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**Abstract:**

The article presents the results of experimental studies on the treatment with Praestol flocculants of actual sludges of industrial wastewater generated during the chemical treatment of a metal surface. The technological parameters of the operation of the sludge thickening equipment have been established: the optimal dose of flocculant Praestol 2500 for the treatment of industrial wastewater sludges is 0.1 g/kg; the specific productivity of gravitational thickeners on the dry matter of the sludge is 20–30 kg/(h · m<sup>2</sup>).

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**Key words:**

*metal surface chemical treatment; industrial wastewater; sludges; flocculants; thickening*

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## OVERVIEW OF COMPOSITE FLOOR SYSTEM

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**Abstract**

This study is a general review of composite floor system, the element of a composite beam, some advantages in the use of composite floor with steel sheet in construction industry, the type of deck for composite floor, the main mode of failure of composite beam and review of some research works done on composite floor system. In composite beam, the slab can have steel decking with shear connector and other type slab can be concrete slab with shear connector, the slab with steel decking can be placed perpendicular or parallel.

The mode of failure of composite beam in this paper where divided in 3 main mode of failure (1), flexure failure (2), shear failure (3), longitudinal failure and will be explained in detail in this paper. Some overview of researches was done on the composite beam analysing the behaviour of the composite floor, the influence of the shear studs span, the used of the pair studs compared to the use of single stud. Another review was conducted on the comparison of the normal concrete slab and the composite floor made of steel beam, steel deck but the shear connectors were not placed. The overview from previous researches show that the composite floor system analysis takes more emphasis on the behaviour of composite action between steel and concrete. The choice of the steel sheet, the span of shear connector, the choice to use a pair or single shear connector and the orientation of the steel sheet on beam need to be understood by the engineers for a safe design of composite structures (composite beam with steel deck).

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**Keywords:**

*composite beam, steel deck, shear studs, failure mode of composite beam.*

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Nowadays the construction industry is growing up using different type of composite material and composite structures system. The composite structure systems are now used in many projects due to their advantages such as height capacity of load carrying, effective strength, cost reduction comparing to the non-composite structure, possibility of long spanning.

From the above quality of the composite system, many study was conducted to analyse and study the behaviour of composite structure system. A composite system consists of two structural members connect to each other to act as one member and will deflect as one unit. One of the composite structure system is a composite floor.

A composite floor system also known as a composite beam is made of steel beam, steel sheeting with in situ reinforced concrete, and shear connectors which will have a very important role is making the concrete and steel sheet act as composition floor system.

### Introduction to composite floor

Composite member are structural members made from two or more materials. In construction area the most used material to form composite structure are steel and concrete in the past years. Composite floor is a floor made of steel beam, shear studs and concrete, in some case the use of steel sheeting (steel decking).

The composite floor is also called composite beam. In the composite behaviour the strength is provided by the steel and rigidity by concrete.

### Composite beam behaviour

In composite beam, the concrete takes all the compression force and steel sheet take all the tension force.; The shear connectors play important role by making a bond between steel and concrete. The figure 1 show the composite beam element on site construction made of 5 main elements:

- (1) Steel beam supporting the floor
- (2) Composite steel deck (steel deck)
- (3) Shear connectors
- (4) welding wire mesh
- (5) Concrete which will be filled on top

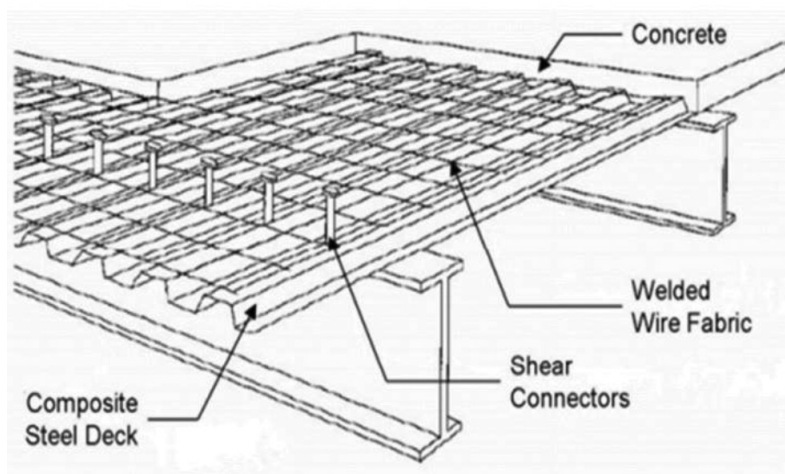
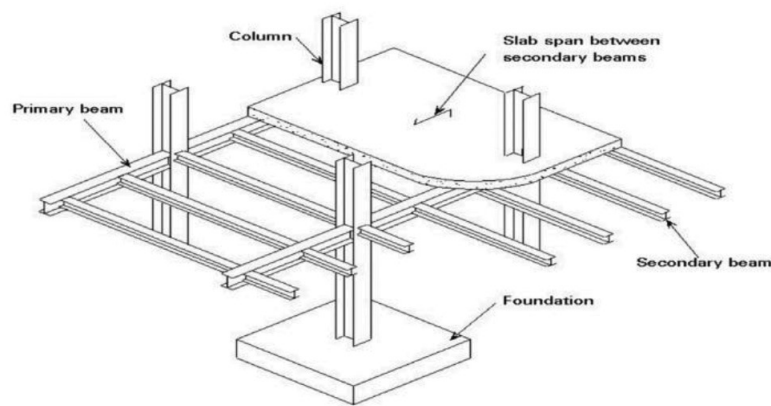


Fig. 1. Composite beam element

### Example of composite floor

Figure 2, It is a multi-story building with composite floor which illustrate the structure member from foundation, columns, primary beams, secondary beams, slab span between secondary beam orientated perpendicular to the secondary beam.

The composite floor can span 10 ft to 15 ft, which make the composite beam with steel deck more interesting and when a composite beam is in shored construction it can reach 30 ft. [1]



*Fig. 2. Multi story building with composite floor system*

**Advantages of composite floor with steel sheet** Using the concrete and steel have many advantages:

- Speed up the construction period.
- The composite floor with steel sheet will reduce the self-weight of the building as the concrete used will reduce compared to the one of concrete only, this will influence the dimension of foundation size and the cost of the building.
- The profile sheet will serve as formwork and will reduce the cost of the project in overall cost.
- The composite floor has a good the flexibility to have long span
- As the steel sheeting are manufactured and brought to site ready to be used, it makes a good quality in construction and accuracy.[2]
- The use of steel decking will not delay the construction period caused by the weather condition as, the steel decking can be erected in a very bad weather, and it can also be used in roofing.
- The steel deck have been used for more than 60 years and have proven to have a good durability and strength for a good composite floor system.[3]

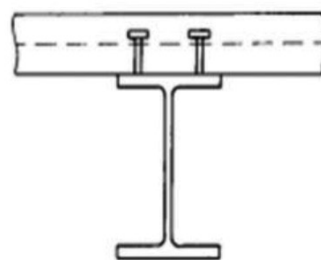
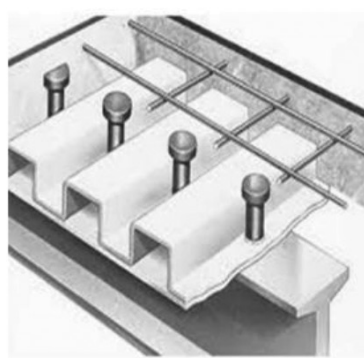
**The shear stud for in composite floor**

In composite beam we need the shear stud called again shear connectors, are very important as they transfer force between steel section and concrete slab.

Shear connectors are placed on steel beam by welding passing through the steel deck, will allow the concrete slab to perform as a top flange to the steel composite beam, while the concrete get its strength and make a strong section to carry the load which will be subjected to the designed composite floor system.[4]

The number of shear stud will determine if the composite beam will act as full composite or partially composite. [5]

Figure 3: show the studs connections



*Fig. 2. Example of shear studs used in composite floor*

### Type of deck for composite beam

There are three different type of slab construction in composite beam

1. Slab with non-steel decking but shear connectors are present.
2. Slab with steel decking oriented parallel to the steel beam, shear connectors are present.
3. Slab with steel decking align perpendicular to the steel beam, shear connectors are present.

The steel decking with rib placed perpendicular to the steel beam is the most used in composite beam/

Figure 4: shows different type of deck for composite beam

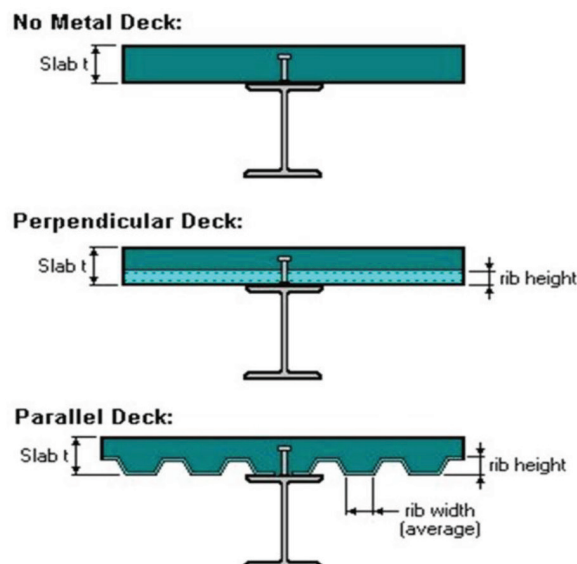


Fig. 4. Type of desk for composite floor

### Failure mode of composite floor

There are three different types of failure of composite beam;

**Flexure failure:** this failure occurs when the slab is taken to the ultimate by bending and resulting the crashing of the concrete and loss of the most of moment capacity. This failure can be considered as the best as it permits the cross section to gain all its resistance, and the failure will appear after a big deflection and cracking.

**Shear failure (or stud breakdown):** The shear failure of the composite beam occurs when the shear connection was inadequate. When this failure occurs the slab separate and slip appear, this result in reduction of moment capacity due to the composite action which is no longer present. After the shear connector broken, beam, the steel sheeting and concrete separate, and failure is visible and dangerous, they are no longer acting as composite beam. [6]

**Longitudinal failure:** is failure occurs when there is no convenient connection between the steel decking and the concrete placed on top of it. This failure mode depends on the degree of connection between the steel and concrete when the slab is subjected to vertical load. Longitudinal failure mode is characterised by the development of an approximate diagonal crack under or near the concentrated loads, followed by an obvious visible end slip between the steel and concrete.

Figure 5 (a),5(b) [4] and 5(c) [7] show different types of composite beam failure .



Fig. 5 (a) Flexire failure



Fig. 5 (b) shear failure of stud



Fig. 5 (c) Longitudinal failure

### Some research on composite floor

*Namdeo et al.*, conducted to study the behaviour and the carrying capacity of composite concrete slab with profile sheet with realist geometries and material characteristics. The result show that the behaviour and stability of composite slab depends most on the span of shear, the deflection increase with the increment of the shear distance from one to another. [8]

*Jawed Quresh et al (2011)*, make an experimental study and FE analysis on the behaviour of composite floor using a pair of shear stud and single stud, the results show that the use of pair stud in favourable place increase the strength more than the single stud. [9]

*R. Amuthaselvakumar et al. (2016)*, An experimental investigation was conducting to see the behaviour of composite slab with steel decking without shear connector and a normal conventional slab. The results on this experimental show that the strength in carrying capacity of the composite steel concrete slab without shear connector is the same as the conventional concrete slab, the stiffness of the composite steel concrete slab without shear connector and the conventional slab found to be almost the same. The material used in composite steel concrete without shear connector is 30 % less than the one needed for conventional slab. [10]

### Conclusion

The composite floor system is growing in construction industry, structural engineers need to be familiar with the design and get a good understanding of it. The conclusion of the overview from previous researches show that:

The composite floor system is mainly governed by the interface between steel and concrete.

The choice of the steel sheet need to be selected from the design manufactured and the selection of it will be according to the project and specification.

The shear connector span plays an important role on the strength of the composite action, the more shear span is the less the strength capacity.

The composite floor is more economic compare to the convention slab.

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### Просьба сослаться на эту статью следующим образом:

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#### Аннотация

Это исследование представляет собой общий обзор системы композитных перекрытий, элементов композитных балок, некоторые преимущества использования композитных перекрытий со стальным листом в строительной промышленности, типы настилов для композитного перекрытия, основные виды разрушения композитной балки. Обзор некоторых исследовательских работ, выполненных по изучению работы систем композитных перекрытий.

В перекрытии плита может иметь стальную опалубку с соединителем сдвига, а плита другого типа может быть бетонной плитой с соединителем наклона, плита со стальным настилом может быть расположена перпендикулярно или параллельно. Разрушения составной балки могут быть 3 видов: 1- разрушение при изгибе, 2- разрушение при сдвиге, 3- разрушения продольной несущей конструкции, все виды разрушения подробно рассмотрены в этой статье.

В исследованиях, рассмотренных в статье, изучение работы композитных балок перекрытия проводилось с учетом следующих факторов: поведения композитного щита настила, влияния пролета срезных шпилек, крепление композитного щита настила одиночными или парными шпильками. Был проведен другой обзор сравнения обычной бетонной плиты и композитного перекрытия, изготовленного из стальной балки, стальной опалубки, но без фиксаторов сдвига.

Обзор проведенных исследований показывает, что при анализе системы композитного перекрытия большое внимание необходимо уделять поведению совместной работы между сталью и бетоном. Выбор стального листа, вид соединителя сдвига, выбор использования парного или одиночного соединителя сдвига и ориентации стального листа на балке должны быть понятны инженерам для создания безопасной конструкции композитных перекрытий (композитных балка со стальной опалубкой).

#### Ключевые слова:

*композитная балка, стальная опалубка, срезные шпильки, режим разрушения композитной балки*

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