DEVELOPMENT OF IOS APPLICATION FOR THE DESIGN OF COMPOSITE BEAMS AND FLOORS

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Abstract
In India majority of the construction system is of low rise buildings. In recent decades due to higher migration towards towns and cities population is increasing rapidly and in order to fulfill the requirement with land constraints high rise building system is adopted. But not only this, effective and economical utilization of resource has to be done for the construction i.e., like steel-concrete construction. Compared to steel and RCC, composite construction has many advantages like high strength to weight ratios, durable finishes, dimensional stability, structural integrity and sound absorption. Due to this composite construction has increased all over the world. But there is no appropriate Indian Standards for the design of composite structure. So to reduce the complexity in the manual design IOS application is developed for the composite floors and beams in this project.
Index Terms: Composite Beam, Composite Floor, IOS, Swift, Xcode.

I. INTRODUCTION

In India majority of the construction system is of low rise buildings. In recent decades due to higher migration towards towns and cities population is increasing rapidly and in order to fulfill the requirement with land constraints high rise building system is adopted. But not only this, effective and economical utilization of resource has to be done for the construction i.e., like steel-concrete construction.

Composite design and construction has many advantages over conventional construction so it becomes necessity in present construction world. Conventional construction are utilized in low rise buildings due to smaller load but for tall buildings conventional construction will not be suitable because of higher dead loads and lower stiffness. Composite construction is increasing rapidly and hence there is need of new technologies for the economical use of steel as a construction material.

A. Composite Beam

When a concrete slab rests over steel beam or I-section then a composite beam is formed. When load applied on these elements they behave independently and a relative slippage occurs between them. If there is no slippage occurs by providing proper connection then that beam will behave like monolithic one.

Concrete is strong in compression and weak in tension whereas steel has the tendency to buckle under compression. Hence both the materials are provided in composite sections in such a way that they can use their properties to their maximum advantage. We can get more economic cross sections by keeping span and load of the beam constant. Because of larger stiffness of composite beams they tend to have lesser deflection than steel beams. The composite beam diagram is shown below in the Fig. I.

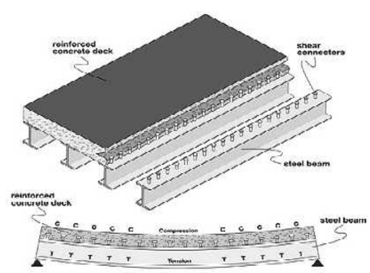


Fig. i: Composite Beam

B. Composite Floors

Composite slab comprise reinforced concrete cast on top of profiled steel decking which acts as formwork during construction and external reinforcement at the final stage. Figure 1.2 shows the Dove tail deck and Trapezoidal deck.

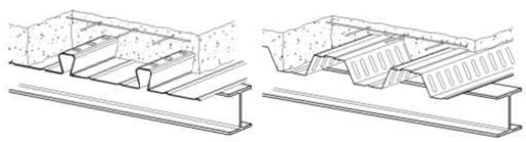


Fig ii: Dove tail deck and Trapezoidal deck

The composite action can be attained by pressing deck into the sheet metal with concrete topping. After concrete becomes harder, the deck attains tension reinforcement. The resulting composite slab acts as a diaphragm providing for horizontal transfer of shear forces to the bracing elements. Furthermore, it acts as stability for the compression flange of steel beams. The shear forces in the diaphragm mostly occur in the concrete topping because the in-plane stiffness of concrete slab is significantly more than that of deck. Thus horizontal forces must transfer from the slab to the beam top flange through welded studs. Structurally, the principal attributes of a composite section are realized by developing appropriate use of each material.

C. Application and its Need

A mobile application is software designed and developed to run on Smartphones, iPhones, tablets and other mobile devices basically developed by computer programing. Applications have paved way for the vast verity and better smartphones. In this way, it will be bolting to follow the history markups for the mobile applications improvement. Almost everyone have smartphones and iPhones in present days, so applications are the easiest way to access solution for all difficulties making life better as a result. Considering the present living situations our thinking is impractical without smartphones. These days everything and anything is possible with smartphones by the beauty of present day science and mobile applications advancement is a standout amongst the most vital parts of it.

D. Xcode

Xcode is tool which runs on Mac OS which is used to develop applications for Apple products like iPhone, pad, iPod, Apple watches and Apple TV. Xcode provides Graphical User Interface (GUI) design, coding, debugging, testing and uploading to App store. Xcode consists of two programming language for the development of application they are objective C and Swift.

E. Objectives of the Study

Design of composite floors and beams are tedious and lengthy in procedure along with this, non-availability of appropriate design codes of Indian Standards have paved way to the development of mobile application.

i. To develop an application for the design of composite floors and beams.
ii. Swift language is used for the application development using Xcode.
iii. To validate the work, results are compared with one of the referenced journal.

II. DEVELOPMENT OF APPLICATION FOR COMPOSITE BEAMS AND FLOORS

A.Graphical User Interface

It is the visual component that discovers how an application appears and interacts with the end user. The Graphical User Interface acts as a blue print for the development of application and also help-full for upcoming up-gradation. The Graphical User Interface is mainly focused on the presentation of mobile application. Some of the elements respond to the user interactions such as buttons, text fields and also other informative such as label, images. The below Fig shows GUI of the application.

Fig iii: GUI of the Application

B. Procedure of Application Development

X-code is the tool which runs on the Mac OS used to develop the applications for iphones, ipads, iwatches and ipods. X code consists of two programming languages that are used for coding and they are Objective C and Swift.

i. When the Xcode app is launched these options are available creating a new project, 'playground' and 'existing project. Click on create new project and then select single view application. The general layout of the application is as shown in the below figure 2.4. This consists of navigation panel, main story board, debug area, inspector panel.

Fig iii: Layout of Xcode

ii. From the tools panel view controllers (VC) are dragged and dropped in the main story board. On VC labels, text fields and images can be placed. Inspector panel helps in changing the size and background color of VC etc. Multiple VC can be placed and are connected by push segue and can be seen in navigation panel.

iii. GUI of the applications are created and then the coding are written in the cocoa touch class each VC will have individual cocoa touch classes. The below figure shows the assistant editor. Were the coding is done

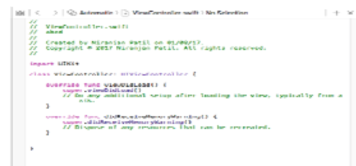


Fig iii: Assistant editor

iv. After building up the application it is tested with the help of simulator. Simulator is a virtual I phone which helps in finding the error or bugs during the working of the application.

C. Flow Chart

Flow chart is a diagrammatical representation of a coding sequence

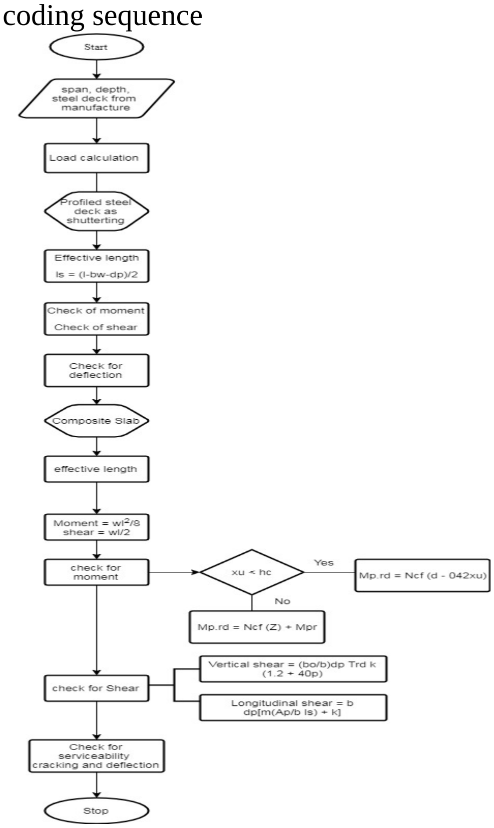


Fig IV: Flow Chart for Design of Composite Floor

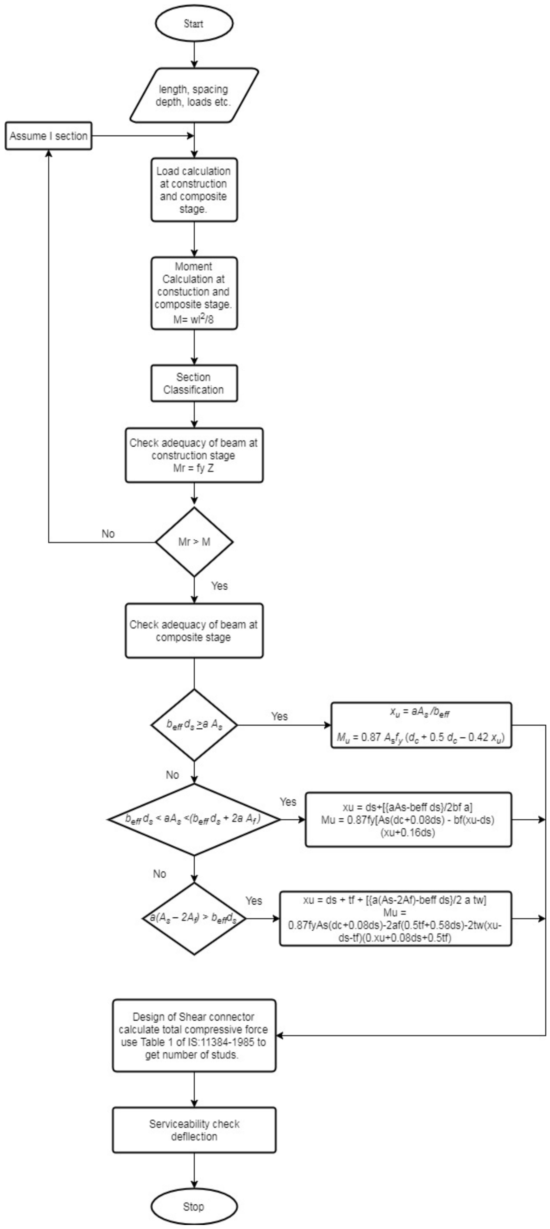


Fig V: Flow Chart for Design of Composite Beams

III. MODELING AND ANALYSIS

The composite building consists of 3x3 bay G+6 floors, floor height 3.1m and slab thickness of 150mm of modeled and analyzed using ETABS 2016.

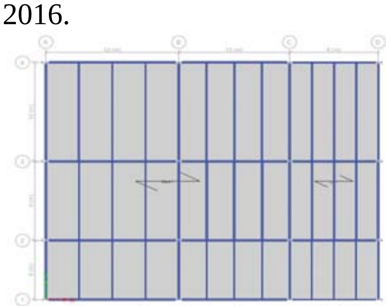


Fig V: Plan View in ETABS

i. Design Loads and Load Combinations

a) Dead load (IS 875-1987 part 1): It consists of self-weight of the structural members which are fixed permanently and do not vary in their magnitude like beam, column, slab, wall and floor finishes.
Self-weight of slab with slab thickness of 150mm = 0.15 x 25 = 3.75 kN/m^2
Floor finish = 0.5 kN/m^2

b) Live load (IS 875-1987 part 2): It consists of loads which are of no permanent and vary in their magnitude
Live load for office, class room, corridors, toilets and stairs = 3 kN/m^2
Accessible roof = 1.5 kN/m^2
Seminar halls and auditorium with capacity more than 200 people = 5 kN/m^2
Partition wall loads = 1.5 kN/m^2

c) Load Combination: Two types of combinations are considered for the analysis of composite structures they are at construction stage and composite stage. During construction stage self-weight of the structural members are considered as dead load and construction load of 0.75 kN/m^2 is considered as live load. During composite stage except the construction load all other loads are considered. Partial safety factors for dead loads are 1.35 and for live load is 1.5

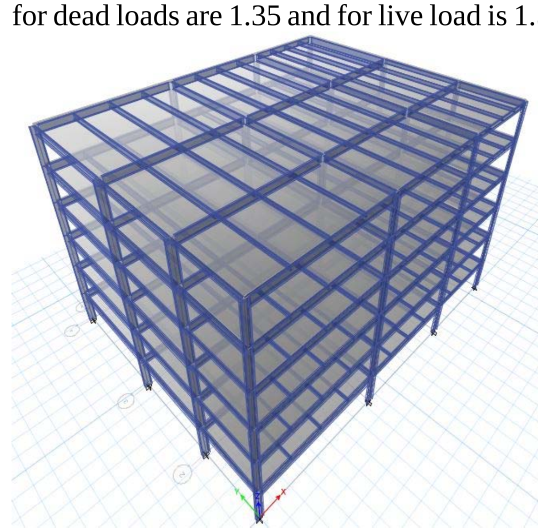


Fig VI: 3D Model

IV. RESULTS AND DISCUSSIONS

In this part, the composite beams are designed with the help of the application are checked with the analysis results obtained from the ETABS. One of the composite beam designs is shown below and the rest of the beams are designed with the help of application and are tabulated.

i. Composite Beam Designed Using Application

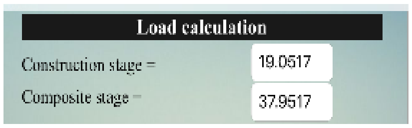
Beam group = A-B, 1-2

Span =6m, beam spacing = 3m, slab thickness = 150mm

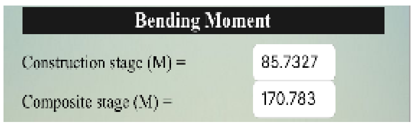
Steel section = ISMB250

Live load = 3kN/m^2, Floor finish = 0.5kN/m^2, Partition load = 1.5kN/m^2 and Construction load = 0.75 kN/m^2

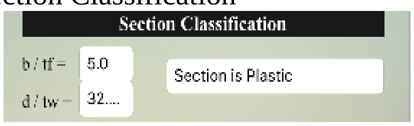
a) Load Calculation



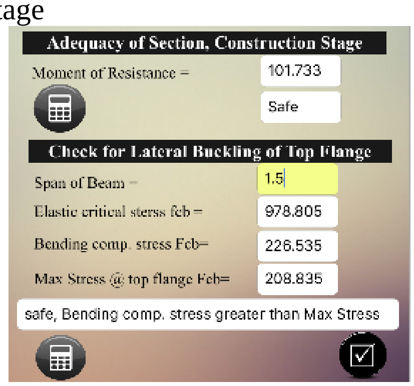
b) Moment Calculation



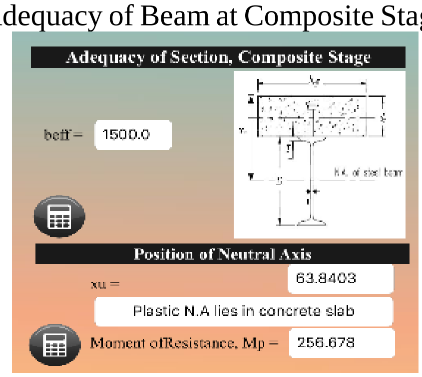
c) Section Classification



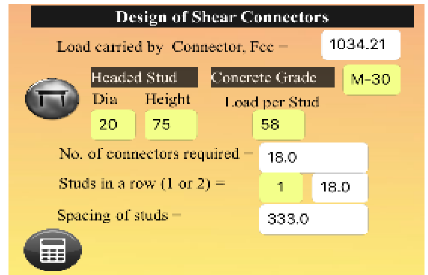
d) Adequacy of Beam at Construction Stage



e) Adequacy of Beam at Composite Stage



f) Design of Shear Connectors



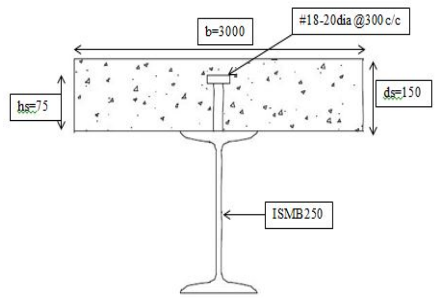


Fig VII: Typical c/s of Composite Beam in Grid A-B, 1-2

Table i: Results of Beam from Application

Grid		A-B 1-2	A-B 2-3	A-B 3-4	B-C 1-2	B-C 2-3	B-C 3-4	C-D 1-2	C-D 2-3	C-D 3-4
Span (m)		6	8	10	6	8	10	6	8	10
Spacing (m)		3	3	3	2.5	2.5	2.5	2	2	2
Section		ISMB250	ISMB350	ISMB450	ISMB225	ISMB300	ISMB400	ISMB225	ISMB300	ISMB350
Moment Check at construction stage	M1	80.7	153.9	243.9	71.4	128.3	203.5	57.5	103.6	163.2
	Mor	101.7	193.0	334.7	75.8	142.1	253.5	75.8	142.1	193.0
Moment Check at composite stage	M2	170.7	305.1	480.2	142.3	254.3	400.3	114.2	204.4	320.7
	Mor	256.7	430.6	689.9	207.4	337.9	551.9	207.4	337.9	430.6
No. of studs		18	26	36	16	22	30	16	22	26
Remark		Safe	safe	Safe	Safe	Safe	Safe	Safe	Safe	Safe

Etabs Result

a) Load Calculation

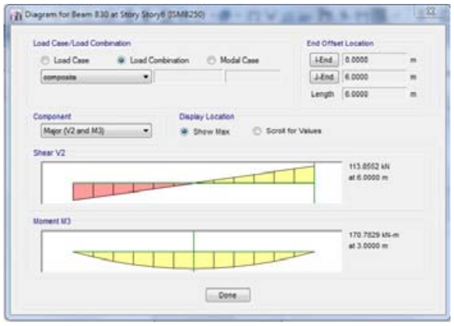
Loading (composite combo)

	Constr.	Dead	SDL	Live NR	Factored
Line Load (kN/m) 0 m→6 m	0.000	11.612	1.500	13.500	37.952

b) Moment Calculation

Strength Checks

	Combo	E_d	R_d	Ratio	Pass
Shear at Ends (kN)	composite	113.8552	307.9023	0.370	✓
Partial Comp. Bending (kN-m)	composite	170.7829	297.7286	0.574	✓



Grid		A-B 1-2	A-B 2-3	A-B 3-4	B-C, 1-2	B-C, 2-3	B-C, 3-4	C-D 1-2	C-D 2-3	C-D 3-4
Span (m)		6	8	10	6	8	10	6	8	10
Spacing (m)		3	3	3	2.5	2.5	2.5	2	2	2
Section		ISM B250	ISM B350	ISM B450	ISM B225	ISM B300	ISM B400	ISM B225	ISM B300	ISM B350
Moment Check at construction stage	M1	85.7	154	243.9	71.4	128.8	203.5	57.5	103.6	163.2
	Mor	-	-	-	-	-	-	-	-	-
Moment Check at composite stage	M2	170.7	305.2	480.2	142.3	254.8	400.3	114.2	204.4	320.7
	Mor	297.7	544.6	933.2	238.4	452.9	734.2	238.4	416.2	564.7
No. of studs		18	28	44	16	26	38	16	24	32
Remark		Safe	safe	Safe	Safe	Safe	Safe	Safe	Safe	Safe

Fig VIII: Bending Moment of Beam in Etabs

c) Shear Connetors

Acceptable Designs

Section	Shear Studs	Camber	Ratio
ISMB250	18	0	0.574

Table ii: Results of Beam from ETABS

From the above tables i and ii it is seen that the results obtained from the developed application and EABS are comparable and the small difference in the number of studs is because of ETABS uses empirical formula and the application uses Table 1 of IS: 11384-1984

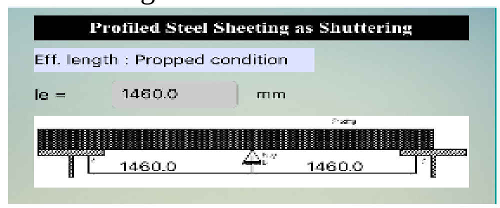
ii. Composite Floor Design

Span = 3m, depth = 150mm, fck = 30Mpa, Imposed load = 4.5kN. Construction load = 0.75kN

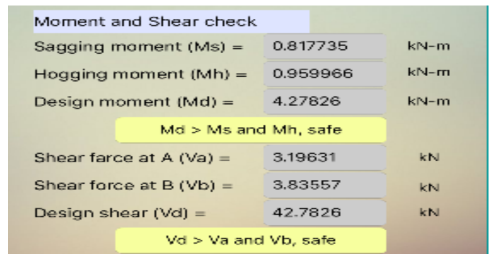
Dead load = 2.41kN

a) Profiled deck as shuttering

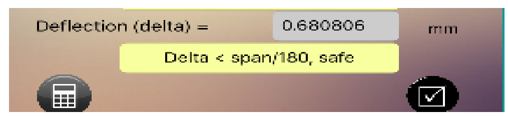
Effective length of Slab.



Moment and Shear Check



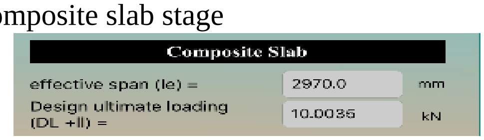
Deflection Check



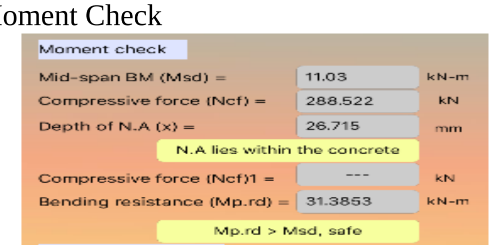
b) Composite slab stage

Effective span

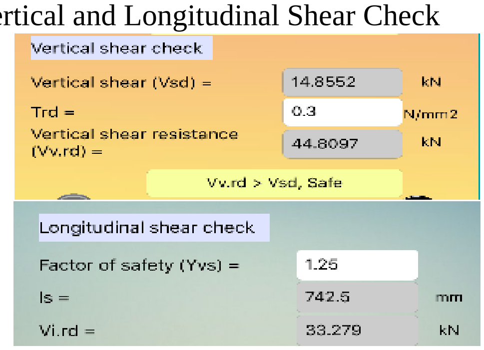
Composite slab stage



Moment Check



Vertical and Longitudinal Shear Check



Serviceability and Deflection Check

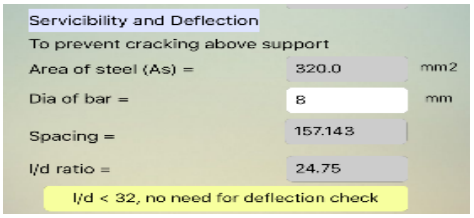


Table iii: Results of Composite Floors from Application

Span (m)	Depth (mm)	Slab as shuttering			Slab at composite stage			Reinforcement	Remark
		Moment (kN-m)	Shear (kN)	Deflection (mm)	Moment (kN-m)	Shear (kN)			
						Vertical	Longitudinal		
3	150	0.9	3.8	0.7	31.3	14.9	33.2	#8-150 c/c	Safe
2.5	150	0.7	3.2	0.3	31.3	12.3	38.9	#8-150 c/c	Safe
2	150	0.4	2.5	0.1	31.3	9.8	47.5	#8-150 c/c	Safe

V. CONCLUSIONS

Based on the comparison of obtained results from the developed application and ETABS the following conclusions are drawn.

i. By using the developed application the time required to design the composite beams and floors is reduced enormously compared to manual method of design.
ii. The developed application is very interactive and user friendly with lesser complexity, a person with minimum technical knowledge about the composite beam and floor can design it.
iii. The developed application fills the lacuna of lack of awareness of codal provisions with the design engineers.
iv. The design results obtained from developed app are comparable with the design results obtained from ETABS software.
v. The small difference in the number of shear connectors in the application and ETABS may be due to the use of empirical formulas provided by Euro code 4 and application uses Table 1 of IS:11384 – 1984.

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