UNIVERSITI TEKNOLOGI MARA

THE STUDY ON THE BEHAVIOUR OF PLATE GIRDER WITH PROFILED WEB

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ABSTRACT

Engineers have long realized that corrugated webs enormously increase steel girders' stability against buckling and can result in very economical design. Recently, the new idea of combining the two profiled webs brought new issues of research.

The objective of the research presented in this thesis is to investigate the behavior of steel girders with profiled web subjected to shear. Relative buckling modes are also discovered. The work includes experimental works and nonlinear finite element analyses, which includes the development of material and geometric finite element model, whose results are verified against the test results. All the tested specimens and the model were loaded under three point bending. At the same time, calculations are made to investigate their validity in analyzing this kind of girder.

The detailed ultimate shear capacity and buckling modes of the girders subjected to different profiled web arrangement cases were studied. The three buckling modes have occurred in this investigation were local, zonal and global buckling mode. It was found that, within the parametric range studied in this thesis, the typical failure modes of the girder with profiled webs are initially in the local buckling mode which occurred either at the top, middle or bottom of the one corrugation fold. After reaching a peak load the buckling propagated to other folds which transformed to zonal or extended to a global buckling mode in a diagonal direction of tension field action beyond the peak load (post-buckling load) and gradually buckled due to crippling of the web and subsequently buckled till the flanges yielded vertically into the web.

In the process of buckling, the load displacement relationship of the girder switched to a sudden and steep descending branch. The buckling can reduce the post-buckling shear capacity in the range of 30% to 50% of the ultimate shear capacity. However, the ultimate or post-buckling capacities of profiled web girder did not depend on their buckling mode. Comparison between experimental results and finite element results were satisfactory.

Comparison of the ultimate shear capacities between corrugated web girders with the equivalent conventional girders, the ratios were up to 2.00 and 4.30 for singly and doubly webbed corrugated girders respectively.

CANDIDATE'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic or non-academic institution for any degree or qualification.

In the even that my thesis be found to violate the conditions mentioned above, I voluntarily waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

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CHAPTER 1

INTRODUCTION

1.1 General Statement

For many structures, all of the beams may be selected from among the standard range of rolled sections. Sometimes, none of the available section has sufficient capacity. Such situation may occur when it is necessary for the beams to bridge a long span and/or carry heavy static/moving loads. For example, most bridges need to carry heavy primary live loads such as HA and HB loading. Certain industrial buildings have girders called gantry girders that carry rails for large-capacity overhead cranes. Normal (gantry) girders are made up of built-up sections, called plate girders. Nowadays it is a common practice to fabricate such sections simply by welding together three plates to form the top and bottom flanges, and the web. Figure 1.1 shows the application of plate girder for bridges.

However, from time to time, a new generation of optimized steel girders is developed. In general, innovated girder systems would require less material and result in a lighter structure when compared to a conventional girder system having webs reinforced with vertical/horizontal stiffeners. According to the author's knowledge, the two web profiled shapes which are commonly used for girders, are trapezoidal (most frequently used), and sinusoidal. Figure 1.2 shows the web profiled shapes used for girders. Therefore, this study tried to determine the performance of these newly discovered girders with single or double corrugated webs.

1.2 Problem Statement

The primary function of the top and bottom flange plates is to resist the axial tensile and compression forces arising from the bending action, whilst the web plate resists the shear force. Since the efficiency of the cross-section in resisting plane bending requires that the majority of the material be placed as far as possible from the neutral