

CHAPTER 1

INTRODUCTION

1.1. Motivation and Scope of the Research

Cold-formed steel decks have been widely used in composite slab systems in steel-framed structures. The system has proven to be very attractive to structural designers because of many advantages it has over conventional systems of reinforced concrete slabs. These advantages have been listed by Finzi (1968), Oudheusden (1971), Hogan (1976), Porter and Ekberg (1976), Fisher and Buettner (1979), Porter (1985), Wright et al. (1987), Evans and Wright (1988). Among them, elimination or significant reduction of the positive moment reinforcement and form work for concrete casting are two of the most important ones. This is in contrast to the early use (before 1950) of the steel deck-concrete floor, where the concrete is used only as a *filling* material (Dallaire 1971).

The knowledge of this composite interaction as well as elemental behavior involved in the system has progressed rapidly during the past two decades. Much effort has been put forth to better understand and model the behavior of the system. Research on the subject has been conducted worldwide (U.S., Canada, Europe and Australia). Motivations for the research can be summarized as follows:

1. To develop an efficient composite floor system that optimally utilizes the material and thus yields an economical design.
2. To avoid the dependency on many full-scale experiments which are expensive and time consuming.

3. To provide structural designers with analytical means by which they can verify design calculations.

Efficient composite floor systems can be obtained by optimally utilizing materials, which includes the possibility of developing long span composite slab systems. These long span systems require investigation of new deck profiles that can be used to provide an adequate interaction with the concrete slab. However, with the dependency of steel manufacturers on full-scale slab tests, a substantial number of tests have to be performed to develop a new deck profile. Therefore, from the manufacturer point of view, an alternative that can reduce the required number of full-scale tests is desirable. This can be achieved by using analytical means supported by elemental tests that are less expensive than the full-scale tests. Many kinds of analytical means are now being made available due to development in the past decade, particularly in the area of nonlinear analysis. By the same means, structural designers will have analytical tools to cross-examine the design calculations. Current design formulations, such as the m and k method (Schuster 1970, Porter et al 1976), do not sufficiently describe the physical behavior of composite slabs. The only way structural designers can verify the design calculation based on load tables generated by the m and k method is to look back into the experimental test results. Depending upon the application, these analytical tools may range from a simple hand calculation to a special purpose nonlinear finite element code.

As a continuation of on-going research in the area of composite slabs, with the same motivations as mentioned above, this study has been conducted. New deck profiles, which enable the deck to span longer than the typical spans currently used, are investigated. By introducing a longer span floor system some filler beams can be eliminated along with their connections to the girders. This results in more economical floor systems.

To establish a profile suitable for long spans, analytical models are developed to predict the behavior of the new slab prior to any experimental tests. Two mechanical based models and a finite element model are introduced. These models require knowledge of interaction properties of some components of composite slabs. Hence, elemental tests for the shear bond and end anchorages are performed. These analytical models, along with the elemental tests, offer an alternate solution to the full scale tests that are required for the current design procedures. Additionally, resistant factors, ϕ , for flexure design of composite slabs are also sought. The current resistant factors, ϕ , for composite slab design (Standard for 1992) were taken from the

steel or concrete design specifications. Therefore, it is desired to obtain these factors based on test results and refined analytical studies of composite slabs.

1.2. Organization of this report

This report is organized as follows. Following Chapter 1, elemental tests for shear bond and end anchorages that were performed are described in Chapter 2. Results of these elemental tests were used in the analytical methods of prediction for the composite slab strength and stiffness using simple mechanical and finite element models that are presented in Chapter 3 and Chapter 4, respectively. In these chapters, by using the afore-mentioned methods, predicted strength and stiffness of experimentally tested composite slabs were compared to test results. Chapter 5 discusses the investigation toward the long span composite slab systems. New deck profiles are introduced for these long span systems and the methods described in Chapter 3 were applied to predict the strength and behavior of the slab. In Chapter 6, ϕ factors for flexural design of composite slabs are derived and discussed. Finally, conclusions and recommendations for future research are presented in Chapter 7. Note that pertinent literature is reviewed in each chapter.