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Behavior of thin gusset plates in compression

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Abstract

The use of cold-formed steel members for roof and floor truss applications is gaining widespread acceptance in the United States. However, there is little technical information regarding the behavior and design of thin gusset plates in compression. Thus, a study was initiated at the University of Missouri-Rolla aimed at investigating the behavior of thin steel gusset plates in compression. Key parameters that were considered in the experimental study were the thickness of the gusset plate, the width and length of the gusset plates, the fastener location, and the fastener pattern. Both a plate model and a column model were investigated for computing the strength of a thin plate in compression. Based on the findings of this study, design recommendations are proposed.

Keywords: American Iron and Steel Institute; Truss systems; Thin gusset plates; Cold-formed steel

1. Introduction

The use of cold-formed steel members for both roof and floor truss applications is gaining widespread acceptance in the United States. Cold-formed steel truss design in the United States is based on the American Iron and Steel Institute (AISI) publication [1,2]. However, neither the specification nor the standard includes guidelines for the design of gusset plates. These plates are critical for connecting structural elements in the same plane. Truss systems commonly utilize gusset plate connections, as illustrated by Fig. 1.

A study conducted at the University of Missouri-Rolla focused on the general behavior of thin flat gusset type plates in compression [3]. The test data was compared against

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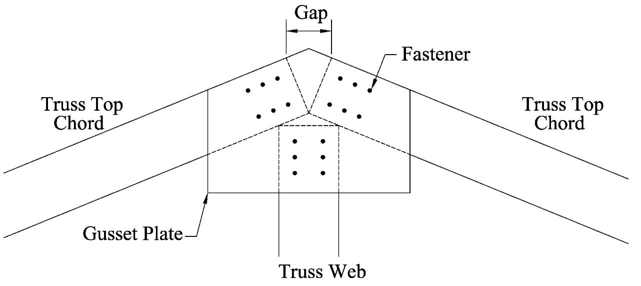

Fig. 1. Roof truss with gusset plate connection.

current design methodologies and modifications were suggested. Both unstiffened and edge stiffened gusset plates were studied.

2. Literature review

One of the earliest studies in the United States on gusset plates was performed by Whitmore [4] at the University of Tennessee. His study focused on the stress distribution within aluminum plate connections. Whitmore concluded that the stresses start at the outside edge of the top row of fasteners and propagate out at an angle close to 30°. The stresses continued to spread out at this angle until they reached the last row of fasteners. This pattern has become known as the Whitmore Section and is illustrated in Fig. 2.

Thornton [5] presented a design methodology for brace connections in heavy construction. The author suggested that the plate be analyzed as an effective column. Thornton's analytical model, summarized by Eqs. (1)–(3), is based on assumptions that have only been verified for thick gusset plates

$$P_n = A_g F_{cr} \tag{1}$$

For λ_c 1.5

$$F_{cr} = (0.658^{\lambda_c^2})F_y \tag{2}$$

For $\lambda_c > 1.5$

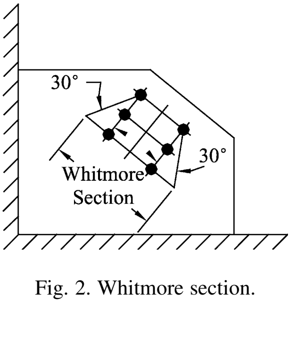

Fig. 2. Whitmore section.