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A REVIEW PAPER ON THE AXIAL BEHAVIOUR OF CONCRETE FILLED STEEL TUBES CONTAINING HIGH VOLUME WASTE TYRE RUBBER CONCRETE.

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ABSTRACT One of the solution to reduce tire waste is by incorporating rubber as fine aggregate replacement, producing a rubberized concrete. This type of concrete generally has lower compressive strength, however, could potentially be used as structural application due to its inherent ductility. Crumb rubber concrete, in which a portion of the mineral aggregates in concrete is replaced by the waste tire rubber, has attracted great research attention as a sustainable building material. It is a promising solution to the over-exploitation of river sand and the recycling of waste tire rubber. However, the concrete strength decreases significantly when crumb rubbers were used to replace the fine mineral aggregates. A reliable strength reduction model for the crumb rubber concrete with ordinary strength is essential for its practical use in engineering structures. With different volume replacement ratios of rubber fine aggregate and thicknesses of steel tube, 12 rubberized concrete-filled steel tube (RuCFST) columns were fabricated. Then axial compressive tests were completed. The test results show that RuCFST columns exhibit lower axial compressive capacity and higher ductility than normal CFST columns. The steel tube of the RuCFST with a high rubber replacement ratio is more prone to local buckling and the axial load-displacement curves of RuCFST columns tends to exhibit hardening post-peak response. Based on the experimental results, the relationship between the critical value of the confinement coefficient and the rubber replacement ratio of RuCFST columns was obtained.

KEYWORDS :

INTRODUCTION

Rubberized concrete has become not only a sustainable solution to the recycling of waste tire disposal but also a promising material for civil engineering. Compared with traditional cement concrete, rubberized concrete has improved toughness, durability, shock absorption, impact resistance, air and water permeability, heat insulation, and sound insulation [1], [2], [3]. However, the compressive strength and elastic modulus of rubberized concrete decrease obviously when crumb rubber replaces part of fine or coarse aggregates, which significantly limits the structural application of rubberized concrete [4]. To solve the problems, it's a feasible scheme to combine rubberized concrete with steel tube to form a composite member of rubberized concrete-filled steel tube (RuCFST). The steel tube provides lateral confinement to the core rubberized concrete, which makes the core rubberized concrete in a three-dimensional compression state and improves its compression strength and ductility [5], [6], [7], [8]. Gholampour et al. [9] carried out the axial compression tests of rubberized concrete with a maximum volume replacement ratio of 18% under different active confinement. The results show that the axial strength and peak strain of rubberized concrete increase with the confining pressure, as found in conventional concrete. However, the lateral dilation of rubberized concrete is obviously greater than that of conventional concrete. In other words, the mechanical properties of rubberized concrete under active confinement is different from that conventional concrete.

1.1 Concrete Filled Steel Tube

CFST columns have been increasingly used especially in high-rise buildings. The infilled concrete increases the buckling load of the steel tube, while the steel provides confinement to the concrete core, improving its strength and ductility[2], [3]. The use of this composite structure reduces the labour and material costs during the construction process as the steel tube serves as permanent formwork during concrete casting[1], [2], [4], [5] . The main disadvantage of the CFST column is that the steel tube is exposed, leading to lower fire resistance compared to concrete-encased steel columns. The different properties of components of CFST lead to different dilation and this will initiate different initial elastic stage under compression[6][2]. Contemporary with development of the steel manufacturing, engineers use thinner tubes that are made from high-strength steel rather than thicker tubes made of normal strength steel to produce the CFST column[7].

1.2 Rubberized Concrete

Tire waste in the form of crumb rubber can be mixed with concrete creating a homogeneous mix called rubberized concrete[8], [9]. Incorporation of rubber in the concrete mix could improve the elastic behavior and toughness as well as decrease the brittleness of concrete[10]. However, the compressive strength and modulus of elasticity of the rubberized concrete reduces in comparison to the normal concrete[11]. Many studies showed that replacing the course aggregate with crumb rubber resulted to larger decay in compressive and flexural strengths, while replacement of 25% fine aggregate with rubber decreases the flexural strength by 4.5%[12]. Additionally, it was found that the optimum percentage of replacement of rubber aggregates can be up to 15%. Rubberized concrete could be an ideal material for energy absorption under impact or seismic loads, however, its use is not recommended in structural elements where high strength is required. The use of scrap tires in structure engineering is currently uncommon as it is attributed to decreasing in strength when mixed with concrete[13]. Limited researches on RCFT have been conducted in recent years. The cyclic behaviour of short CFST and RCFST columns. It was observed that the increase in the rubber particle content up to 15% leads to a decrease in the cyclic strength and stiffness of the columns due to the lower compressive strength[7]. It was also discovered that the circular sections exhibit better performance in terms of ductility compared to square and rectangular columns. Additionally, the rubberized concrete is recommended to be used in seismic areas, where ductility and energy dissipation are essential requirements. Experimental push-out tests have been conducted[14] on RCFST, with up to 30% of rubber as fine aggregate replacement. Similar results were obtained in terms of compressive strength, stiffness and ductility.

LITERATURE REVIEWS

Shankar Jagadesh in May 2014, Concrete-filled steel tubes are gaining increasing prominence in a variety of engineering structures, with the principal cross-section shapes being square, rectangular and circular hollow sections. The study about the behavior and the characteristics of CFST columns is the prime need of the hour. This review paper outlines the important contributions on CFST columns contributed in the recent years.

Lin-Hai Han, Wei Li, Reidar Bjorhovde in June 2013, Concrete-filled steel tubular (CFST) structure offers numerous structural benefits, and has been widely used in civil engineering structures. This paper reviews the development of the family of concrete-filled steel tubular structures to date and draws a research framework on CFST members. The research development on CFST structural members in most recent years, particularly in China, is summarized and discussed.

Baochun CHEN in July 2008, The Concrete Filled Steel Tubular (CFST) structure has been applied prevalently and rapidly to arch bridges since 1990 and this trend is continued with more and more long span CFST arch bridges been built since 2000. The paper briefly introduces the present situation of CFST arch bridges, their five main structure types and the construction methods.

BoaChun Chen in 2009, this paper briefly introduces the present situation of concrete filled steel tube (CFST) arch bridges in China. More than 200 CFST arch bridges were investigated and analyzed based on the factors of type, span, erection method, geometric parameters, and material. Some key issues in design calculation were presented, such as check of strength, calculation of section stiffness, and joint fatigue strength.

REFERENCES

[1] H. Liu, Y. Wang, M. He, Y. Shi, and H. Waisman, “Strength and ductility performance of concrete-filled steel tubular columns after long-term service loading,” Eng. Struct., 2015.
[2] Q. Wang, D. Zhao, and P. Guan, “Experimental study on the strength and ductility of steel tubular columns filled with steel-reinforced concrete,” Eng. Struct., vol. 26, no. 7, pp. 907–915, 2004.
[3] G. D. Hatzigeorgiou, “Numerical model for the behavior and capacity of circular CFT columns, Part II: Verification and extension,” Eng. Struct., 2008.
[4] Y. Li, C. S. Cai, Y. Liu, Y. Chen, and J. Liu, “Dynamic analysis of a large span specially shaped hybrid girder bridge with concrete-filled steel tube arches,” Eng. Struct., 2016.
[5] N. E. Shanmugam, B. Lakshmi, and B. Uy, “An analytical model for thin-walled steel box columns with concrete in-fill,” Eng. Struct., 2002.
[6] M. H. Lai and J. C. M. Ho, “A theoretical axial stress-strain model for circular concrete-filled-steel-tube columns,” Eng. Struct., 2016.
[7] A. P. C. Duarte, B. A. Silva, N. Silvestre, J. de Brito, E. Júlio, and J. M. Castro, “Tests and design of short steel tubes filled with rubberised concrete,” Eng. Struct., 2016.
[8] A. O. Atahan and A. Ö. Yücel, “Crumb rubber in concrete: Static and dynamic evaluation,” Constr. Build. Mater., vol. 36, pp. 617–622, 2012.
[9] M. M. R. Taha, M. Asce, and M. A. A. El-wahab, “Mechanical , Fracture , and Microstructural Investigations,” vol. 20, no. 10, pp. 640–650, 2009.
[10] M. M. Al-Tayeb, B. H. Abu Bakar, H. M. Akil, and H. Ismail, “Performance of Rubberized and Hybrid Rubberized Concrete Structures under Static and Impact Load Conditions,” Exp. Mech., vol. 53, no. 3, pp. 377–384, 2013.
[11] MoreR et al “Strength Appraisal of Concrete,” 2015.
[12] M. A. Aiello and F. Leuzzi, “Waste tyre rubberized concrete: Properties at fresh and hardened state,” Waste Manag., vol. 30, no. 8–9, pp. 1696–1704, 2010.
[13] M. Rahman, A. Al-Ghalib, and F. Mohammad, “Anti-vibration characteristics of rubberised reinforced concrete beams,” Mater. Struct., vol. 47, no. 11, pp. 1807–1815, 2014.
[14] R. Abendeh, H. S. Ahmad, and Y. M. Hunaiti, “Experimental studies on the behavior of concrete-filled steel tubes incorporating crumb rubber,” J. Constr. Steel Res., vol. 122, pp. 251–260, 2016.