

BEHAVIOUR OF FOAMED CONCRETE FILLED STEEL TUBES (CFST)



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ABSTRACT

A concrete-filled steel tube (CFST) column is a composite structure and consists of a steel tube that is filled up with concrete. The application of this composite structure has become increasingly popular in structural applications. There are many advantages of using a composite structure as compared to its equivalent conventional reinforced concrete (RC) structure and steel structure due to its cost and ease of construction. However, the usage of CFST structures is not very common in Malaysia as compared to conventional RC structures. At present, the behavior of CFST columns filled with normal strength concrete has been studied by many researchers. Use of foamed concrete as the infilled material is rare and has not been studied comprehensively. Thus, this research was conducted to investigate the strength and structural behaviour of CFSTs filled with different densities of foamed concrete and with different replacement levels of Waste Paper Ash (WPSA) to cement by weight under axial (compression) loading. Two (2) types of columns namely short and long (slender) were also prepared and the structural performance of these two types of columns were also compared with theoretical values. A series of short tubes of 200 mm x 200 mm section having 2 mm thickness with additional 25 mm height of longitudinal stiffeners and 40 mm height of tab stiffeners were filled with different densities of foamed concrete which are 1400, 1600 and 1800 kg/m³. The height of a short column specimen is 600 mm and the height of a long column specimen is 3000 mm. Another batch of foamed concrete with density 1800 kg/m³ that contained waste paper sludge ash (WPSA) as the cement replacement levels by 10% and 20% were also adopted. All CFST column specimens were loaded on the entire surface of the CFST column specimens under axial loading. The results of the experiment showed that the series containing different densities of the foamed concrete failed at loads less than 90% of the theoretical values. It also appears that the ultimate strength of the CFST specimens mainly depends upon the strength of the infilled material. It is also concluded that the CFST specimens that were infilled with concrete attain higher strength than those without infilled concrete. It is found that the CFST that was infilled with foamed concrete shows inferior in strength as compared to that with normal concrete. Also, higher strength of CFST is achieved when higher density of foamed concrete is adopted as the infilled material. The inclusion of WPSA in the foamed concrete mix does not enhance the strength of the resulted CFST. The failure mechanism of CFST long columns was observed mainly due to local buckling.

Keyword : Concrete filled steel tube, foamed concrete, axial load, waste paper sludge ash, infilled material, ultimate load, failure mechanism

CHAPTER!

INTRODUCTION

1.1 Background of Study

A concrete-filled steel tube (CFST) column consists of a steel tube filled with concrete. Original reason why this CFST concept was developed was to prevent shear failure and to improve ductility of short columns. In recent years, CFSTs have become increasingly popular as structural members for buildings around the world. This is mainly due to their excellent axially compressed nature making them superior to conventional reinforced concrete and steel structural systems in terms of stiffness, strength, ductility and energy absorption capacity (Baig *et al.*, 2006). The concrete core adds stiffness and compressive strength to the tubular column and reduces the potential for inward local buckling. Conversely, the steel tube acts as longitudinal and lateral reinforcement for the concrete core helping it to resist tension, bending moment and shear and also providing confinement for the concrete.

The CFST column system has many advantages compare to ordinary steel or conventional reinforced concrete systems. One of the important advantages is the composite interaction between the steel tube and infilled concrete which can delay the local buckling and strength deterioration of the steel due to the restraining effect of the concrete. In addition, the steel ratio in a CFST section is much larger than in conventional reinforced concrete and concrete-encased steel cross sections (Morino and Tsuda, 2002). Furthermore, CFSTs are designed to resist higher forces compare to using thin-walled fabricated steel columns. Also, usage of CFSTs can reduce the