Research Paper

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Comparative Study And Programming of Various Types of Slabs

Engineering

KEYWORDS : Abrasion, Composite Slab, Deck, Shear Connectors, Post Tension Slab

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ABSTRACT

The design of structures for commercial and industrial buildings is mainly concerned with the provision and support of load-bearing horizontal surfaces. These floors or decks are usually made of reinforced concrete as it satisfies the criteria of low cost, high strength, and resistance to corrosion, abrasion, and fire. In composite slab consist of profiled steel decking with an in-situ reinforced concrete topping. The composite interaction is achieved by the attachment of shear connectors to the top flange of the beam. Further post tensioned slabs are widely used in field for large spans and heavy loads subjected to it. Here, our aim is to study development of program of the design the Reinforced cement concrete slab, Composite slab & Post tensioned slab along with its parametric study. Programming is carried out using powerful MS Excel for design of slabs. Estimation of material quantity and cost are also studied here. The results tabulated from the program reveal that, the composite slab with profiled deck sheet provides better results than the post tensioned slab and reinforced concrete slab for one way simply supported and continuous slabs. Also the post tensioned slab provides better results than the composite slab with profiled deck sheet and reinforced concrete slab for two way simply supported and restrained slabs.

INTRODUCTION

In India, the escalation of the building material price and the labor cost are taking place to such an order that the profit margin of the builders / promoters has come down considerably because the hike in sales price of the buildings / apartments has not taken place at the same pace. Hence, it is necessary to reduce the cost of construction to make the builders interested in real estate business, which would solve the accommodation problem in India. The cost of construction and cost of capital could be lowered either by applying some innovative technology or by early completion of the project by adopting some fast track construction methodology.

The use of new techniques in construction of slabs could help achieving faster completion of the project by allowing some construction activities to go parallel as well as reducing number of columns and offering larger area free for construction. Early completion of the construction leads to early generation of revenues and reduces the interest burden on borrowed capital, which ultimately gives cost effectiveness of the project.

India has entered into the second phase of market liberalization and hence, construction activities have taken an upsurge as part of the on-going development process of converting India to a developed nation from a developing one.

Therefore, the engineers need to play their vital role in the process of building the nation with their full capacity and responsibility. So reducing the cost of structure by using proper slab as per the requirement with proper design can be helpful.

TYPES OF SLABS

A slab is a plate element with its depth much smaller than its other two direction sizes. It is usually subjected to uniformly distributed load. They may be simply supported, cantilever or continuous, like beam, depending upon the support conditions.

Hence various types of slabs are required in practices which are as follows:

- Reinforced Concrete Slab
- Composite Slab
- Post Tensioned Slab
- Flat Slab
- Grid Slab
- Pre Cast Slab

Also slabs are supported on walls or beams or columns. So these slabs are differentiated on the bases of spanning and support conditions provided on the four edges of the slab.

The slab can be categorized as follows:

As per spanning in two directions:

- One Way Slab
- Two Way Slab

The slab supported on two sides and bending takes place predominantly in one direction only is called One Way Slab. On the other hand, when slab is supported on all four sides and bending takes place in two directions are said to be Two Way Slab. Also slab having ratio of longer length to its shorter length (ly/lx) greater than 2 is called one way slab otherwise as two way slab. In one way slab main reinforcement is parallel to shorter direction and the reinforcement parallel to longer direction is called distribution steel. In two way slab main reinforcement is provided along both directions.

As per support conditions provided on the four edges:

- Simply Supported Slab
- Continuous Slab

When a slab in a structure is isolated from other slabs and is not continuous, meaning no span is there just adjacent to it, and then it is a Simply Supported Slab. The reverse of this, defining a slab having another span just adjacent to it and these slabs are connected to each other is a Continuous Slab. In Simply supported slab, reinforcement are not bend up to pass in adjacent slab where as in continuous slab, the direction in which slab is continuous requires reinforcement to bend up and pass up to the adjacent slab to provide proper connection and this provides a continuous support in between them. In two way slab the corners may be held down by restraints or may be allowed to lift up. Additional torsion reinforcement is required at corners when it is restrained against uplifting.

Composite floors consist of rolled or built-up structural steel beams and cast in-situ concrete floors connected together using shear connectors in such a manner that they would act monolithically. The principal merit of steel-concrete composite construction lies in the utilization of the compressive strength of concrete slabs in conjunction with steel beams, in order to enhance the strength and stiffness of the steel girder.

Post-tensioning system can be used for either in situ or pre-cast construction. In most cases, the tensioning of the tendons is done in stages either at site or in factory. Post-tensioning construction does not require rigid abutments, so it is more versatile for large spans. The anchorage is obtained through several patent methods using wedges or cones and bearing plates etc.

RESULTS OF ONE WAY THREE SPAN CONTINUOUS SLAB

TABLE-1

ONE WAY THREE SPAN CONTINUOUS SLAB MOMENT

One Way Three Span Continuous Slab (kNm)									
	R.C.C.			Composite			Post Tensioned		
Span (m x m)	Depth (mm)	Moment due to Applied Load	Moment of Resistance (kNm)	Depth (mm)	Moment due to Applied Load	Moment of Resistance (kNm)	Depth (mm)	Moment due to Applied Load	Moment of Resistance (kNm)
2 x 4	80/65*	5.35	10.82	100/60*	5.88	19.73	90	6.19	18.21
2.5 x 5	100/75*	8.9	19.92	110/80*	9.19	19.73	110	10.25	35.29
3 x 6	115/85*	13.36	28.56	125/100*	13.8	25.08	130	15.61	50.29
3.5 x 7	130/95*	18.91	38.75	150/130*	19.71	37.89	150	22.39	70.24
4 x 8	150/110*	26.03	54.76	170/110*	25.77	51.32	170	30.75	93.51
4.5 x 9	165/120*	34.13	67.6	185*	33.47*	56.95*	190	40.82	119.47
5 x 10	180/130*	43.63	82.86	200*	42.9*	65.38*	210	52.73	151.03
5.5 x 11	200/145*	55.29	105.63	215*	53.83*	73.82*	230	66.64	188.63
6 x 12	215/155*	67.93	124.51	230*	66.34*	82.26*	260	84.38	226.95

TABLE-2

ONE WAY THREE SPAN CONTINUOUS SLAB SHEAR

One Way Three Span Continuous Slab (kN)									
	R.C.C.			Composite			Post Tensioned		
Span (m x m)	Depth (mm)	Shear due to Applied Load	Shear Resistance	Depth (mm)	Shear due to Applied Load	Shear Resistance	Depth (mm)	Shear due to Applied Load	Shear Resistance
2 x 4	80/65*	14.4	26.21	100/60*	11.76	24.32	90	12.19	19.44
2.5 x 5	100/75*	19.32	32.57	110/80*	14.71	20.71	110	15.94	32.24
3 x 6	115/85*	23.96	39.48	125/100*	18.41	22.13	130	20.81	32.89
3.5 x 7	130/95*	29.14	48.36	150/130*	22.53	25.07	150	25.59	38.87
4 x 8	150/110*	35.1	55.71	170/110*	25.77	50.57	170	30.75	43.47
4.5 x 9	165/120*	41.01	61.99	185*	29.75*	50.51*	190	36.28	47.7
5 x 10	180/130*	47.25	69.19	200*	34.32*	52.55*	210	42.19	51.57
5.5 x 11	200/145*	54.45	75.5	215*	39.15*	54.56*	230	48.47	55.06
6 x 12	215/155*	61.43	80.03	230*	44.22*	56.55*	260	51.56	59.62

TABLE-3

ONE WAY THREE SPAN CONTINUOUS SLAB DEFLECTION

One Way Three Span Continuous Slab (mm)									
	R.C.C.			Composite			Post Tensioned		
Span (m x m)	Depth (mm)	Deflection due to Applied Load	Permissible Deflection	Depth (mm)	Deflection due to Applied Load	Permissible Deflection	Depth (mm)	Deflection due to Applied Load	Permissible Deflection
2 x 4	80/65*	25	26	100/60*	27.39	32	90	2.33	11.43
2.5 x 5	100/75*	24.67	26	110/80*	34.33	32	110	-1.05	14.29
3 x 6	115/85*	25.48	26	125/100*	34.16	32	130	4.78	17.14
3.5 x 7	130/95*	24.9	26	150/130*	33.68	32	150	6.47	20
4 x 8	150/110*	24.26	26	170/110*	33.68	32	170	8.37	20
4.5 x 9	165/120*	25.3	26	185*	31.28*	32*	190	10.28	20
5 x 10	180/130*	25.23	26	200*	31.48*	32*	210	12.44	20
5.5 x 11	200/145*	24.65	26	215*	31.64*	32*	230	14.87	20
6 x 12	215/155*	25.29	26	230*	31.77*	32*	260	15.53	20

TABLE-4

ONE WAY THREE SPAN CONTINUOUS SLAB COST

One Way Three Span Continuous Slab (₹)						
	R.C.C.		Composite		Post Tensioned	
Span (m x m)	Depth (mm)	Cost (₹)	Depth (mm)	Cost (₹)	Depth (mm)	Cost (₹)
2 x 4	80/65*	25880	100/60*	20310	90	25850
2.5 x 5	100/75*	41775	110/80*	33660	110	49090
3 x 6	115/85*	63940	125/100*	54330	130	71450
3.5 x 7	130/95*	94785	150/130*	82380	150	95930
4 x 8	150/110*	134240	170/110*	107430	170	153160
4.5 x 9	165/120*	186840	185*	152970*	190	208840
5 x 10	180/130*	248730	200*	203010*	210	281690
5.5 x 11	200/145*	325740	215*	265260*	230	366520
6 x 12	215/155*	411460	230*	339450*	260	474110

CONCLUSIONS

For one way slabs with simply support and continuous end both, post tensioned slab gives more moment resistance capacity with nearly same depth than reinforced concrete and composite slab with profiled deck sheet.

For one way three span continuous slabs, shear resistance is more for reinforced concrete slab than composite slab with deck sheet and post tensioned slab. In continuous condition reinforced slab requires more steel than the others, giving higher value for permissible shear stress in concrete.

For two way simply supported composite slabs with profile deck sheet has more shear resistance than reinforced concrete and post tensioned slab. Here in two way slab the load factor for composite is more than the other slab in weaker direction. This holds true for simply supported condition in shear. Hence composite can resist more shear than the other slab where reinforcement is less.

For one way slabs with simply support and continuous end both, post tensioned slab has very less deflection than reinforced concrete and composite slab with profiled sheet. This is because the prestressing force induced in the slab provides upward deflection to counter balance the loads from above and hence the deflection control is better than the other slabs.

For one way slabs with simply support and continuous end both, composite slab with deck sheet is structurally economic by 20 - 30 % than reinforced concrete and post tensioned slab.

For two way slabs with simply supported and restrained end both, post tensioned slab is structurally economic by 20 - 40 % than composite slab with deck sheet and reinforced concrete slab.

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