CHAPTER 1

INTRODUCTION

1.1 GENERAL

In the current scenario composite construction is picking up significance throughout the world due to quicker, lighter and conservative when compared to traditional construction technique. When two or more materials are combined together to act as a single unit it is referred to as composite. In general it can be concrete/timber, steel/concrete or steel/timber etc. The emerging type of composite slab construction system comprises of cold-form profiled steel sheet and concrete. Composite slabs consist of profiled steel sheet with cast in situ reinforced concrete. The steel sheet acts as permanent formwork to the concrete during casting, act as tensile reinforcement during service life and also provides adequate shear and bond with the concrete. After the concrete has gained sufficient strength, the two materials act together compositely. The composite interaction between the slab and concrete is achieved by providing shear connectors. These connectors are in the form of headed studs. These studs are welded to the steel sheet prior to placing the concrete. The shear connectors provide adequate longitudinal shear transfer mechanism between the profile sheet and concrete so that they act monolithically. Composite slabs are predominantly used in commercial, industrial, hospital and residential buildings due to speedy construction and lower construction costs. Although in most of the situations it is used on steel framed buildings, it may also be supported on masonry or concrete components.
The shear and bond transfer between profile sheet and concrete is a very important factor that needs to be ensured for slabs to act as composite unit. Integration of any two material can be achieved only by providing a good interlocking mechanism. Composite action between the profile sheet and concrete is achieved by providing interlocking mechanism, which is able to resist horizontal shear and vertical separation of steel and concrete. The most common method of achieving this composite action is by rolling a pattern of ‘embossments’ on the surface of the steel profile sheet. In composite construction using steel profile sheet and cast in situ concrete, there are three different types of interlocking mechanisms to ensure the integrity of the two: frictional interlock (geometry of profile sheet), mechanical interlock (embossment) and end anchorage (shear connector or deformed rib at the end of profile). The cold formed profile sheets have thickness varying from 0.6 mm to 2.5 mm and cast in situ concrete of thickness ranging from 50 mm. Additional reinforcements are provided to prevent nominal shrinkage. A composite slab is defined by ASCE (1992) as “a slab system comprising normal weight or light weight structural concrete placed permanently over cold formed steel decks in which the steel deck performs dual roles of acting as a form for the concrete during construction and as tensile reinforcement for the slab during service”. This floor system has many advantages over traditional flooring system such as acting as safe working platform, formwork for casting concrete, profile sheet acting as tensile reinforcement, reducing tedious work of providing heavy reinforcements, increases the headroom by allowing the service ducts within the depth of the slab and significant reduction of construction time and cost. The ‘composite slab action’ thus established provides the floor deck with a spanning capability in one direction. A typical steel composite flooring system is shown in Figure 1.1.
The steel concrete composite considered in this study, comprises of steel profile sheet and concrete. The steel sheeting is designed as an external main tensile reinforcement for the composite slab. The composite action may not be fully achieved because the concrete does not bond perfectly with the steel sheet. This may give rise to improper stress transfer at the concrete steel interface and also may cause horizontal slip in the longitudinal direction. Inadequate interlocking at the interface in vertical direction may also lead to uplift of concrete from steel profile sheet. Hence, a firm connection at the interface is required for achieving effective composite action.

Welded shear-stud connectors are commonly used for efficient transfer of shear between concrete and steel profile sheet. When profiled steel sheeting is used as the steel component in composite element, it is not possible to weld shear connectors as the steel sheet may be less than 1 mm thick. Hence shear connection is provided either by pressed or rolled embossments (indentations) that project on the surface of profile sheet. Another way of
enhancing composite action is by giving the profiled steel sheeting a re-entrant shape, thereby arresting the vertical separation of the steel from concrete.

For rolled steel composite sections, it is relatively easy to design by controlling the number of shear connectors used. However, for composite members formed with profiled steel sheeting, it is more difficult to ensure strong ductile behaviour and hence this study has been carried out.

1.2 SCOPE AND OBJECTIVE OF RESEARCH

The scope of the present investigation is to understand the longitudinal shear bond characteristics of steel-concrete composite specimen. Towards this, the following specific objectives were established:

• To understand the behaviour of steel-concrete composite elements cast using trapezoidal, re-entrant and rectangular profile sheet with and without embossments by conducting small scale elemental bending test.

• To understand the behaviour of steel-concrete composite slab cast using trapezoidal, re-entrant and rectangular profile steel sheet with and without embossments by conducting full scale testing under static loading.

• To understand the longitudinal shear-bond behaviour of steel-concrete composite specimens using different embossments like chevron, rectangular and inclined tablet shape.

• To develop the moment-curvature (m-k) curves for steel-concrete composite slab cast with different profile geometry by conducting full scale tests.
To compare the test results obtained from experimental investigations, with finite element simulation.

1.3 ORGANIZATION OF THE THESIS

The present investigation mainly deals with the performance evaluation of steel-concrete composite deck slab cast using different profile sheets (Rectangular, Trapezoidal and Re-entrant) with and without embossed profile under static loading. Towards this, different experimental investigations comprising of small scale bending test and full scale bending test were varied out. Numerical investigations were also carried out to understand the behaviour of steel-concrete composite deck slab.

The thesis is organised into seven chapters (Chapter 1 to 7) as described below.

Chapter 1 presents the introduction and the need for carrying out this research work. It also presents scope and objectives of the research work reported in this thesis.

Chapter 2 presents the description of steel-concrete composite slab and its principle. It also describes about the advantages of using steel-concrete composite slab in construction industry.

Chapter 3 presents the review of relevant studies as reported in literatures. It includes details of experimental and numerical investigations carried out by recent researchers in the relevant field of steel-concrete composites slab and its performance.

Chapter 4 presents details on preparation of steel-concrete composite specimens for small scale and full scale experimental
investigations. It also describes studies carried out on evaluation of engineering properties of materials used in preparing steel-concrete composite slab specimens.

Chapter 5 describes the preliminary experimental investigations (elemental bending test) carried out on the behaviour of small scale steel-concrete composite specimens under static loading. The specimens were cast using different types profile sheets like trapezoidal, re-entrant and rectangular with and without embossments. Numerical studies were also carried out for small scale steel-concrete composite specimens have also be reported here.

Chapter 6 describes the experimental investigations carried out on full scale steel-concrete composite slab specimens under static loading. The composite slab specimens were cast using trapezoidal, re-entrant and rectangular cold-form profile steel sheet with rectangular embossment. Three different embossments namely chevron, rectangular and inclined tablet type were also investigated with trapezoidal profile sheet. Results of Finite element simulation carried out on full scale steel-concrete composite slab specimens are compared with the results of the experimental investigations. The m-k chart for steel concrete slabs are developed.

Chapter 7 presents the conclusions drawn based on the FE simulation and experimental investigations carried out and suggestion further studies.