International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

Interference Behaviour in Steel Concrete Composite Construction

K. Vidhya, M. Vignesh, P. Dhamodharan, S. Manishankar

Abstract: The objective of this study is to obtain the most effective utilization of steel and concrete by the method of composite construction through obtaining proper interaction between steel and concrete. Composite construction has various advantages compared to normal method of non composite construction. It provides greater stiffness and provides good strength against bending. By providing proper interaction we can obtain a more economical section and sections with good structural properties It is also a fast track construction practice. Both theoretical and software analysis of normal composite section and a section with profiled steel sheeting have been presented. After analysis it is found that shear connectors and profiled steel sheeting are advantageous in strength increment, reducing deflection and other factors.

Keywords: connectors, deflection, interaction, stiffness.

I. INTRODUCTION

1.1 General Overview

Traditional steel- concrete composite structural members consists of rolled or built-up structural steel members and cast in-situ concrete filling 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 to its maximum extent, in order to enhance the strength and stiffness of the steel member. Composite deck slabs are particularly useful where the concrete floor has to be completed quickly. More recently, composite floors using profiled sheet decking have become very popular in the Western countries for high rise and office buildings.

1.2 Scope of study

Manuscript received on February 10, 2020.
Revised Manuscript received on February 20, 2020.
Manuscript published on March 30, 2020.
* Correspondence Author
Dr. K. Vidhya*, Professor and Head, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, Tamil Nadu, India.
Mr. M. Vignesh, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, Tamil Nadu, India.
Mr. P. Dhamodharan, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, Tamil Nadu, India.
Mr. S. Manishankar, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, Tamil Nadu, India.

The study of interference action of composite structures is studied and a new design is made and compared with normal profiled sheeting. Analysis is made both theoretically and manually and they are compared.

II. THEORY OF COMPOSITE CONSTRUCTION

2.1 Composite Deck Slabs

Comprise profiled steel decking acts as the permanent form work to support the underside of the concrete slab spanning between supporting beams.

The steel decking by it supporting loads applied to it before the concrete has gained adequate strength. The steel decking has a numbers of roles, detailed below

- It supports the loads during and acts as a working platform
- It develops adequate action with concrete to support construction loads. (i.e.loads of construction materials used for floors above)
- It transfers the in-plane load action to the vertical bracing by diaphragm.
- It stabilizes the beam against lateral buckling, until the concrete hardens
- It acts as transverse reinforcement to composite beam.
- It distributes shrinkage strains; thus preventing serious cracking compared with precast or in-situ concrete
- It reduces the volume of concrete in tension zone (in sagging moment region)

The decking can be easily handled, can be cut to the required length and openings can be formed. Shear connectors can be welded through the decking on to the decking on to beams. These factors help to cut down the construction periods and thus lead to significant economies.

2.2 Advantage

The advantages of this form of construction include speed, safety and efficiency of construction. The structural behavior is the same as that of a reinforced concrete slab, with the steel sheeting acting as the tension reinforcement.

2.3 Construction

The ‘construction stage’ gives rise to the major load that the deck is designed to carry. As the concrete hardens, it forms an integral composite connection with the deck. Small embossments positioned in the web of the profile provide the shear keys, thus ensuring composite action. The total depth of the slab is normally around 130 mm to 150 mm and concrete is usually of a lighting aggregate type. The slab would now resist its service load and this stage is referred to as the ‘composite beam stage’.

The slab also acts compositely with the supporting steel beams of the frame. Stud shear connectors are welded through the sheeting onto the top flange of the beam.
The composite beam formed by employing the profiled steel sheeting is different from the one with a normal solid slab, as the profiling would influence its strength and stiffness. This is termed 'composite beam stage'.

2.4 Ponding

During casting, the concrete acts as a liquid and causes "ponding", i.e. the sheeting deflects, needing additional concrete pour and the finished surface always remains level despite the deck having deflected this can be significant on longer spans and affect the composite behavior. The design of a composite slab is normally based on the nominal depth of slab. The ponded mid-span depth increases the section modulus of the slab considerably beyond the value determined for a slab of nominal depth.

2.5 Behaviour of Composite Beams

In the following, we consider only the case of structural steel sections and reinforced concrete slabs. A comparison of behaviours is: The non-composite beam deflects further, hence it is less stiff. Note that the E-value hasn't changed so it is the I-value that changes. In addition to the increase in stiffness there is also a large increase in moment capacity leading to reduced section sizes. The metal decking can also be used as permanent formwork, saving construction time.

2.6 Need for Shear Connectors

- Transmit longitudinal shear along interface, and
- Prevent separation of steel beam and concrete slab.

2.6.1 Types of shear connectors:

2.6.1.1 Rigid type:

As name implies, these connectors are stiff and they sustain only a small deformation while resisting the shear force. They derive their resistance from bearing pressure of the concrete, short bars, angles, T-sections are common example of this type of connectors.

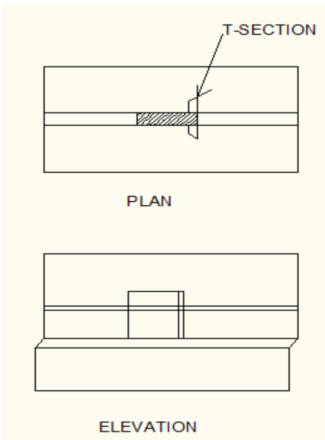

Fig.1. Rigid Type Shear Connectors

2.6.1.2 Flexible type:

Headed studs, channels come under this category. These connectors are welded to the flange of the steel beam. They derive their resistance through bending and undergo large deformation before failure.

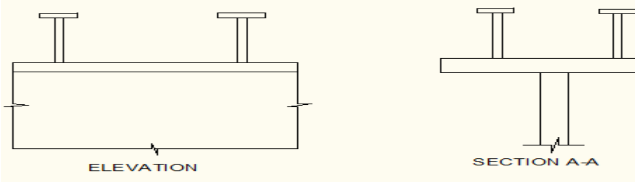

Fig.2. Flexible Type Shear Connectors

2.7 Uplift

The tendency of the concrete slab to separate from the steel section is called uplift. Uplift is caused when downward loading is applied to the lower part of a composite beam or due to the slab being stiffer then the beam. Complex effects such as torsion and the stress distribution in the vicinity of the shear connectors also cause uplift. Therefore share connectors are normally designed to resist such uplift.

Consider a composite beam with partially completed flange or a non-uniform section as in figure 4.AB is supported on CD, without any connection between them and carries a uniformly distributed load of magnitude w. if the flexural rigidity of AB is larger even by 10% then that of CD, the whole load on AB is transferred to CD at A to B was connected to CD, there will be uplift forces at mid span.

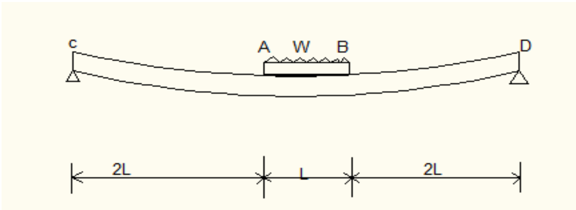

Fig.3. Section Showing Uplift.

III. CALCULATIONS

3.1 Comparison of Properties of Normal and Composite Sections

(i).Data

b = 200 mm
d = 400 mm
Ast = (2 × 314) = 628 mm
Fck = 20 N/mm
Fy = 415 N/mm

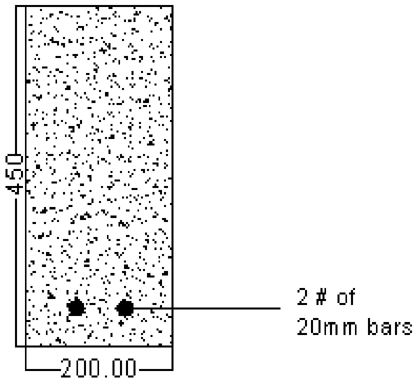

Fig.4. C.S.of A Normal Section

Retrieval Number: F7213038620/2020©BEIESP
DOI:10.35940/ijrte.F7213.038620
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Depth of neutral axis:

If xu = depth of neutral axis

$\left(\frac{xu}{d}\right)$ = (0.87 fy Ast/ 0.36 fck b d)

= (0.87 × 415 × 628/0.36 × 20 × 200 × 400)

= 0.39

Limiting value of $\left(\frac{xu}{d}\right)$ for fe-415 grade steel is 0.48

Since $\left(\frac{xu}{d}\right)$ = 0.39 < 0.48, the section is under reinforced.

Moment of resistance:

Mu = 0.87 fy Ast d [1- Ast/ b d fck]

= (0.87 × 415 × 628 × 400) [1- (628 × 415) / (200 × 400 × 20)]

= 76 × 106 N mm

= 76 kN.m

(ii)

Since As(d-dc) ≤1/2 × b/m × dc2

Where

As - Area of steel section
d - Overall depth
dc - depth of concrete
b - Width of concrete
m - Modular ratio

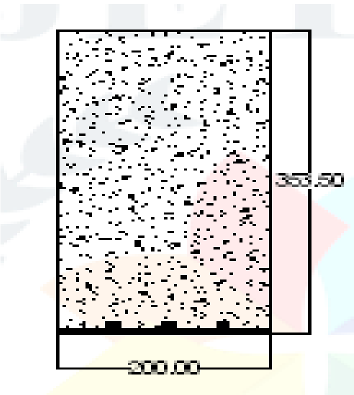

Fig.5. C.S.of Composite Section

[Es/Ec] = (2 ×10^5) / (3 × 10^5)
= 7

The neutral axis lies within the concrete layer.

Equating the compressive and tensile forces

0.36 × fck × b × xu = 0.87 × As × fy

0.36 × 20 × 200 × xu = 0.87 × 1000 × 415

Xu = 250 mm

Moment of resistance Mp = 0.87 × As × fy × (d-xu/2)

= 0.87 × 1000 × 415 × (353.5-125)

= 82.5 kNm.

(iii) Sections without embossements:

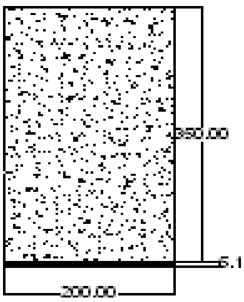

Fig.6.C.S.of a Normal Composite Section

The general axis lies within the concrete layer.

Moment of resistance Mp

= 0.87 × As × fy × (d-xu/2)

= 0.87 × 1000 × 415 × (353.5-125)

= 63 KNM

Hence the section (ii) has higher moment of resistance compared to I and II

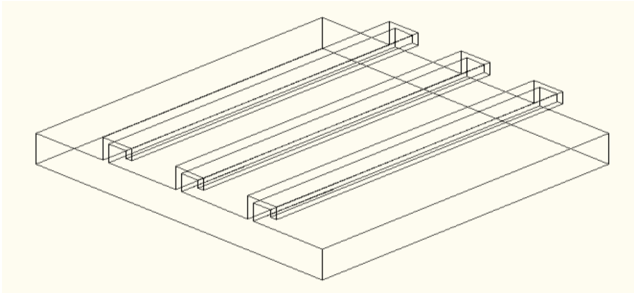

Fig.7.Designed steel sheeting.

3.2 Theoritical analysis:

M_u(profile sheet composite section)>
M_u(composite section)>
M_u(normal section)

IV. ANALYSIS BY ANSYS:

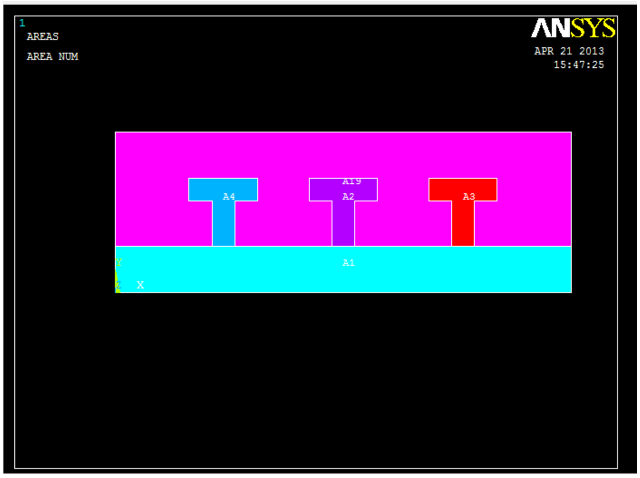

Fig.8.Section with shear connectors

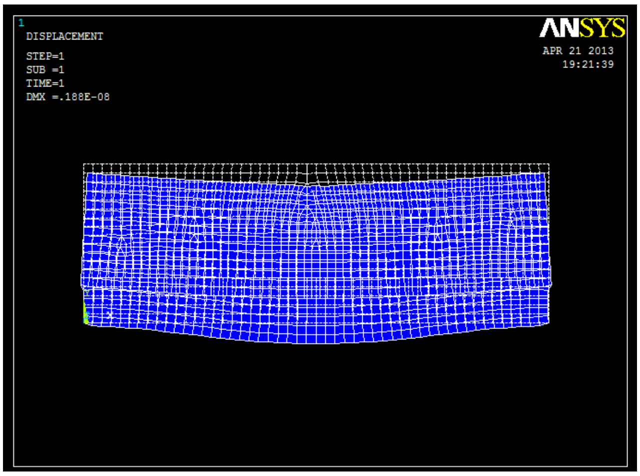

Fig.9.Displacement diagram after solving

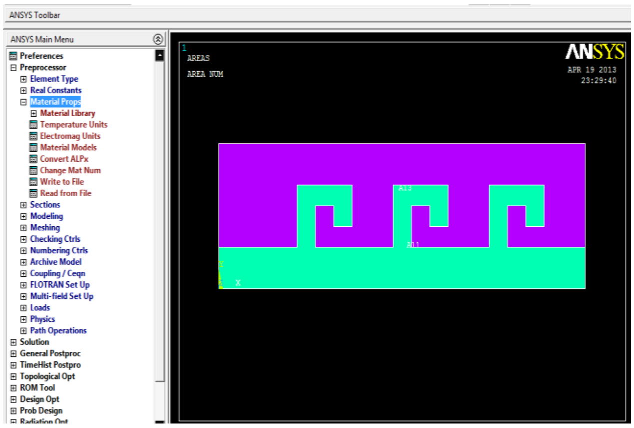

Fig.10.Section with profiled steel sheeting

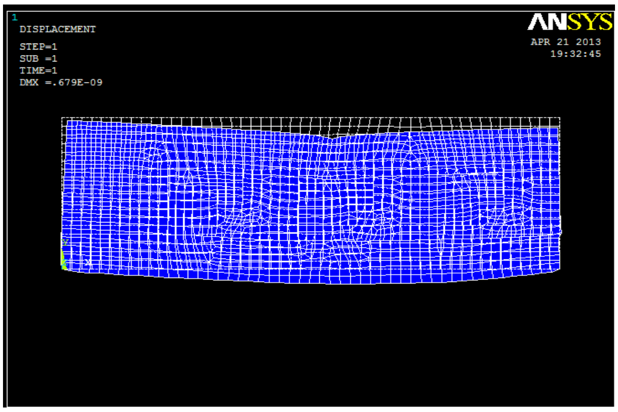

Fig.11.Displacement diagram after solving

V. INFERENCE:

1.) M_u(profile sheet composite section)> M_u(composite section)> M_u(normal section)

2.) Slip(composite section)> Slip (profile sheet composite section)

3.) Deflection (composite section)> Deflection (profiled sheet section).

4.) Once the fabrication of steel sheeting is made familiar then these sections will be economical compared to composite and conventional construction methods.

5.)Formwork works will also be easier for profiled sheeting type construction.

VI. RESULT AND CONCLUSION:

DESCRIPTION	SECTION WITH SHEAR CONNECTORS	SECTION WITH PROFILED STEEL SHEETING
Size Of Section	1000*100*500mm	1000*100*500mm
Load Applied	50N	50N
Support Condition	Simply supported on two sides	Simply supported on two sides
Max .Stress Due To Vertical Loading	.298*10^-5	.146*10^-5
Max.Stress Due To Horizontal Loading	.145*10^-5	.136*10^-6
Displacement Due To Vertical Loading	.188*10^-8	.679*10^-9

- The analysis has clearly emphasized on the interference behavior between steel and concrete in composite construction.
- The use of these profiled steel sheeting increases the strength of the members in various aspects like moment of resistance and shear resistance
- This mode of construction reduces the formwork usage.
- Paves the way for new technologies in slab casting

These sheetings will also be economical compared to conventional methods.

REFERENCES

1. Widjaja, Budi R.; Easterling, W. Samuel (2000). "Developments in Long Span Composite Slabs," Engineering Journal, American Institute of Steel Construction, Vol. 37, pp. 73-81.
2. Stephen Hicks (2010). "Strength and ductility of headed studd connectors welded to modern profiled steel sheeting," American Steel Institute, Vol.44, pp. 2-10.
3. IRC22-1986, 'Standard specification and code of practice for Road Bridges', Section VI – Composite construction – New Delhi.

AUTHORS PROFILE

Dr.K.Vidhya, Professor and Head, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, completed her Bachelor of engineering in Government college of Technology coimbatore and her Master of Engineering in Structural engineering at Government college of Engineering, Salem. Completed her Ph.D by doing research in the area of innovative bricks. She has also published about 25 papers in various journals. She has also presented her papers in 34 international conference and about 55 national conference. Her papers were presented mainly under the topic of innovative Bricks.She has also owned about 5 patents for her works. They are application of new technology for hybrid ash bricks, application of new echnology for hybrid ash aggregate concrete, application of new technology for building health monitoring device, application of new technology for fabrication and testing methods of strain measuring instruments for brick masonary SMIBM, application of new technology for incinerator ash paving blocks. She is also an active member of Institute of Engineers India, Indian concrete Institute, American Society of Civil Engineers, Indian Society for Technical Education. She has been awarded the young women scientist and Best teaching Faculty Award by Dr. Kalam Educational Trust in march 2017, Best Women Engineer Award from Institute of Engineers India in 2018, Innovative Research Technologist and Dedicated P rofessor Award from University of Technology Mara, Malaysia in 2018 and Best Academician Award by the Planning Commission, Government of India in March 2019.

Mr.M.Vignesh, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, completed his Bachelor of Engineering in Sri Venkateshwara college of Engineering, Sri perumbudur and completed his Master of Engineering in Construction Engineering and Management as a gate scholar at College of Engineering, Guindy. He did his projects in the areas of interaction behaviour between concrete and steel and regarding management he had analysed about contractual procedures.He has guided project in the area of soil stabilization.

Mr.P.Dhamodharan, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, completed his Bachelor of Engineering in Mahendra Engineering college, Namakkal and completed his Master of Engineering in Construction Engineering and Management at Mahendra Engineering college, Namakkal.

He did his projects in the areas of experimental study on behaviour of concrete by using polymer materials as partial replecement of fine aggregate. He is also an active member of Institute of Engineers India He has guided project in experimental study on partially replacement of coconut shell as course aggregate, an experimental study on waste granite powder as partially replacement of cement in paver block.

Mr. S. Manishankar, Assistant Professor, Department of Civil Engineerig, Mahendra Engineering College, Mallasamudram, Namakkal, completed his Bachelor of Engineering in Mahendra Engineering college, Namakkal and completed his Master of Engineering in Structural Engineering at Gnanamani college of technology, Namakkal**.**He did his projects in the areas of mortar stabilization and admixture utilization**.** He is also an active member of Institute of Engineers India. He has guided a number of projects for students. His area of interest lies in the region of energy saving and waste usage in building materials. Some of his works include plastic concrete and thermal grids for insulating wall panels.