Concrete-filled Steel Tubular (CFST) Trussed Arch Bridges in China

Nagasaki University Student Member ○WANG Qu Nagasaki University Member NAKAMURA Shozo
Nagasaki University Member OKUMATSU Toshihiro Nagasaki University Member NISHIKAWA Takafumi

1 Introduction

CFST trussed structure, adopting relatively small pipes mainly subjected to axial force to achieve greater vertical and transverse stiffness, is a kind of structure suitable for long-span bridges. Among CFST arch bridges in China, trussed arch rib accounts for 32% of the total number and 54.6% of the total number with the span length over 100m[1]. In Japan, there are few CFST trussed arch bridges, New Saikai Bridge, which has a main span length of 230m, is the first CFST trussed arch bridge for highway, meanwhile CFST trussed arch bridges have been rapidly developed in China since 1990. In this study, information on 146 CFST trussed arch bridges in China with the span length over 50m has been obtained from website survey and literature review, and analyzed in terms of main structural parameters and material used.

2 Span length and structure type

Fig.1 shows the distribution of main span length. The main span length is mostly from 100m to 250m, whose number is 100 out of 143 (68.5%). The average, maximum and minimum values are 186m, 530m, and 52m, respectively.

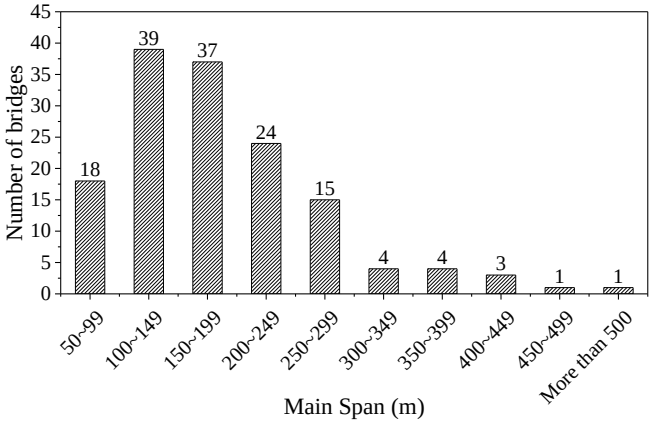

Fig.1 Main span length distribution

There are many forms of CFST trussed arch bridge. With respect to the relative position of the bridge deck and the arch rib, CFST trussed arch bridges can be categorized into deck arch bridges, half-through arch bridges, fly-bird-type arch bridges, through deck-stiffened arch bridges, through rigid-frame tied arch bridges and other type bridges. As shown in **Fig.2**, in the 146 bridges with the deck relative location known, the numbers of bridges for each type are 17(11.72%), 52(35.86%), 33(22.76%), 10(6.90%), 21 (14.78%), 12(8.28%), respectively.

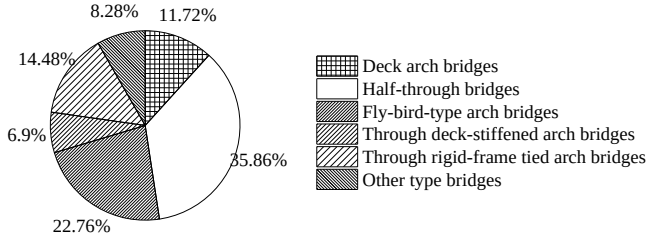

Fig.2 Structure type distribution

The rise-to-span ratio is an important parameter of CFST trussed arch bridges. The distribution of rise-to-span ratio of 139 bridges in the sample database is illustrated in **Fig.3**. It shows that the rise-to-span ratio is from 1:8 to 1:3, commonly from 1:5 to 1:4.

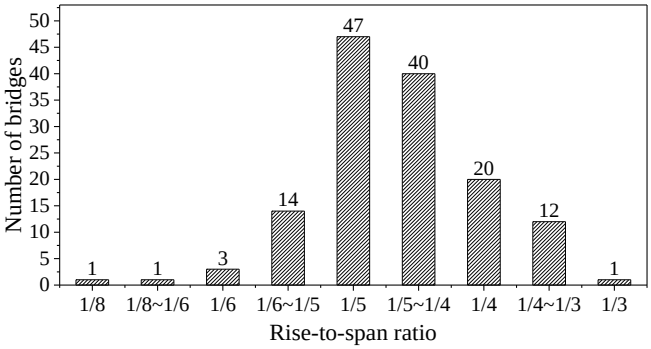

Fig.3 Rise-to-span ratio distribution

3 Diameter and thickness of chord tube

Fig.4 shows the distribution of chord tube diameter. The diameter is mostly from 600mm to 1100mm. The number of bridges in this range is 109 out of 144 (75.7%). The average, maximum and minimum values are 875mm, 1500mm and 299mm, respectively.

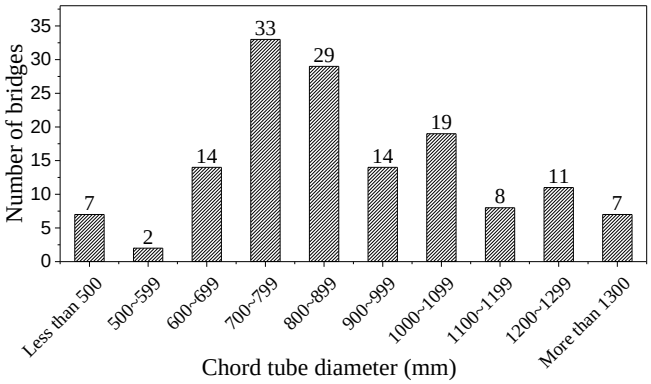

Fig.4 Chord tube diameter distribution

Fig.5 shows the distribution of chord tube thickness. The thickness is mostly from 12mm to 16mm. The number of bridges in this range is 81 out of 140 (57.8%). The average, maximum and minimum values are 12.9mm, 32mm and 8mm, respectively.

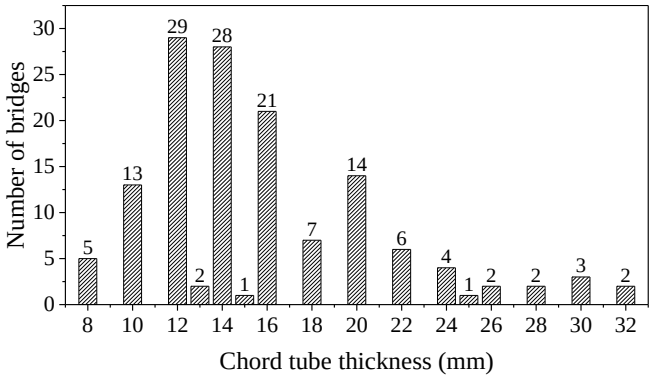

Fig.5 Chord tube thickness distribution

As shown in **Fig.6**, chord tube diameter has a direct relationship with main span length. The regression curve obtained by using the least-squares method is also shown in the figure.

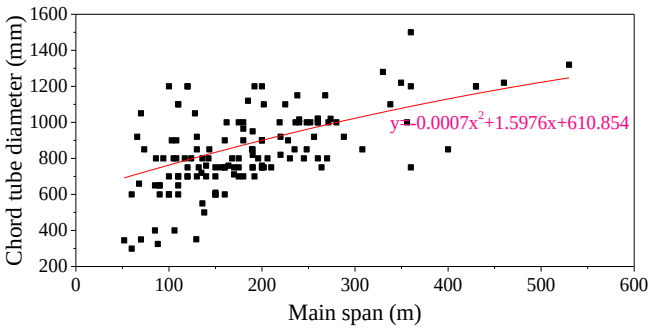

Fig.6 Relationship between chord tube diameter and span length

The distribution of chord tube diameter-thickness ratio of 140 bridges in the sample database is illustrated in **Fig.7**. It shows that the diameter-thickness ratio is in the range of 20 to 96, commonly from 40 to 70.

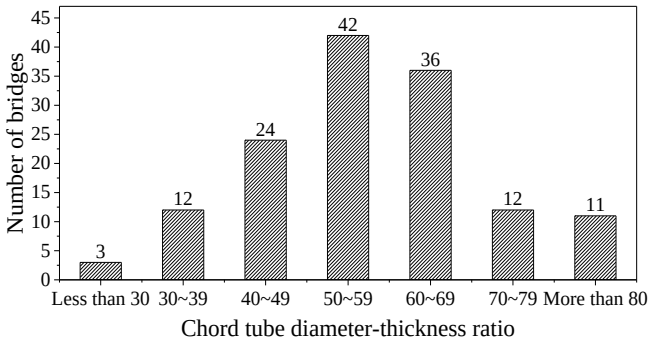

Fig.7 Diameter-thickness ratio distribution of chord tube

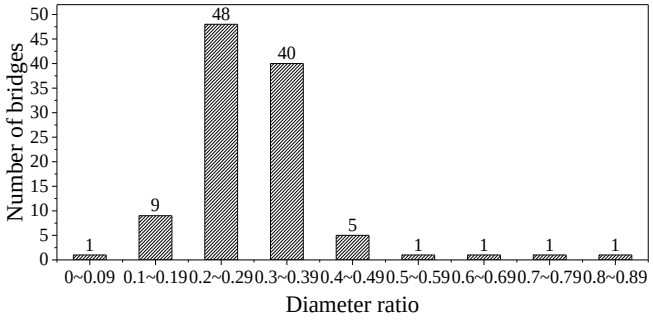

Fig.8 Diameter ratio distribution

As shown in **Fig.8**, web member diameter d is linked to chord tube diameter D. Diameter ratio is $0 \prec d/D \leqslant 0.9$, mostly from 0.2 to 0.4, whose number is 88 out of 105(83.8%).

As shown in **Fig.9**, web member thickness t is linked to chord tube thickness T. Thickness ratio is $0.3 \leqslant t/T \leqslant 1.0$, mostly from 0.6 to 0.9, whose number is 63 out of 98(64.3%).

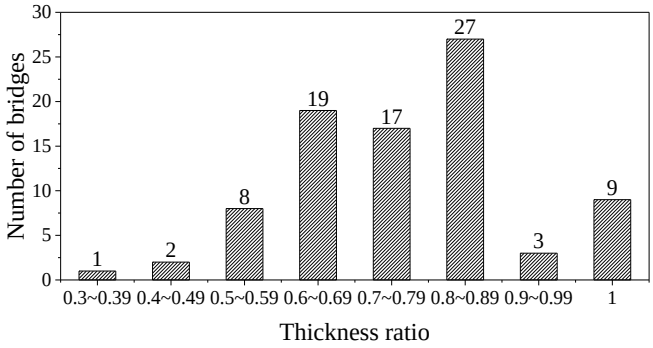

Fig.9 Thickness ratio distribution

4 Materials

As shown in **Fig.10**, 111 bridges in the sample database mainly adopt Q345 steel (yield stress is 345MPa) and 16Mn steel (yield stress is 343MPa), which account for 92.8% of the total. As shown in **Fig.11**, 133 bridges in the sample database mainly adopt C50 (compressive strength is 50MPa) concrete, which accounts for 75.2% of the total.

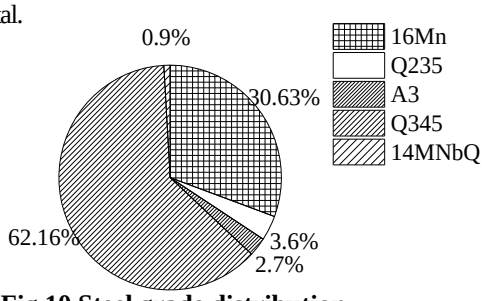

Fig.10 Steel grade distribution

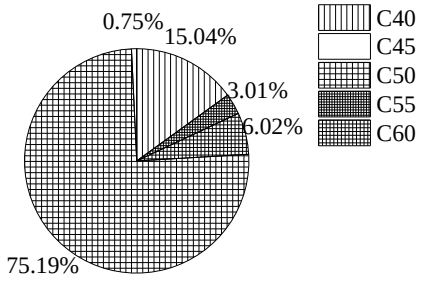

Fig.11 Concrete grade distribution

5 Last remarks

The development of CFST trussed arch bridges in China has improved bridge engineering technologies in the fields of design, fabrication and erection for long-span bridges. Many CFST trussed arch bridges will be built for their elegant appearance and favored for highway, city road and railway.

References

[1] CHEN Bao-chun. Concrete Filled Steel Tubular Arch Bridges. China Communications Press, 2007. (in Chinese)