 0.138 fck bdx^2 req

23.292 x 10^6 = 0.138 x 20 x 1000 x dx^2 req

dx req = 91.864mm

SAFE.

6) Calculation of reinforcement

$$\text{Ast x req} = \frac{0.5 \times fck \times bdx}{fy} \times \left[1 - \sqrt{1 - \frac{4.6\,Mx}{fck \times bdx^2}}\right]$$

$$= \frac{0.5 \times 20 \times 1000 \times 164}{415} * \left[1 - \sqrt{1 - \frac{4.6 \times 23.292 \times 10^6}{20 \times 1000 \times 164^2}}\right]$$

= 415.37 mm

Assume dia of bar = 12mm ф

Spacing $= \frac{area\ of\ one\ bar}{ast\ required\ (x)} \times 1000 = \frac{\pi/_4 \times 12}{415.393} \times 1000 = 272.26\ mm \cong 250\ mm$

Or

3 x d = 492

Provide 250 mm c/c

ast (x) provided = $\frac{\pi/_4 \times 12}{250}$ x 1000

= 452.389 mm^2

Provide 12mm - 250mm c-c as shorter span reinforcement

7) Calculation of reinforcement along longer span

Dy = D-30-12-(12/6)

= 200-30-12-6

= 152mm

Ast y required = $\frac{0.5\times 20\times 1000\times 152}{415}\times\left(1-\sqrt{1-\frac{4.6\times 14.138\times 10^6}{20\times 1000\times 152^2}}\right)$

= 267.51 mm^2

Assume 12ϕ mm bar

Spacing = $\frac{\pi/4\times 12^2}{267.57}$ x 1000 = 422.77mm

Or

3d = 3 x 157 = 462mm

Provide min spacing of 300mm

Ast y provided = $\frac{\pi/4\times 12^2}{300}\times 1000 = 377$ mm^2

Provide12 mm @ 300mm c-c as longer span reinforcement

8) Check for shear

Calculation of nominal shear

$$\tau v = \frac{vx/y}{bdx/y} = \frac{5.36\times 10^3}{1000\times 164} = 0.0326\ N/mm^2$$

Calculation of percentage of steel (Pt %)

Pt % = ast px / bdx x 100

= $\frac{452.389}{1000}$ x 100 = 0.275%

Determination of design shear stress in conc.

0.25	0.36	
0.275	x	k= 1.20
0.50	0.48	

Therefore τc = 0.372

$\tau_{v(0.0326)} < \tau_{c(0.372)} < k_{(1.20)}$

SAFE.

9) Check for deflection (MF)

Fs= 0.5fy ast x required/ ast x provided

= 0.58 x 415 x 415.393/452.389

= 221.075

Pt%= 0.275%

From graph of modification factor

MF=1.65

Therefore leff/dx = 20 x 1.65

4040/dx= 20x 1.65

dx= 122.42

dx required < dx provided

SAFE

10) Torsional reinforcement

Ast (t) = 3/4 x Ast xp

= 3/4 x 452.384

= 339.288 mm^2

Size of mesh = lx/5

= 4340/5

= 868

Therefore 868 x 864 mm is mesh size.

Assume diameter of bar = 10mm

Spacing = $\frac{\pi/_4 \times 10^2}{339.2\,88}$ x1000 = 231.48 mm $\cong 225\ mm$

Therefore Ast provided = $\frac{\pi/_4 \times 10^2}{225}$ x1000

= 349.065 mm^2

Therefore provide torsional mesh of 868mm x 868mm of 10mm @ 225mm c-c on all four corners.

Minimum reinforcement

Ast min = 12% b x D

=0.12/100x1000x200 (12mmϕ)

= 240 mm^2

Spacing = $\frac{\pi/_4 \times 10^2}{240}$ x 1000

= 471.238 mm

Or

5 x d = 820mm or min = 450mm

Ast min provided = $\frac{\pi/_4 \times 10^2}{240}$ x 1000

= 251.327 mm^2

Therefore provide 12- 450 mm c-c as min reinforcement

Ast x provided = 113.097 mm^2

Torsional reinforcement

Ast (t) = 3/4 x 113.097

= 84.823mm^2

Size of mesh = 4340/5

= 868mm

868 x 868 mm mesh size

Assume diameter = 6mm

Spacing= $\frac{\pi \times 3^2}{240} \times 1000$

= 333.33 mm

Take 250mm spacing

Ast (t) provided = $\frac{\pi \times 3^2}{250}$ x 1000

= 113.097mm^2

11) Development length (ld)

$$\frac{Mx}{Vx} + lo = \frac{23.292 \times 10^6}{5.36 \times 10^3} + (12 \times 12)$$

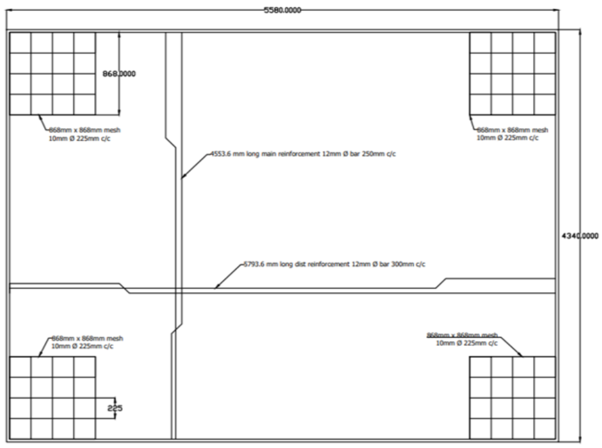
= 4489 mm.

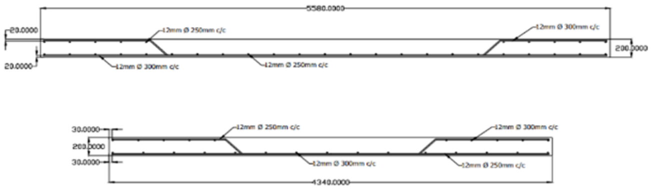
$$Ld = \frac{\phi\sigma s}{4\tau bd} = \frac{12 \times \left(\frac{fy}{1.15}\right)}{4 \times 1.6\ \tau bd} = \frac{12 \times (0.87 \times 415)}{4 \times 1.6 \times 1.2}$$

= 564.14 mm

SAFE.

Provide ld = 564.14mm





2.2 QUANTITY AND ESTIMATION OF NORMAL SLAB

QUANTITY OF STEEL

1) Length of straight bar shorter span = 4.34+2×9×0.012-2×0.03

= 4.496 m (main steel)

2) Length of straight bar longer span = 5.58+2×9×0.012-2×0.03

=5.736 m (distribution steel)

3) Number of bar in shorter span = (5.736/0.250)+1

=24 bars

4) Number of bar in longer span = (4.496/0.300)+1

=16 bars

MAIN STEEL BENT UP BAR

1) Length of bent up bar on shorter span = 0.45x+ (length of shorter span)

Here x = 0.20-2×0.03-0.012

= 0.128 m

Therefore, length of bent up bar on shorter span = 0.45×0.128+ (4.496)

= 4.554 m

DISTRIBUTION STEEL BENT UP BAR

1) Length of bent up bar on longer span = 0.45x+ (length of longer span)

x = 0.128

Therefore, length of bent up bar on longer span = 0.45×0.128+ (5.736)

= 5.794 m

Torsional steel with 30 mm cover 10 mm Ø 225 mm c-c

Top side = (0.868/0.225) + 1

= 5 nos.

10 bars on one corner

Therefore, total number of bars in all four corner for top reinforcement = 10×4

=

bars

Total number of bars in all four corner for bottom nforcement = 10×4

= 40

's

Bars on top of bent up bar on shorter span

Length of top extra bar (bent up) = (868/250) +1

=5nos.

Therefore, no of bars = 10 nos.

Bars on top of bent up bar on longer span

Length of top extra bar (bent up) = (5580/5)

No of bars = (1116/300) +1

= 5 bars

Therefore, 5 bars on one side and 5 on other so the total number of bars 10 bars.

Minimum steel on shorter span

No of bars = (5736/450) +1

= 14 bars

Volume of slab = L×B×H

= 5.58×4.34×0.2

= 4.843 m^3

1) Volume of slab of main bar on shorter span

$V_1 = \pi \times r^2 \times h$

$= \pi \times 0.006^2 \times 4.496$

$= 0.0005084\ m^3$

Total volume = 0.0005084 × 12

$= 6.1008 \times 10^{-3}\ m^3$

2) Volume of slab of main bar on longer span

$V_2 = \pi \times r^2 \times h$

$= \pi \times 0.006^2 \times 5.736$

$= 6.487 \times 10^{-4}\ m^3$

Total volume = $6.487 \times 10^{-4} \times 8$

$= 5.1896 \times 10^{-3}\ m^3$

3) Main steel bent up

$V_3 = \pi \times r^2 \times h$

$= \pi \times 0.006^2 \times 4.554$

Total volume = $5.150 \times 10^{-4} \times 12$

$= 6.180 \times 10^{-3}\ m^3$

4) Distribution steel bent up

$V_4 = \pi \times r^2 \times h$

$= \pi\times0.006^2\times5.794$

$= 6.553\times10^{-3}\ m^3$

Total volume $= 6.553\times10^{-3}\times8$

$= 5.241\times10^{-3}\ m^3$

5) Torsional steel

$V_5 = \pi\times r^2\times h$

$= \pi\times0.005\times0.868$

$= 6.817\times10^{-5}\ m^3$

Total volume $= 6.817\times10^{-5}\times80$

$= 5.454\times10^{-3}\ m^3$

6) Bars on top of bent up bar (x direction)

$V_6 = \pi\times r^2\times h$

$= \pi\times0.006^2\times4.398$

$= 5.084\times10^{-4}\ m^3$

Total volume $= 5.084\times10^{-4}\times10$

$= 5.084\times10^{-3}\ m^3$

7) Bars on top of bent up bar (y direction)

$V_7 = \pi\times r^2\times h$

$= \pi\times0.006^2\times5.736$

$= 6.487\times10^{-4}\ m^3$

Total volume $= 6.487\times10^{-4}\times10$

$= 6.487\times10^{-3}\ m^3$

8) Minimum steel

$V_8 = \pi\times r^2\times h$

$= \pi\times0.006^2\times4.396$

$= 5.084\times10^{-4}\ m^3$

Total volume $= 5.084\times10^{-4}\times14$

$=7.1176\times10^{-3}$

Volume of concrete = volume of slab – $(V_1+V_2+V_3+V_4+V_5+V_6+V_7+V_8)$

= 4.843 – 0.0468

= 4.796 m3

The calculation for u boot slab remains as same as normal slab but the quantities will differ :

2.3 QUANTITIES CALCULATED FOR U BOOT SLAB

Top reinforcement
Shorter span length = 4.34+2×9×0.006-2×0.050
= 4.348 m
No of bars = (4.348/0.125)+1
= 36 bars
Longer span length = 5.58+2×9×0.006-2×0.050
= 5.588 m
No of bars = (5.588/0.250)+1
= 24 bars
Same amount of steel for bottom reinforcement.
X-direction = 36 bars, Y-direction = 24 bars
Shear reinforcement length = 170 mm
No of stirrups on one strip = 45
Total no of stirrups = 45 × 6
= 270 no.

TORSIONAL STEEL
Size of mesh = 868 × 868 mm
Spacing = 300mm
$Ast_p = (\pi\times3^2/300)\times1000$
$= 94.24\ mm^2$
Provide torsional mesh of 868×868 mm of 6 Ø @ 300 mm c-c spacing.
No of bars = (868/300) + 1
= 3.89 = 4 bars
Total bars = 4×4×2
= 32 bars
Volume $= \pi\times r^2\times h$
$= \pi\times3^2\times868$
$= 24542.12\ mm^3$
$= 2.545\times10^{-5}\ m^3$
Total volume $= 2.545\times10^{-5}\times32$
$= 0.000785 m^3$
Volume of steel$V_1 = \pi\times r^2\times h$
$= \pi\times0.003^2\times4.348 = 1.229\times10^{-4}$
$= 1.229\times10^{-4}\times36 = 0.00442\ m^3$
$= 0.00442\times2 = 8.84\times10^{-3}\ m^3$
$V_2 = \pi\times r^2\times h$
$= \pi\times0.003^2\times5.736 = 1.6218\times10^{-4}$
$= 1.6218\times10^{-4}\times24 = 0.00389\ m^3$
$= 0.00389\times2 = 7.78\times10^{-3}\ m^3$
$V_3 = \pi\times r^2\times h$
$= \pi\times0.003^2\times0.17 = 4.806\times10^{-6}$
$= 4.806\times10^{-6}\times270 = 0.00129\ m^3$
$V_4 = \pi\times r^2\times h$
$= \pi\times0.003^2\times0.868 = 2.45\times10^{-5}$
$= 2.45\times10^{-5}\times32 = 0.000785\ m^3$
Volume of single block of u-boot = 0.0213 m^3
Total no of blocks = 7×9 = 63 nos.

2.4 COST COMPARISION

For Normal Slab

Sr No	Material	Quantity	Rate	Amount
1	Cement	39 bags	180	7020
2	Sand	2.014 cu m	350	705
3	Aggregate	4.028 cu m	900	3625

For U Boot Slab

Sr No	Material	Quantity	Rate	Amount
1	Cement	27 bags	180	4860

2	Sand	1.463 cu m	350	512
3	Aggregate	2.925 cu m	900	2633
4	Uboot	63	350	22050

3. FUTURE SCOPE

As the future beholds new technology and techniques, optimization of concrete mix designs is acceptable for U-boot. It makes it possible more irregularly distribute the pillars, as beams are not needed. This technology provides early age strength estimation for detection of failure for future. As early detection of failure is done improving safety is an improvised factor which can help minimizing the loss of life and structure caused during disaster. Savings in concrete and cost of formwork, the analysis is immediate and intuitive for this. This technology helps reducing polypropylene that is thermal plastic as waste generation of this material is on high rate. Reducing material consumption made it possible to make the construction time faster and reduction in overall cost of construction. Due to modularity designing its light and easy to place hence can adapt in all situations with great architectural freedom. Maximum space designing encourages more definite and spacious buildings in future with freedom of different designs.

4. CONCLUSION

The U-boot technology is an advanced, economical, asthetically innovative and fastest method of construction of a slab. The purpose of the partial results of designing of which are presented, is focused on modelling and comparison of the variants of lightweight slab construction in terms of structural weight, cost of material and labour resources as well as in terms of the total construction cost. The usage of U-boot technology is extremely rare because of lack of awareness in our country. The responsibility of saving natural and renewable resources for our future generaations should be the moto of every individual hence, this technology should be utilized more

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