

Semantics and technologies in modern design of interior stairs

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Abstract. Use of metal in the design of interior stairs presents new features for shaping, and can be implemented using different technologies. The article discusses the features of design and production technologies of forged metal spiral staircase considering the image semantics based on the historical and cultural heritage. To achieve the objective was applied structural-semantic method (to identify the organization of structure and semantic features of the artistic image), engineering methods (to justify the construction of the object), anthropometry method and ergonomics (to provide usability), methods of comparative analysis (to reveal the features of the way the ladder in different periods of culture). According to the research results are as follows. Was revealed the semantics influence on the design of interior staircase that is based on the World Tree image. Also was suggested rational calculation of steps to ensure the required strength. And finally was presented technology, providing the realization of the artistic image. In the practical part of the work is presented version of forged staircase.

1. Introduction

In today's world stairs becomes dominant in the interior of apartments and houses. Development of new technologies and the variety of materials (stone, concrete, metal, glass) allow to constantly improve its appearance and decoration. However in addition to functional, aesthetic and artistic value staircase has a symbolic meaning, which manifests itself in many aspects of our lives.

The aim of the article is to study the symbolism of staircase image and to identify interferences of symbol, style and production technology of interior spiral staircase made of metal.

The main objectives are:

- to identify the symbolic aspects of staircase image;
- to consider the theme of staircases in the history of cultures;
- to submit relationship of the symbolic image and stylistic solutions of staircase;
- to propose and justify a method for manufacturing the stairs.

2. Research

The symbolism of staircase is connected with possibility of people, gods, inhabitants of the underworld to move. Thus, the staircase in the myths reflects the hierarchical levels of cosmic zones. Image of Osiris on the top the stairs symbolized his resurrection from the dead. In Buddhist mythology Shakyamuni Buddha descended to earth via a staircase, brought to him by Indra. The tribes of Siberia perceived stairs as an image of the World Tree, by which the supreme shamans got in a top world. In Christianity is popular the image of Jacob's ladder, which the biblical patriarch saw in a



dream. Angeles were going up and down the Jacob's ladder. The Virgin in the iconography depicted sitting on a throne with a ladder in the hands [1].

Going upstairs symbolizes good luck, knowledge, holiness, perfection; downstairs – degradation, misery. In Norse saga hero King Olaf dreamed that he climbed the stairs to the high heavens; this dream was interpreted as a sign of impending death and ascension to heaven as a saint. In Islamic tradition Muhammad describes the ladder by which believers climbed to reach God.

Stairs as an attribute of ascension stands as analogue of column, tree or mountain (also symbolizing the world axis) [2]. Stairs also was considered as an attribute of the descent, in which the hero falls into the underworld.

The semantics of stairs image is multivalued and the main thing in it is the vertical dimension, where the rise signifies the triumph of overcoming the Earth's gravity, as well as the triumph of the spirit over the flesh. Thus, we can identify the following symbolic aspects of stairs image:

- communication between the different levels of the universe and the transition from one to another;
- ascension and evolution, presented as a sequence, gradual, stepwise process.

These meanings of ancient interpretation of stairs appear so far - staircase connects the floors of buildings, creating a connection between them, help the movement of people, contribute communications.

In today's world the presence of stairs in the house is a testament of prosperity. However was not always so, for example, theorists of Quattrocento (early Renaissance) considered the ladder as an annoying functional necessity of city construction. In his treatise "On the Art of Building" Alberti recommends hiding the stairs at the buildings' corners or behind columns in order not to "spoil" the interior space. All these difficulties are constructional, they are experienced by the one who builds stairs, but not by the one who has to climb them; it is not the difficulty of use. The task the architect is to make stairs comfortable and safe as much as possible [3].

Thus, Alberti gives inversed interpretation of stairs symbol (by which raises the righteous and overthrown sinners) - way up is extremely relieved, and accidental drops is safe. In the painting of the Renaissance stairs theme was also secularized. Staircase of Ghirlandaio devoid of semantic meaning and does not lead to the entrance of the temple. As Alberti advised, it only leads to an intermediate platform for a relaxing.

In the second half of the 16th century, at the end of his career Michelangelo returned to the theme of stairs. Laurentian stairway roughly rushes down and it seems impossible to climb over it. Deprived of railing, it is like a marble waterfall catastrophically clamped between too narrow walls. This ladder does not lead to the exit; it almost rests against the blank wall of the Library's lobby. This stairway is "hopeless". [4]

In 17th, 18th century stairs image gradually loses its sacred symbols. Main staircase is a way of significance, ceremonial ascent and descent.

At the end of the 19th century the development of the Art Nouveau style has shown a new attitude to stairs, with the special attention to decor of railings. Modernity is characterized by lightness and elegance of lines, graceful asymmetry of floral motives [5]. Staircase becomes "accent" of interior around which the script is tied. In the author's design project stairs "remembers" its symbolic meaning. Like the Tree it grows and unites the upper and lower space of the house, spiraling around the support pillars (pipes, transformed into a spiral). Decor of handrails emphasizes the symbolism of Tree-Stairs with fanciful twists of branches, dynamics of the rhythm which is directed upward (Fig. 1). From a technical point of view, this stairs refers to the spiral staircase [6].



Figure 1. Decor of forged railings. Design project by A. Sokolov.

In the design of stairs it is necessary to provide its maximum flatness. Thus the length of walkline increases. When designing a spiral staircase walkline is carried out not in the middle of step, but at a distance of $2/3$ of the step, starting with the pillars. Therefore the spiral staircases are more compact than stairways.

To calculate the ideal step size of the stairs is recommended method of French mathematician, engineer and architect François Blondel:

$$2s + a = 63 \text{ cm},$$

with s the step height, and a the step width [7].

However, anthropometric and ergonomic parameters, reflected in the building regulations as well as state standards [8] for stairs allowed to specify the above formula:

$$s = 20 \text{ cm} - \text{the maximum step height};$$

$$a/s = 1.5 - \text{the recommended ratio of the width and height of the steps};$$

$$a = 25 \text{ cm} - \text{minimum width of the steps}.$$

The ratio ($a/s = 1.5$) provides comfortable movement along the stairs. Thus, was suggested the ideal measurement for the stairs: step height - 19 cm; 28 cm - width of the steps, calculated by walkline. It is noteworthy that for spiral staircase the walkline can be varied according to one's individual anthropometric data to make climbing as comfortable as possible [9,10].

3. Results and discussion

The technical project specifies the size of stairs and the length of walkline. It was necessary to take into account the following requirements: small size of top platform and access to the window.

In drafting was decided to abandon the wooden bearing structure and to make it out of steel, while steps' cover of wood. Modern technologies and automated tools simplify the production of stairs [11,12]. The complex shape of fencing is carried out using the methods of artistic forging [13].

Figure 2, 3 shows the construction of stairs, which can be divided into three parts: pillar, steps, railing. For pillar was used 325 mm pipe with 6 mm wall thickness and a length of 2.4 meters. In order to lighten the stairs, as well as saving material, a section of pipe was cut along a helical line (double-threaded spiral). As a result we got two parts that was welded together to form a pillar.

Steps were also performed with welding [14]. Each of the steps consists of a plate and the reinforcement rib. For the ribs was used 89 mm pipe. It was sawn along the cutting plane and welded to plate. The resulting billet was machined on the edges to get surface close to column's surface. These steps were welded to pillar to provide a predetermined length of walkline, building codes and standards of ergonomics. During the tests of produced staircase steps elastically deformed when walking.

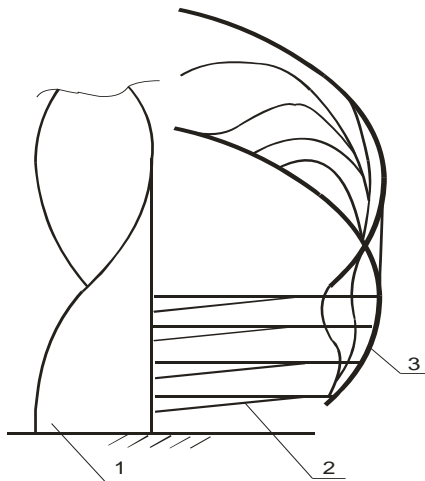


Figure 2. Construction of stairs:
1 - pillar; 2 - step; 3 - fencing

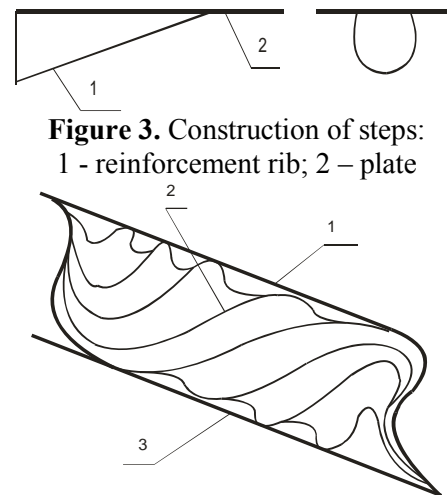


Figure 3. Construction of steps:
1 - reinforcement rib; 2 - plate

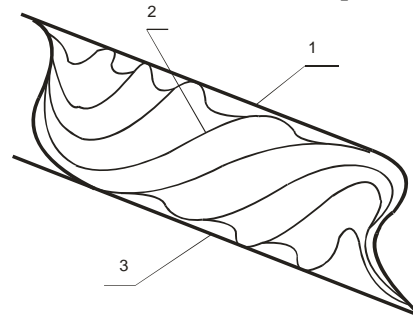


Figure 4. Sweep of fencing:
1 - rails, 2 - grille, 3 - stringer

To increase the rigidity was strengthen links between steps and fencing. The bases of fencing are stringer and railing, which are made of 26 mm pipe. Stringer and railing are connected by 14 mm steel rods curved to match the style of Art Nouveau (Fig. 4). The result is a rigid railing, which increased hardness of steps to the required level.

For convenience of manufacture and installation the fencing was divided into three sections of varying lengths. The middle section can be pulled off to provide access to the window. In the design of fencing also is fully used dignity of Art Nouveau, which allowed performing the middle section, on the basis of functional requirements and without creating aesthetic "tension" of joining elements.

Fencing was performed by the following technology. After joining steps to a pillar at each step were installed removable vertical racks to which was attached a sheet of hardboard. On this sheet with scaling method was drawn the reamer of all sections of the fence. By plastic deformation were prepared sections of stringer and railings. Details of stringer were joined by bolts to the steps; railing sections were fixed on the racks, and then all parts of grilles were connected by tack welds [13]. As a result of these operations have been received three sections of the fencing. After disconnecting them from steps further surface processing was carried out outside.

Thus, in the space of modern interior recreate the image of the stairs, the semantics of which is associated with the World Tree. Organicity of Art Nouveau and ancient symbolism embodied in the design project, because of the opportunities of art metal treatment technologies. The performance

characteristics are provided due to correct choice of sizes that correspond to the anthropometric and ergonomic parameters.

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