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Performance and development status of H-beam waveform web

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Abstract
After waveform web H-beam mechanical properties, process development and engineering brief overview of the advantages and disadvantages and proposed waveform H-beam web in engineering application and promotion.

Keywords: Waveform web H-beam, mechanical properties, engineering application

1. Introduction

From abroad in the 1950s and 1960s began to develop mechanical properties of the corrugated metal sheet; since the 1980s, researchers began to explore waveform instead of ordinary steel H-beams in the flat web. Sumitomo Corporation of Japan first welding process for the production of H-beam web in the middle portion of the waveform. Northeast China Heavy Machinery Institute in 1985, rolling out full waveform web H-beam. In recent years, along with sophisticated automatic welding technology, welding H-beam web in full waveform European countries such as Germany, Sweden and the United States and other developed rapidly. Has special provisions in certain European norms on such steel, such as Sweden Strut norms, Eurocode like. Web web H-beam steel consumption waveform typically accounts for about 25% of the members of the lowest even as low as 4%, and the web thickness ratio can reach 600. The waveform of hot-rolled H-beam web beam and hot-rolled H-shaped steel compared to the stiffness under similar circumstances, the amount of steel savings of about 40% to 60%, saving more than 30% of H-beam welding. Because this steel has good mechanical performance and superior economy, its research has a high economic and social benefits. Our current research in this area lags behind foreign research results are not fully form a conclusion. Therefore, the combination of production and processing levels of independent innovation research has practical significance.

2. The mechanical properties of H-beam waveform web

2.1 Shear Capacity of H steel beam waveform web

Corrugated Steel Webs less prone to shear buckling, shearing the working mechanism of the plate to play thinner webs are not yielding to full cross-section before buckling, showing thick flat steel plate only with nature. However, the waveform of the web does not have the strength after buckling, after it reached the limits of capacity, the outer surface deformation increases rapidly, with the wave surface is leveled, its carrying capacity decreased rapidly, showing sensitivity to initial imperfections.

2.2 Waveform beam flexural capacity of H-beam web

1) Ending Bearing Capacity of H-shaped steel beam web waveform mainly from the contribution of the lower flange.
2) Bend test and finite element analysis of H-beam web waveform by simply supported beam are able to verify the correctness of the theory of wave web H - beam analytical model.
3) Dense web waveform and a smaller beam flange thickness ratio can improve the ultimate moment.
4) Theoretical waveform web H-beam beam test was much higher than the limit moment sectional analysis of plastic moment, so the waveform of H steel beam web design, you can use a cross-sectional conservative theoretical plastic moment as a waveform belly H-shaped steel plate girder design moments.

2.3 Waveform web H - beam lateral torsional buckling

Waveform web H-beam steel beam H can improve the ability to withstand lateral pressure to some extent. Its amplitude H increase the carrying capacity of the waveform amplitude and wavelength λ related. Noting the critical stress wave plate and the plate is the yield stress, so the whole yield pressure is the critical pressure. Of the same size compared with the waveform flat plate, and the plate length ratio of the length of the curve of its carrying capacity is available to improve the corrugated plate to express, if the waveform has n half-wave plate, to improve the bearing capacity can be expressed as:

$$\frac{ns-1}{1}\% = \frac{ns-n\lambda}{n\lambda}\% = \frac{s-\lambda}{\lambda}\%$$

The result is more convenient for engineering applications. Seen by the above analysis, the correct choice of amplitude H and the wavelength λ, can determine a reasonable waveform shape plate, give full play to its advantages, to show its economic benefits.

2.4 Waveform web H - beam Local Bearing capacity

Compared with the flat web - shaped member having an outer web waveform better plane stiffness and stability, and the greater the actual pressure area, it has a better local bearing capacity. Waveform web - shaped beam when subjected to in-

plane bending moments and partial load together, the flange of the normal stress will increase, so more prone to plastic hinge, so the presence of bending moment M would reduce the local pressure limit Carrying Capacity.

2.5 Waveform web H-type steel column force performance

Stability waveform web H-type steel column improvement over the flat web H-type steel column, the degree of improvement related to the wavelength and wave height, and the height is proportional to the square of the waveform.

3. The main advantages of steel girder with Corrugated Steel Webs

Compared with the traditional steel girder with Corrugated Steel Webs webs of flat steel beams, it has the following advantages:

(1) Local web stability is greatly improved, thereby reducing the thickness of corrugated steel webs.
(2) Avoid all the web stiffener, using the amount of steel and welding work has been reduced, full use of the material and reduce the cost.
(3) At the same carrying capacity, the steel beam from the waveform quality web to be reduced by 30%.
(4) Corrugated steel webs can be avoided to some extent by the geometry of the defect of premature buckling phenomenon, while the corrugated steel web thickness defect sensitivity is also greatly reduced, because the corrugated steel web thickness defects with corrugated steel webs off groove depth or wave height is small compared.
(5) Corrugated steel webs have a strong resistance to shear buckling capacity. Corrugated steel web shear capacity has greatly improved (approximately 2-fold).
(6) Corrugated steel webs to the flange provides increased support.
(7) Corrugated steel webs improves the fatigue life of the beam.
(8) Corrugated steel web application on the concrete bridge to replace the traditional web, greatly reducing the weight and cost; improve the shear buckling strength steel webs; avoids the difficulties often encountered in concrete web of high perfusion, and to simplify construction equipment, reducing field operations, the purpose of accelerating the construction progress; in terms of aesthetics and maintenance costs are also competitive.

4. H waveform web applications in engineering

4.1 Used in construction of the portal frame houses

Traditional flat web can actually be seen as the wave height is zero, once subjected to load stress, flat belly girder webs easy local buckling, which will force local "Exit computing" is actually the web plane stiffness loss stable to shear ability. For the mechanical characteristics of the web, the researchers introduced the industry's wave theory webs. Waveform web container concept is subject to revelation, a standard size container outside warehouse 12192mm × 2438mm × 2591mm, a TEU can carry 22 t, cabinets people think truss support, with only side waveform. Thus, the webs made "self-stiffened" effective waveform, so that the web "full and effective cross-section" is an effective means of reducing the amount of steel. Waveform H-beam web member as a new and efficient profile, can replace ordinary flat web H-beam member as the main force component light portal frame system. Waveform H-beam web portal frame structure system thus formed has a high capacity, the economy is good, and many other advantages.

4.2 For Bridge engineering corrugated steel webs prestressed concrete (PC) Composite Box Beam

In order to meet the needs of economic construction and social development, the development of modern concrete bridges, proposed a "lightweight, high strength, large span," the goal. In 1975 the French company Campenon Bernard proposed waveform instead of steel flat steel envisaged, the original flat steel plate to the axial direction along the bridge scalable wave plate, thereby forming a new, more rational box girder structure --- corrugated steel webs prestressed concrete (PC) Composite Box Beam.

Since 2005, China has built with corrugated steel web PC composite box girder bridge are: Huaian Long footbridge, Henan Guangshan splash River Highway Bridge, Yongchuan Dayan River Bridge, Dongying, Shandong Ginza footbridge, Qinghai three River Bridge and Ningbo, Ningbo new river bridge and the like. In 2007 after the construction of the bridge are: Yingyugou 2nd bridge on the highway connecting national highway trunk Huo Zhengzhou to Luoyang, Henan and Hebei wide high-speed sector to the Wei River Bridge south music piece, Xinmi Qin sea Bridge, Shandong Juancheng Yellow River Highway Bridge and the like.

PC composite box girder with corrugated steel webs as a new type of steel - concrete composite structure, full use of the concrete compressive strength, high corrugated steel webs shear yield strength advantage, effectively steel, concrete combination of two kinds of materials, efficient use of materials, is an economic, rational and efficient structural forms. With the deepening of China mature corrugated steel web PC box girder structure of a combination of research and application of technology, it will be more widely used in China's bridge engineering.

5. Conclusion

Current study abroad girder webs waveform continues, and has accumulated a certain amount of practical experience in engineering, domestic research on this new architecture has just started following aspects need further study:

(1) Steel beam changes and changes affect their flexural and shear behavior of steel varieties waveform flange thickness of the upper and lower webs.
(2) The initial curved corrugated steel webs, initial deformation and residual stress its initial shear strength.
(3) The waveform reasonable board, give full play to its advantages, to show its economic benefits.
(4) The overall stability of the waveform web steel beams.
(5) Flange steel beam web waveform local stability.
(6) Waveform web girder design.
(7) Fold local stability and resistance to bending a linear steel webs.

With this new structure to further improve the theory and design calculation methods, this new structure will get more broad prospects for development.

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