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METAL FRAME CONSTRUCTIONS FOR ONE-STOREYED INDUSTRIAL BUILDINGS

Generalization and analysis of designing experience and construction of one-storey industrial buildings in metal frame constructions are conducted.

Проведено аналіз досвіду проектування і будівництва сучасних одноповерхових промислових будівель з рамними металевими конструкціями.

Introduction

The generalization and the analysis of modern one-storeyed industrial buildings from metal frame constructions was led at the department of computer technologies of construction of the airports faculty under the direction of professor Valery N. Pershakov.

Wide use of steel designs in construction is promoted by a variety of their properties: high durability, plasticity, raised heat conductivity, electroconductivity and weldability.

Alongside with this metals and especially steel and cast-iron at action with various gases and moisture are strongly influenced by corrosion and therefore need special protection.

The researches and publications analysis

Steel elements are used in various engineering constructions, which depending on the constructive form and purpose, can be divided into the following kinds [1].

One-storeyed industrial buildings

Such buildings can be one-span (fig.1) and multispan, including flights of different length, with built-in working platforms and multi-storey inserts.

Fig. 1. An interior of a one-storeyed building

Their sizes are rather various: from several tens meters up to 1000 m and more. Industrial buildings are usually equipped with the built in vehicles such as conveyors, pendant or bridge basic cranes. Floor transport (electrocars, loaders, etc.) are used in buildings without cranes.

Recently the steel skeleton was authorized to be applied in industrial buildings at flights of 24 m and more, height more than 18 m and at carrying capacity of cranes more than 50 t. These restrictions are lifted. Now steel constructions are widely used in repair shops, shelters for agricultural machinery, canopies, warehouses and other buildings at 12, 18 m flights. Nowadays building-modules of full factory readiness on the basis of arch designs, the arches from the volumetric-formed thin sheet, structural designs of extensional networks found wide application.

Along with steel, mixed skeletons are applied in which on reinforced-concrete columns steel designs of a covering and undercrane ways are installed.

Low rise buildings

Formerly such buildings were built of brick, reinforced-concrete, wood and other traditional building materials.

Nowadays in similar buildings steel and aluminium alloys are also used of which skeleton, a warmed walls covering, window reliures, doors built in cases, furning of partitions are made. All-metal buildings manufacturing of complete delivery on "turn-key" basis is mastered.

Multi-span buildings and hangars

Big spans(50...150 m and more) have the sports constructions, the covered markets, exhibition halls and some industrial buildings (hangars (fig. 2, *a*), aviaassembly shops (fig. 2, *b*), etc.). For overlapping such flights, as a rule steel designs are used.

Systems and constructive forms of big-span coverings are various. In such cases beam, frame, arch, dome, trailing and combined systems, both flat, and spatial are possible.

The basic loading in wide-span buildings is the body weight, for whose decrease it is rational to apply the facilitated protecting designs, steel of the raised and high durability, various ways of efforts regulation, including a preliminary pressure.

Usage of steel designs in installation of big buildings – natural result upon the conditions, imposed on the property owners within big cities, and the result of application of new materials and equipment.

The steel frame is usually used in construction as "a frame" consisting of vertical steel columns and the horizontal Ibeams located in a rectangular grid.

The frame perceives loading from a covering, overlappings and walls of a building which are supported on the frame.

Bearing designs for buildings are I beams of variable section and cold bent structures of *Z* and *C* form. Such designs differ by the small metal content (in comparison with ordinary constructive decisions they are 30–40 % lighter). Application of bolts assembly connections instead of welded considerably reduces terms and complexity of installation works, raises reliability and durability of designs. All design calculations are made with special licensed software application, with the further checking on conformity to standards. Rolled "profile" or cross-section steel columns takes the form of the "H" letter. Two wide column shelves are thicker and wider than shelves on a beam for the better resistance to a compressing pressure in structure. Square and round tube sections of steel can be also used, they are often filled by concrete. Steel beams are connected with columns by bolts and the bound clips and attached by rivets. Central "grid" of the steel on "I" beams is often wider than a grid of a column for better resistance to high bending moments which arise in beams.

Let's consider applied types of constructive decisions.

1. The multispan frame from welded I beams of variable section (fig. 3, *a*). The general width is not limited. It is used where intermediate columns do not break technological process. Application of flights essentially reduces metal consumption for skeleton erection. It is used for industrial and warehouses. Variants of this design are also possible with direct columns and through crossbar.

2. The multispan frame with a rigid wall or a through crossbar (fig. 3, *b*). The multispan frame with plate girder or through crossbar (in the form of a truss) with the general width from 12 up to 120 m and more. It is used where intermediate columns do not worsen function of a building. Breakdown of large span reduces metal content of a skeleton. An ideal design for industrial and storage buildings.

3. The one-span frame from I beams of variable section (fig. 4, *a*). Provides free space without intermediate columns of the span from 12 up to 72 m in a standard variant and more than 72 m – in individual projects. Section of columns and crossbars of a frame are Ibeams with variable height of a wall. Hinged (moment-free) columns support allows to decrease essentially the bulk of bases. An ideal construction for gyms, classrooms, hangars, warehouses, industrial shops, universities and shopping centers.

4. The one-span frame from rolled I beams (fig. 4, *b*). Optimum span is from 6 up to 18 m. Columns and crossbars of a frame are made from hot rolled I beams. Thin columns with a small wall height of I beams can be located between the internal and external coverings of a wall. It allows to execute internal furnishing of a building without arising details of a metal skeleton. Applied for rooms for shops, canteens, expocentres, banks and offices departments.

5. The multispan frame with columns of constant section (fig. 5). The multispan frame with direct columns of the general width from 12 up to 120 m and more can be in two variants with a continuous crossbar or with a truss. Intermediate columns decrease metal content of a skeleton in comparison with a one-span frame. Perfectly that's for offices and warehouses.

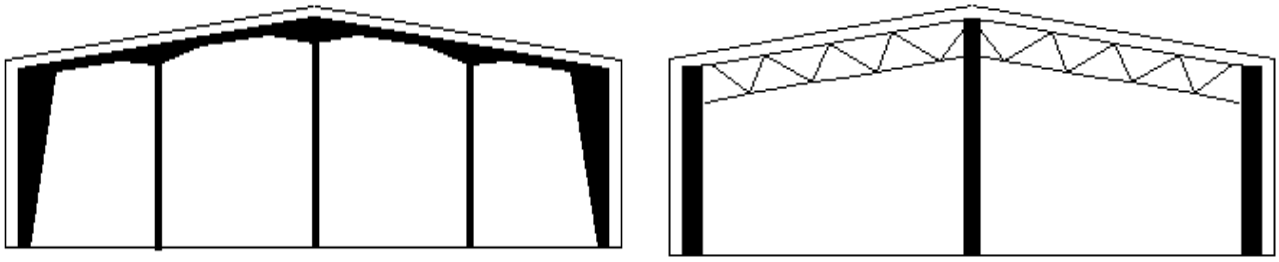
6. The rectangular frame (fig. 6). The rectangular frame with a span from 12 up to 36 m has double pitch crossbar of a variable section with a horizontal bottom belt. Columns from hot rolled I beams. It can be used for the buildings equipped with pendant or bridge cranes.

7. Single pitch frame (fig. 7) with flights from 6 up to 36 m provides a unilateral bias of a roof. It is used for shopping centers, office complexes where the drain of rain water should be directed from the carriageway.

Wide sheets of a steel flooring can be used for a building steel frame covering as the form below the thick layer of concrete and steel bars. There is another popular alternative a covering from a modular concrete flooring. Often in the office construction the final covering surface is a relief system of a flooring with emptiness between a surface and the structural floor used for cables and pipes for air conditioning.

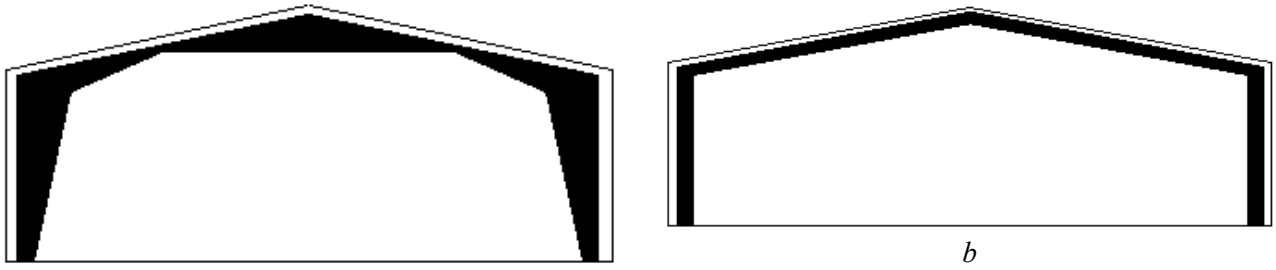
a *b*

Fig. 2. Interior view:
a – large span hangar;
b – large span building



a *b*

Fig. 3. The multispan frame:
a –variable section;
b – with a through crossbar



a *b*

Fig. 4. One-span frame:
a – variable section;
b – from rolled profiles

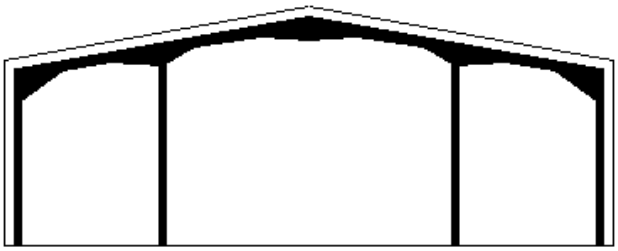


Fig. 5. The three-span frame with constant section columns

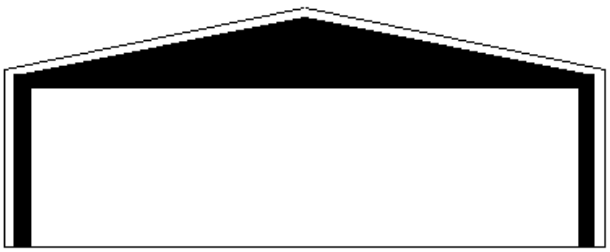


Fig. 6. Rectangular frame

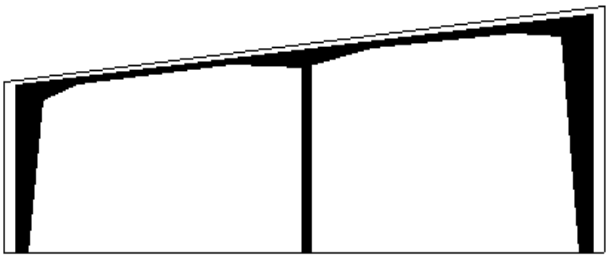


Fig. 7. Single pitch frame

8. The inclined frame (fig. 8). The Г-shaped frame with a flight from 3 up to 36 m. It is used first of all for extensions to existing buildings.

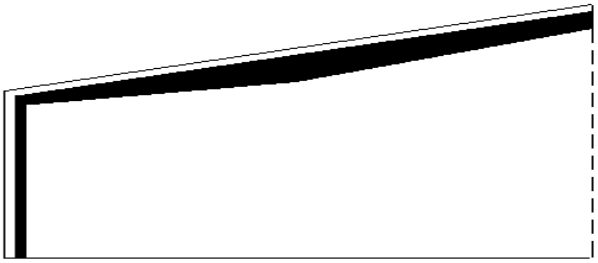


Fig. 8. Inclined frame

The frame should be protected from fire as steel is softened at high temperature that can cause partial destruction of a building.

In such a case usual facing material should have the fire-resistant structure, for example a stone laying, concrete or a plaster plate.

Beams can be covered by concrete, dry plaster or a layer of isolation from a heat of fire and can be protected by a fire-resistant design of a ceiling.

External facing of a building is reliably attached to a frame, variety of building technologies and architectural styles.

To cover a frame brick, stone, reinforced-concrete, architectural glass, sheet metal and simple paint were used to protect from the influence of weather conditions.

Buildings from steel have mainly frame structure.

Columns connection with the base is rigid or hinged in one or two directions, with crossbars – hinged, with covering beams – rigid or hinged.

Work stability of a building skeleton is characterized by rigidity of frames or connection system on columns and covering.

Columns of a skeleton are designed from solid or through Ibeams. Crossbars can be produced from cold stressed welded profile or angles, beam - from Ibeams of the perforated or variable section. Roof beams are made from rolled or bent channels.

The order for performance of metal works can be implemented from any kind of steel used for the construction.

Ready products pass clearing by means of sandblasting.

Conclusion

1. Excellent metal durability and anticorosive coverings give an opportunity to use metal products in any climatic regions. It is easy in assembling which allows to reduce charges on installation.

2. Production of metal elements with a help of modern equipment gives high accuracy of the geometrical sizes that should significantly fasten the assembling of structure.

3. Technological preparation of the production and obligatory technical checking of production allows to provide high quality products. The modern systems of the automated designing allow to carry out it quickly and with high quality that should reduce metal consumption.

4. Steel frame design has a number of advantages:

– light weight and high durability (stronger and lighter than concrete);

– modular frames are quickly erected;

– accuracy and predictability (excellent quality check).

References

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