Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 49 (1986)

Artikel: Use of cold-formed steel in the building industry of China

Autor: Zhang, Zhong-Quan

DOI: https://doi.org/10.5169/seals-38309

Use of Cold-Formed Steel in the Building Industry of China

Application de l'acier formé à froid dans l'industrie chinoise de la construction

Anwendung des kaltgeformten Stahls im Baugewerbe in China

Zhong-Quan ZHANG
Structural Engineer
Hubei Ind. Building Design Inst.
Wuchang, Hubei, China

Zhong-Quan Zhang, born 1942, graduated from the Departement of Mechanics, Tongzhi Univ. in 1964. He is one of the chief editors of the 1975 and subsequent editions of the specification «Design of Cold – Formed Steel Structures» in China.

SUMMARY

This paper mainly describes the use of cold-formed steel in the building industry of China with some engineering examples. A brief review is presented of the state-of-the-art in design specification and the current situation.

RÉSUMÉ

Cet article donne une vue générale concernant l'application de l'acier formé à froid dans l'industrie chinoise de la construction illustrée par quelques exemples. Un bref survol de l'état des connaissances et du développement des règles de construction ainsi que des recherches en cours est présenté.

ZUSAMMENFASSUNG

Der Bericht behandelt vorwiegend die allgemeine Anwendung des kaltgeformten Stahls im Baugewerbe der Volksrepublik China. Als Beispiele werden einige Bauwerke vorgestellt. Die Entwicklung in Bezug auf Normierung und die Forschungsarbeit in diesem Bereich werden kurz erläutert.

In the People's Republic of China, cold-formed steel products were for the first time produced in the mid 1950's. Cold-formed steel structural members have begun to be widely used in the building industry only since the last two decades. Since the mid 1960's, a series of cold-formed steel constructions have been successively built up throughout our country such as Shanghai, Beijing and Guangdong, Shanxi, Hubei provinces, etc. According to incomplete statistics, the construction area of civil and industrial buildings using cold -formed steel have far exceeded 1,000,000m^2.

1. MATERIALS

In China, Cold-formed sections are shaped from low cabon or high strength low-alloy steel sheets, strips or plates. The following steel have been used as their virgin materials: A3, 16Mn, 15MnV, 15MnVNi, 09PV, 10PCuRe and 12MnPV, etc. among which the most poular ones are A3 and 16Mn, their yield strength being 240MPa and 35MPa, and their ratio of specified ultimate tension strength to yield strength being about 1.58 and 1.48 respectively.

2. SHAPES

Usually, cold-formed steel sections used in the building industry can be divided into two categories: framing members and surface members.

2.1 Framing members

The depth of such sections ranges from a few centimeters up to 30cm or more. Their thickness varies from 2 to 6mm. Among these shapes, the most popular ones are square or rectangular tubes, cold-rolled circular tubes, channel sections, hat sections, C - sections, Z- sections, angle sections and some other built-up sections (as shown in Fig. 1).

2.2 Surface members

The depth of profiled steelsheetings ranges generally from 12 to 173mm, their thickness varies from 0.5 to 1.6mm, their ribs space at 90 to 230mm.

The typical sheetings are shown in Fig. 2.

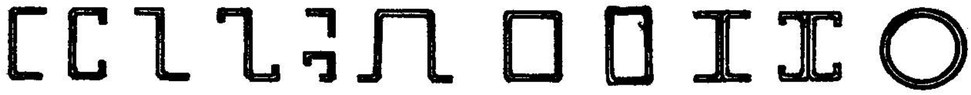
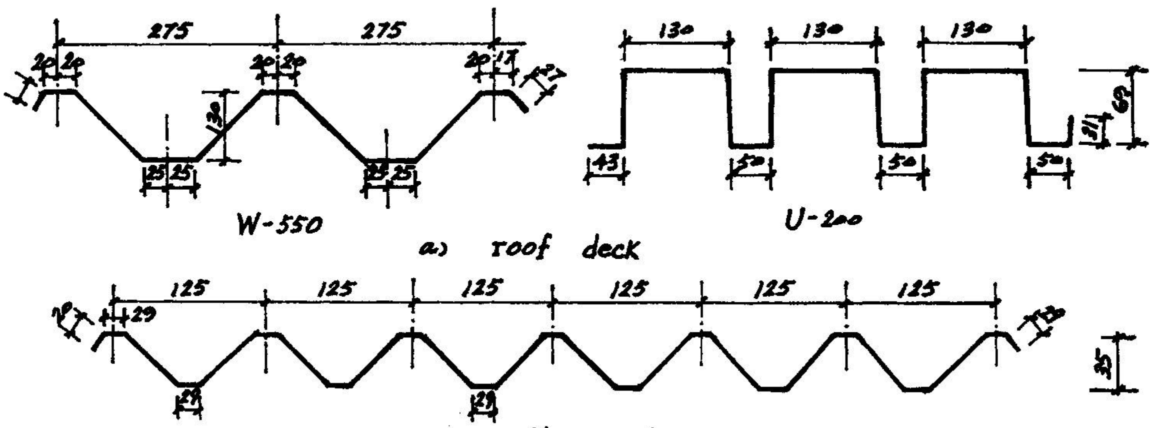


Fig. 1 framing member



a) roof deck

b) wall penel (V-125)

Fig. 2 surface member

3. APPLICATION AND EXAMPLES

In the building constructions of our country, cold-formed steel sections are mainly used as gable frames, space grids, trusses, columns ,beams, purlins, studs, wall girders, skylight frames, keels, vessels and railings, window frames, bridgings, bracings, etc. The profiled steel sheetings are generally used as roof decks, wall panels and cellular panels. In recent years, various pre-engineered one-story or two-story buildings, hothouses, Mongolia tents and high-rise rack structures, etc., which are made of cold-formed sections, have been designed and built. The importance of these sections is growing with days to come.

The portal frames made of cold-formed sections are now in common use, their forms are different from each other, including columns and/or beams or lattice members, of which the cross sections are variable or uniform, connected by either welding or bolt or high strength bolt, subjected to dead load only or to dynamic load on the columns or beams in addition. The spans of frames are from about 8 to 30m, for examples, the lattice gable frames with 29m span were made of cold-rolled circular tubes and built at Shanghai Exhibition Hall in 1967, and the gable frames with 18m span were made of Z- sections and built at Shaoguan Plastic Factory in 1966.

Among the various cold-formed section structures, the most popular ones are the roof structures (including roof trusses, purlins, skylight frames, bracigs or space grids and framed domes, etc.) which are used in civil buildings (such as halls and exhibition center, etc.) and workhouses or warehouses, they are also used not only in light workhouses without cranes, but also in heavy workhouses with bridge cranes of lifting capacity up to 125 tons and " flexible workshops " of large column spacing with hanging-crane facilities. Usually the range of purlin span is 4 to 6m or 12m, including solid (C - sections and Z - sections), open web and lattice purlins. The roof truss span varies from 9 to 30m, including triangular, trapezoidal, shuttle and parallel chord trusses. They are made of closed square or rectangular tubes or cold-rolled circular tubes and also of full open sections, such as the trapezoidal roof trusses, with 30m span, were made of cold-formed square tubes and built at Baotou Iron and Steel Plant in 1968; the triangular roof trusses, made of square tubes and installed with hanging-crane facitities of lifting capacity equal to 2.5 tons at any bottom chord joint (see Fig. 3) were used with spans of 12 and 15m in The Second Automobile Works P.R.C. at Shiyie in early 1970's.

The space grids, made of cold-rolled circular tubes or other sections with welding balls or screwed cast balls,began to be widely used both in civil (such as halls and gymnasiums, etc.) and industrial buildings in the last two decades. Among these structures, the most popular ones are planar grids (consisted of an intersecting system of lattice beams or trusses) and space trusses (consisted of pyramids). Up to now, the completed space grids have amounted to several tens. Among those, there are some examples as following: a planar grid consisted of an inclined intersecting system of lattice beams (40m long X 40m wide) made of cold-rolled circular tubes was built at Beijing International Club in the mid 1970's; an inclined pyramid grid (35m long X 35m wide), also made of circular tubes with welding balls, was built at Shanghai Gymnasium for Practice in 1966.

Since the mid 1970's, the high-rise rack structures, made of cold-formed sections, have been built and mainly used in warehouses or libraries such as a high-rise rack structure (6.3m wide X 50.7m long X 15m high), made of square tubes and other sections and connected with high strength bolts(see Fig. 4), was built at Beijing Automobile Manufactory in 1977, and so on.

In recent years, the use of profiled steel sheetings has been increasing gradually in building constructions. According to incompleted statistics, the buildings using these materials as roof decks and wall panels have far exceeded 1,000,000m^2 up to now, among these are Shanghai Baoshan Iron and Steel General Plant, Shanxi Shentou Power Station, Shenzhen Dock Warehouse and Guangzhou Container Plant, etc.

Fig. 3 roof trusses with hanging-crane

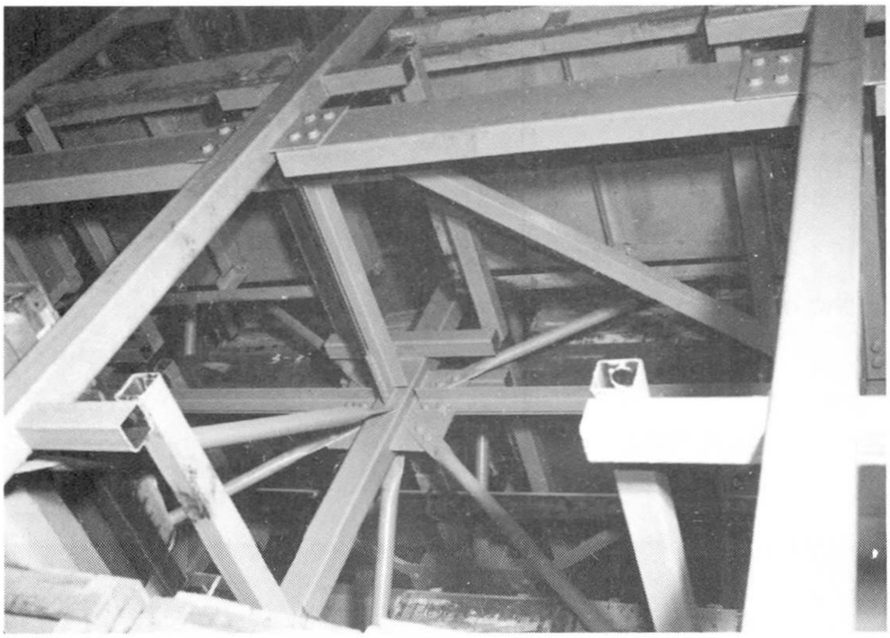


Fig. 4 rack structure

4. ECONOMICAL ANALYSIS

According to incompleted statistics ,the steel consumption (per unit area) of several popular types of cold-formed steel structures (members) is shown as follows:

—Roof systems made of cold-formed sections (including roof trusses, purlins , skylight frames and bracing members only):
with span ≤ 18m and roof load ≤ 10KN/m²: about 12kg/m²;

—Planar grid (consisted of an inclined intersecting system of lattice beams) made of cold-rolled circular tubes of 16Mn steel with 40m long x 40m wide: about 25kg/m²;

—Purlins:
lattice purlins: about 2-4kg/m²;
solid Z - shapes purlins: about 4-6kg/m²;

—Roof trusses with span ≤ 24m and roof load ≤ 15KN/m²:
about 2-5kg/m²;

—Gable frames with span ≤ 30m and roof load ≤ 6KN/m²,
wind load ≤ 10KN/m²: about 3-12kg/m²;

—Profiled steel sheetings (their thickness varies from 0.5 up 1.6mm): about 5-20kg/m².

5. DEVELOPMENTS IN SPECIFICATION

In China, the first edition of the Specification for the Design of Cold-Formed Steel Structures was published in 1969. Since then, based on the findings of research works and accumulated practical experiences, the Specification was revised and issued as a second edition in 1975. The new one is now in being compiled and is to be published next year.

In recent years, to improve the problems existing in analysis,structural design, antirust measures and develapments of new technique, there have been fourteen research projects carried out since 1976. Some valuable achievments were gained and mostly adopted in the new edition of the Specification. In comparison with the existing Specification, the new edition has some different striking aspects as following:

-Limit state design method based on the probablistic approach (level 2) was introduced to take the place of the traditional allowable stress criteria;

-The provision permitting to take into account the possible beneficial effects of cold work is supplemented in the new Specification;

-The equations and relative coefficients to compute stability of the centrally loaded columns, beams and beam-columns are revised and adjusted;

-The computation method for considering the local buckling of flat compression elements is partly revised and adjusted;

-The provisions for dealing with the electric resistence spot welding, high-strength minor diameter bolt connections and design of profiled steel sheetings are added respectively in the new edition;

-The provisions concerning antirust are revised and replaced.

6. ACKNOWLEDGEMENTS

The auther wishes to express his thanks to his colleagues, Mr. Xu Zhong Yao and Chen Xue Ting, Ms. Li Hua and Zhu Wa Li, for their helps in accomplishing this paper.

Leere Seite
Blank page
Page vide