Scaffoldings for nonstandard facades

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Abstract. This article dedicated to structure of scaffoldings on facades with difficult shapes, which sometimes makes impossible for using usual facade equipment. Exactly, in this article, will be learnt angled facades. Considered experience of solutions in such works and suggested new variants of scaffoldings for sloping facades. Reviewed safety questions on the facades. Were given definitions of efficiency and laboriousness for that facade system, and enumerated factors influencing on them. The article is actual for today, because there is not any normative documents in construction sphere for buildings with irregular shapes.

1 Introduction

Nowadays facades can have almost any shape and restricted only by architecture's mind. Often it challenges builders. Because it is not an easy job to transfer facade workers in a high levels of modern buildings. For example, it is impossible to use ordinary falseworks on sloping facades. Therefore, it need to be resolved.
Below was given few pictures of buildings, situated in Moscow, with sloping facades and variants of using scaffoldings.

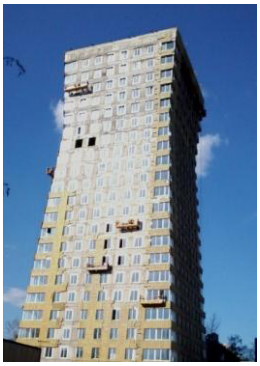

Fig. 1. Sandglass form building

Fig. 2. Sloping in the down part of building

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Fig. 3. Sloping with negative angle in the top part of building

Fig. 4. Transfer workers on sport complex

2 Models of scaffoldings for sloping facades

Basing on that experience, suggesting new facade system, shown in following drawings (Fig. 5, 6 and 7).

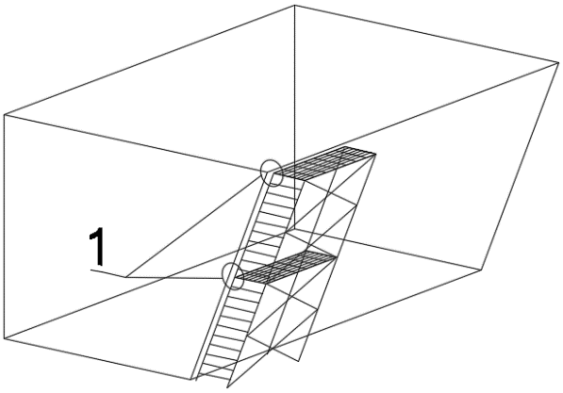

Fig. 5. Scaffolding for façade with negative angle (not existing facade system)

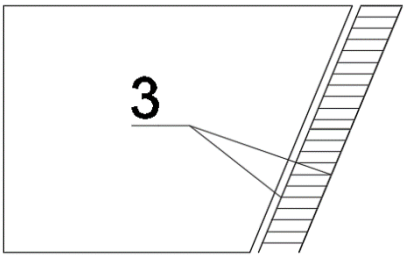

Fig. 6. Side view of the system

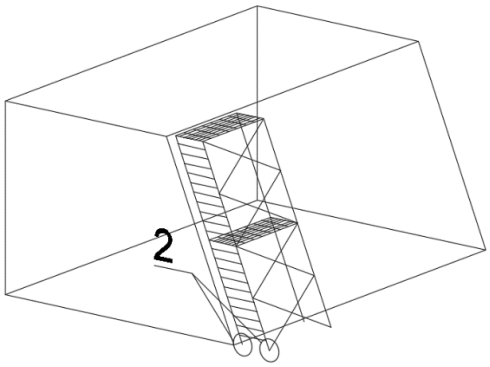

Fig.7. Scaffolding for facade with positive angle

where 1 – nodes for fixing with the wall, 2 – basements of scaffoldings, which can be rotated and fixed in different angles, adopting to sloping facades, 3 – scaffoldings columns, which can change length, also adopting to different angles.

3 Safety on the scaffoldings

Speaking about safety, constructors will be in more dangerous situation than in the scaffoldings for strict vertical facades. Therefore, safety belts and other fixing equipment should be improved and adopt to those systems. In addition, it is important to install safety nets, for example, on each three levels, in case of falling people and subjects from working horizons.

4 Factors influencing on feasibility

Efficiency application of such scaffoldings is restricted by the height. Laboriousness is changing due to angle and height of facades (1):

$$q = q_0 + \Delta q \ (1),$$

where q_0 – basic laboriousness, $\Delta q = f(\frac{h}{tg\alpha})$ – additional laboriousness, which depends on h [meters] - height of building and α - angle of facade, shows change of laboriousness along the height.

With intensive development of monolithic concrete constructions, unification of architectural planning solutions are depart to the background. Buildings are getting different shapes in planes and in facades. Particularly, there are buildings with different curvatures and slopes, broken facades and with different protruded parts. While making overhaul, the difficulty of such works depends on presents of balconies, their amount and character of surface of the walls. When working on such constructions the laboriousness is increasing, In that case there should be introduced coefficient of facade complexity (table 1).

Table 1. Groups of facade complexity of buildings according to geometrical specificity.

Facade complexity	Group of facade complexity	Coefficient of complexity
Flat facades	1	1
Facades with few protruded elements of the building	2	$1 + \frac{2S_1}{S_2}$
Facades with average broken lines equal to “n”	3	1+n

Note for table 1: "n" is determine as a number of broken facade's planes to unit of length of building on perimeter. S_1 – square of protruded elements and windows, S_2 – square of exterior walls.

The ledge, such as balcony also influence on laboriousness. And present as a coefficients on formula. One of the most important things is feasibility of such systems. Below is given diagram, which shows range of factors, influencing on feasibility (fig. 8). [1]

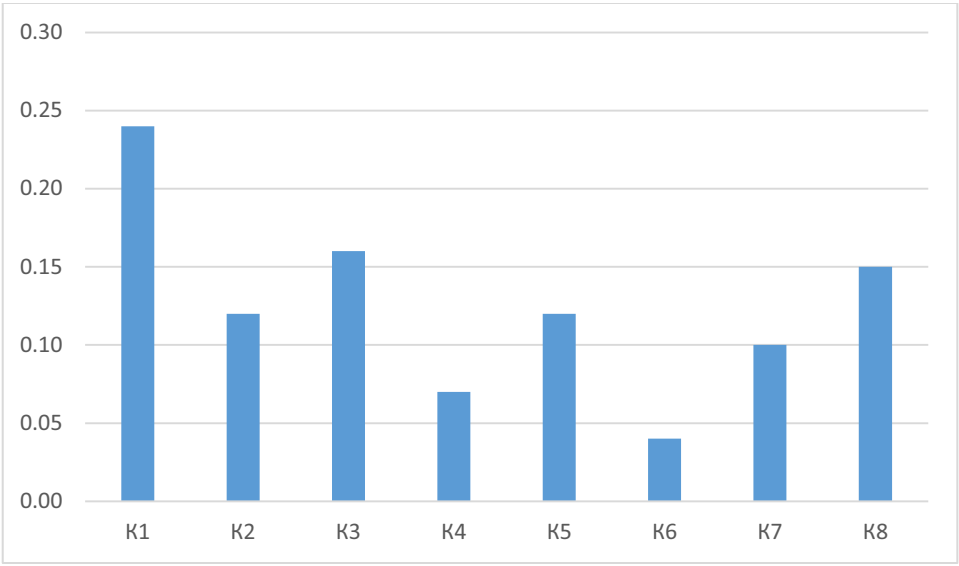

Fig. 8. Range of factors, influencing on feasibility: K1 – geometry of building; K2 – logistic of contract organization; K3 – organizational and technological parameters of work; K4 – spatial and time limits; K5 – climate conditions; K6 – supply conditions; K7 – type of facade system; K8 – finance supply.

In depending on power of influence of certain factors, can change organizational and technological parameters of works. Detailed analysis is necessary for making reasonable decisions.

Because unreasonable choice of organizational and technological parameters of works can lead to significant increase of cost, increase of duration and decrease of quality of works.

According to diagram on fig. 8 the highest influencing coefficients has following factors: geometrical characteristics of building, financial support of construction, organizational parameters of works.

To geometrical characteristics of building, influencing on technical and economical parameters related:

1. The height of building;
2. Complexity of facade, including presence of protruded elements, nonlinearity of facade.

Existing normative documents suggest work on facades from scaffoldings on height until 10 meters. Over 10 meters to labor input should be used next coefficients in depending on height: until 30 m – 1, 2; until 50 – 1,35; until 60 – 1,4; over 60 – 1,5.

According to graph on fig. 9 determined efficiency of using facade systems:

- for buildings with a height until 20 m – scaffoldings;
- with a height from 20 to 58 m – lifting platforms;
- with a height over 58 m – facade lifts.

5 Conclusions

1. Analysis of Russian and international experience with working on facades with irregular shapes showed that existing normative and technical documents does not fully disclose organizational and technological requirements for such works. Meanwhile, unreasonable choice of organizational and technological solutions can lead to significant decrease of feasibility index in works.
2. Defined, evaluated and ranked groups of factors, influencing on feasibility of works. Identification of rational area of organizational parameters concludes in reasonable choice of scaffolding, choice a number of workers and rational splitting to divisions. And also is essential to count indirect factors, which also can impact on organizational and technological parameters of works. They are cramped on construction side and climate conditions of region of construction.
3. In this article were given drawings of new achievable and helpful scaffoldings, which allows working on sloping facades.

References

1. http://dlib.rsl.ru/01005061649
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