Importance of Shear Connectors in Composite Structures

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ABSTRACT: - The shear flow between steel beam and reinforced concrete deck slab is a natural consequence of the requirement for composite action. If there were no connection, consequently a beam and slab would bend. The presence of a shear connection prevents the slip between the two components and achieves a much stiffer and stronger beam. When there is shear connection, the two components behave as monolithic.

KEYWORDS: - Composite Structure, Longitudinal and Transvers Shear, Profile Deck Sheet, Shear Connectors.

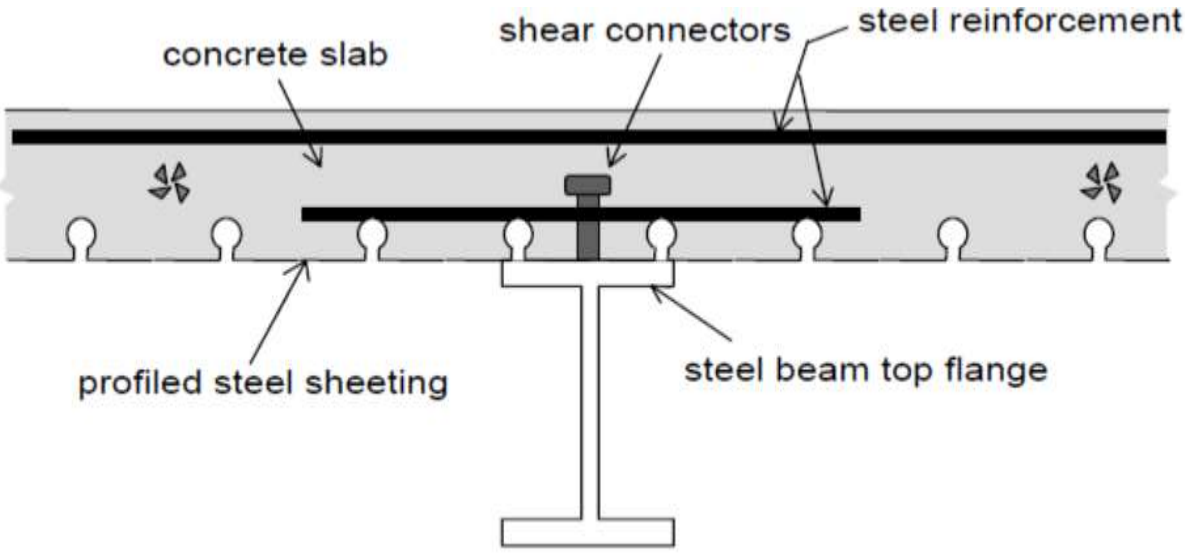
I. INTRODUCTION

The enhanced inventions are needed in the construction industry to overcome the threat of natural disaster such as earthquake. In the event of such natural disaster mass of structure plays important role in serviceable performance of the structure. Hence, this fact has led to the need of reducing load or mass of structure. The mass of structure using composite slab construction reduces 30-40% of total weight of the structure. Composite slab construction is very economical and efficient in terms of reducing construction cost, time of construction and deformation of structure as whole.

- Profile deck sheet is the vital component of composite deck slab. The common shapes available in the market for profile deck sheet are rectangular and trapezoidal with varying heights and corrugation depths. Profile deck sheet works as a framework under constructional loads and in composite action it behaves as tensile reinforcement as well as supports compressive resistance with concrete. However, a nominal reinforcement needs to be provided to nullify shrinkage and temperature cracks, point load distribution, fire resistance, in case of openings and hogging moments. Investigation result indicates that composite slab construction performs efficiently.

- The chemical or mechanical Shear connectors interlocking plays an important role in the composite action of both profile deck sheet and concrete. This helps in enhancing ultimate load carrying capacity of concrete deck slab. On account of various advantages such as light weight construction, easy handling, speedy construction work, convenient transportation, higher strength than the conventional slab and contact strength. For contact strength mechanical interlocking proves to be a firm option in case of interlocks popularly known as shear connectors.

- As concrete is not completely confined with the steel it may give rise to the slip and initial strain at the interface while vertical uplift will be observed if there is no proper interlocking. In the current paper the past research on composite slab is studied thoroughly to determine the gap of information to be investigated. To build a correlation between the past and present work we need to know the background of the topic.



II. COMPONENTS OF COMPOSITE SLAB: - A composite slab consists of profile deck sheet, interlocking part and concrete. All these constituents play an important role in behaviour of composite slab and also composite actions. For composite action to take place the slab profile deck sheet should transfer longitudinal shear through the interface for which proper interlocking arrangements are required. In market there are numerous design of profile sheet available with large options for generating proper interlocking in form of mechanical or chemical bonding.

- PROFILE SHEET: Profile deck sheet is formed by rolling cold forming structural steel using rollers with different corrugation depths The strength of sheet depends on the art of designing the depth of the corrugation so that strength is increased with maximum effective width of the coil.
- SHEAR CONNECTION: Shear connection bonding between the profile sheet and concrete is necessary to transfer longitudinal shear and thus result in composite action. The bonding can be chemical, mechanical or frictional interlocking. Direct connection of profile sheet and concrete without any interlocking is unadvisable.
- Suggested using either any of the provision or combinations of the chemical mechanical or frictional mechanical interlocking etc. Generally mechanical interlocking is used in practice as embossment, welded studs or modifying sheet with ribs deformation at the end. Chemical interlocking is poor as compared to the other interlocking as it does not allow the complete confinement in profile sheet and concrete.

III. **METHOD FOR ANALYSIS AND DESIGN OF COMPOSITE SLAB:** -

- Generally, worldwide this method is used to design composite slab with elastic-plastic behaviour. For elastic behaviour i.e. there is direct relation between longitudinal shear and vertical shear the equations are simple and do not need semi empirical approach for design. In M-K method, 'M' is mechanical interlocking and 'K' is friction between the profile deck sheets and slab concrete.

- The behaviour of the composite slab can be seen in three phases; in construction phase, the sheet should support the wet weight of concrete; in composite slab phase, the imposed load should be properly distributed to the beam, and in composite beam phase, the beams joined with the shear connectors to the slab should support the imposed as well as transverse load.

- The composite slab should support both negative and positive moment. The negative moment due to self-weight is carried by deck alone. The positive moment in the slab is supported by cross-section area of the profile.

- Composite action is the heart of the design to ensure this headed stub shear connector is used. Dimension of headed stub shear connectors' geometrics and direction of profile sheeting reinforcement area and position compressive strength of concrete and location of the stud within the ribs of the profile sheeting, these all factors will decide the

behaviour of the headed stud. Capacity of shear connectors and load slip behaviour of shear connector is determined by the push out test. The main role of shear connectors is to transfer the longitudinal shear which depends on strength of shear connectors and resistance of concrete slab against longitudinal cracking induced by high concentration of shear forces. The change in position of the shear stud is led by the stiffing rib of the modern profile. It is placed either at favourable or unfavourable side of the rib.

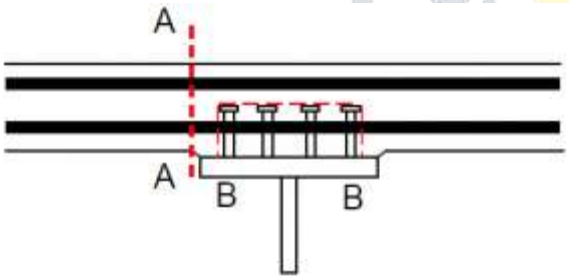
- As there is larger zone of concrete under compression in front of the favourable stud in its load bearing direction than the compressive zone behind it, hence stud on favourable side is stronger than on the unfavourable side. Stud placed on the side of the stiffener away from the mid-span is favourable side while stud place close to mid-span is an unfavourable condition. Favourable position of stud is generally recommended by many codes of design. The stud in favourable position showed less ductile load slip behaviour than the unfavourable stud position. The failure mode for unfavourable stud was rib punching and eventual tearing of the steel deck and for favourable it was observed concrete cone failure. The headed stud is influenced by profile sheet strength in unfavourable condition and by concrete strength in favourable condition.

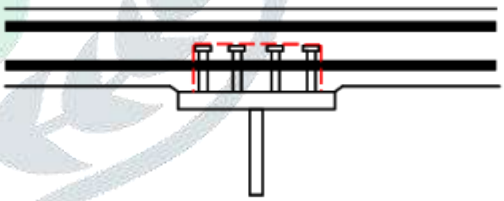
IV. TESTING: -

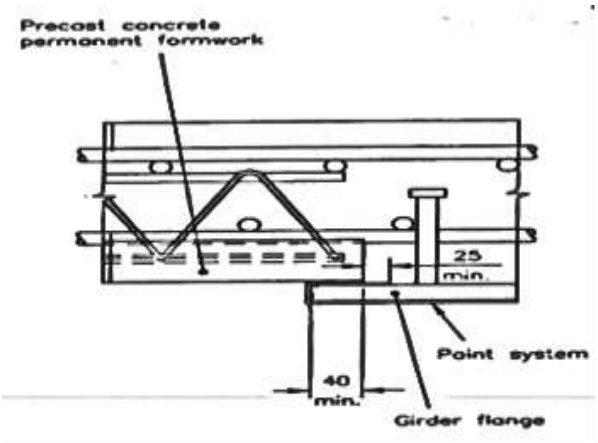
- Ring test- The ring test simply involves striking the side of the head of the stud with a 2 kg hammer. Ringing tone after striking indicates good fusion, whereas a dull tone indicates a lack of fusion. All studs are to be checked in this way by the welder or the welder's mate.
- Bend test- The bend test requires the head of a stud to be displaced laterally by approximately 1/4 of its height using a 6 kg hammer. The weld should then be checked for signs of cracking or lack of fusion. The testing rate should be specified by the designer and is usually 1 stud in 50.

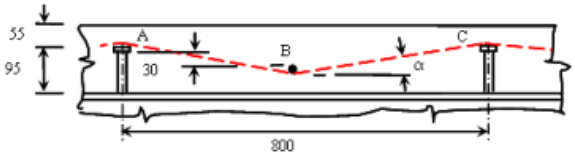
V. FAILURE: -

- Flexure Failure- This failure is seen due to the bending action in the slab. When the moment reaches its ultimate capacity at the critical condition, we can see minor vertical slip is observed at the edge of the profile. In the plastic region yield is observed and concrete is crushed but the longitudinal bond between the two components is safe.
- Longitudinal Shear Failure- This failure is seen when the composite slab reaches its ultimate position for carrying normal shear any more. This ends up with the composite action between steel and concrete, which results in sudden rise in deformation of slab.
- The slip occurs horizontally between the interface of concrete and profile which resembles the separation bond between concrete and steel after the failure the section acts differently with two different materials without any contact separately.
- Vertical Shear Failure: When the depth of slab is relatively smaller than its length, failure may occur. In this type, we observe the diagonal slips at support.
- Punching Shear Failure Composite slab is not good in bearing concentrated load. In this case researcher observed that the concentrated load will cause the conical slips under the loading. The behaviour of these cracks is due to tension followed by loss of bond between concrete and steel. composite slab fails but it was observed as the shear span increases the longitudinal resistance capacity of the composite slab is decreases.







VI. CONCLUSION: -

- Effort has been made to simplify and incorporate the same in different type of shear connector in composite structures. Despite being commonly used to transfer longitudinal shear forces across the steel concrete interface, the headed stud shear connectors have some disadvantages and difficulties to be used in composite beams.

- To ensure the large strength of a block type connector with some ductility and uplift resistance arising from the holes at the perfobond connector web, T-perfobond connectors were introduced. For similar longitudinal plate geometries, the resistance and stiffness of this type of connector are generally higher than that of the perfobond connectors.

- The load capacity of oscillating perfobond strip connectors, when compared to that of the headed studs and T-shape connectors is generally larger. However, due to the fast drop in the load capacity after the peak, it portrays unsatisfactory performance when used in the case of ordinary strength and normal weight concrete.

- T-connector's behaviour is very favourable. The beating stress on the front of the T is very high, as a result of the relatively small area. Local concrete crushing occurs, which results in a quasi-plastic performance.

- Channel connectors might not need inspection procedures, such as bending test of headed studs due to the highly reliable conventional welding system used in the welding of these connectors. The load carrying capacity of a channel shear connector is higher than that of a stud shear connector.
- Pyramidal shear connector which is a welding shear connector may reduce the fatigue strength of the thin bottom plate.

VII.REFERENCES: -

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