Industrialization of Interior Finishing Works in High-Rise Construction

R T Avetisyan

1Moscow State University of Civil Engineering

E-mail: robert.avetisyan.98@mail.ru

Abstract. In the article below the research of process methods named at preparing living residences for painting has been carried out. The methodology taken to analyze various types of finishing works in question has been set out. The general analysis is shown here in identifying the effectiveness of industrial methods in plasteral works while dealing with mass high-rise construction.

1. Introduction

As of today, great attention is being paid to new technologies usage which led to greatly improving quality of construction works, rising payback rate and cutting down the manufacturing deadlines. Industrial construction with extended use of prefabricated structures to be released weigh heavily meaning high labour productivity as well as manufacturing quality. Increasing the shop-mount manufacturing of prefabricated constructions being ready to be timely released and transported to construction site in accordance with working project. Thus giving the chance of assembling any of construction elements directly from trucking systems to their specific locations in appliance with agreement. By organising works in the mentioned above way the building site turns out to be erection site. This leads to reducing construction period, farm labour input but increasing quality and efficiency of construction work. The sign of prefabricability of construction and its details is being one of the major factors of industrialization level.

Adhering the Construction Directives and Rules the assembly’s evidence of prefabricated structures is related between the cost of all structures and separate details to the total cost of building materials and all structural elements to accomplish building construction. The growing level of the building construction industrialisation is reached due to the growth of prefabricated reinforced concrete structures. The most essential and compulsory industrialisation condition is construction work mechanization and robotization of construction assembly work. The timely development of mechanization leads to exclusion of hand force while constructing the building elements. In high level of assembly line process and vehicle population, production-line system is of a particular importance meaning the downtime elimination but round-the-clock operation of construction and installation works as well as labour work load. Also use of technical and material assets in full extent will further lead to higher efficiency in building construction. Special preference to this technology and methods of work manufacturing are explained by the necessity of achieving global goals in the territory of the Russian Federation f.ex. standardization of construction and installation works while rebuilding operations, constructing high consequence and industrial facilities as well as in constricted process of heat, gas and water supply, hot works and wet processes, shop mounting. To date plastering work in high rise construction is the most energy consuming and expensive works, they also demand long task duration. 20-25% of work in high rise constructions are works of interior finishing the cost of which is 15-17% compo ratio to the cost of the building and the duration of
finishing works may reach to 50-60% of the turnaround time. High-rise construction in production-line system involving enlarged elements of the buildings may not successfully and efficiently be manufactured without full introduction of automatic machinery in plastering works.

2. Methods
Economic forces influencing the high rise building construction may be divided into 3 categories: architectural and space-planning design, construction solutions and methods of building. Set of plaster works considered in the article significantly influences technical and economic performance of the high-rise construction, therefore the most rational decision should be taken. That is the most challenging issue. The point of investigated issues in the article lies in the competent method of comparative risk evaluation of an organisation and process structuring in means of technical and economic performance. As the performance markers here are cost and labour input on site as well as cost of building shapes and the duration of the work on site.

The most progressive decision of the siding and walls are factory panels without any liquor. Thus on assembly platform the scope of work is minimal on gap filling and joint of facing the panels. This is merely 15% of total processing time to plaster walls and sidings with the cost of 28%. Total labor input using this method which includes factory supplied panels is 22%. Its successful implementation into high-rising construction practice demands special mechanical engineering to surface dressing of the panel material as well as additional usage of filing liquors in siding and face panels that comply with the criteria of heat retention lagging, toughness index, satisfy the requirements of varnish-and-paint finish.

The material in the panels may not satisfy the requirements of the varnish-and-paint finish (low density, excessive and uneven porosity etc.), but it must be ensured with textured liquor applied by the means of special mechanisms in course of its fabricating. The cost of the process increases in this case compared with the previous method from 28% to 67% almost 2.5 times. if while constructing the width of the structural panels is mashed (at the cost of heat retention lagging and sound proofing properties) for 1 sm by injecting 1.5 sm of textured liquor the total cost will change to 51% instead of 67%. Labour cost using this method of addtl filling of textured surface will be increased about 36% and be equal to 30% compo ratio monolithic walls and siding plastering.

Insufficient quantity of factory processed front parts of the panels and its mounting (abruptness, bugholes, cavities, prohibitive overweight of adjacent sides etc.) causes the necessity of additional processes execution before painting the panels on building sites.

In this case a few minor solid plaster works are due to take place on site, processing time here increases from 15% up to 34% solid float work without layers and up to 42% with one topping layer (compare to ordinary bonding of vertical surfaces), whereas the value raises from 28% up to 37% & 45%.

Sheeting appliance provides for reducing the costs from 14% up to 46% but leads to appreciation of value of on-the-site-works from 55 up to 132%. The basic reason for the cost raise in this progressive method is high sheeting price (90% of the total value of work). The best method to form walls and sidings by using concrete sealer with sheeting material on the fabricated base. Substandard production of general building works may lead to additional expenses to cover cost for levelling attachment which is drives up the process up to 27-34% and increases the costs to 6-14%. Timber frame usage with further nailed joint sheeting will cost 164% more than solid plaster works. This method is 271% more expensive than solid plaster work.

The most progressive method of finishing the sheeting perpends is void filter and its joints pointing by means of a putty knife and joint-free sheeting with plaster white coat.

Proper procedures in mechanical tooling of walls and siding by means of plaster liquors may be rated in high technical and economic performance indexes. Thus highly performed mechanic rendering saves 43% in labour cost expenditure and in value 9% (compared with handicraft technique).

Analyzing the structure of expenditures on manufacturing the vertical surfaces it can be said that in case of monolithic plastering the cost of materials is 72% if manual method is used and in mechanised method 77-80%; in case of sheeting siding the percent may vary from 75% to 90% if panels are prefabricated from 67 up to 78%.
The given above indexes indicate the main source of efficient work savings and that is cutting down the expenditures on materials and its substitution for cheaper ones. The effect is sooner achieved if siding or dividing material is already decorated. Thus giving less expenditures or even reduced to zero on surface treatment (factory processing of panels without textured surface liquor) or if they are in siding (frame loose-fill partitions, external walls with inner lining). If the expenses on cementing component for monolithic plastering are taken as 100%, the expenditure on fabricating the panel constructions is 18% if the are ready for painting and 42% if additional one finishing layer is needed.

Table 1

| Working up of the facilities | Methods of works                                                                 | Labour inputs in % | Total value % |
|------------------------------|---------------------------------------------------------------------------------|--------------------|---------------|
|                              |                                                                                | 1                  | 2             | 3          | 4          |
| Plastering works             | 1) Manual surface plastering, setting up frames after mounting walls, jamb walls from liquor, alignment and setting of window and door elements on the site and fixing moulded projecting course (drawn cornice). | 100                | 100           |            |            |
|                              | 2) The same is true of surface mechanical plastering                             |                    |                |            |            |
|                              | 3) As in practically planned mechanic plastering with filling holes with blocks and samples application for eaves moulding. | 81                 | 98            |            |            |
|                              |                                                                                | 62                 | 65            |            |            |
| Sheet finishing              | 1) Dressing the surfaces with sheeting where sheets are joint to timber-framing of feathers; set up door frames after walls being accomplished; set up sheeting slopes joining them with nails by rods; set up mouldings out of packaged gypsum blocks and make of joints with gypsum putty. | 196                | 211           | 162        |            |
|                              | 2) The same is true of sheets joining with maste with the help of guide strips and markers and filling the holes by blocks, finishing by sticking the slopes and pointing out the joint sheets. | 100                | 108           | 152        |            |
|                              | 3) the same method of direct sticking the sheets to the base and filling the holes with the blocks, then setting up by means of bending sheets and using gypsum mouldings. | 55                 | 62            | 188        |            |
| Prefabricated panels processing | 1) Partial after mounting processing of panels surfaces; filling and further processing of panel joints, setting of frames; fixing and hanging a md measuring of window and door frames, fixing moulding from gypsum blocks. | 67                 | 98            |            |            |
|                              | 2) Mechanical prefabricated processing of surface panels including textured liquor filling, filling and joint processing of the panels, setting of frames at the time of fabricating panels. Fixing window and door elements. | 26                 | 42            | 90         |            |
|                              | 3) Method with no textured liquor filling, no frames used but with siding and already fabricated moulding. | 23                 | 34            | 61         |            |

Nb: numerator shows on-site labour index whereas the denominator total labour intensity at production.

Concluding from the above:

1. The most rational method of processing interior all line of plastering works in high rising construction is manufactured mechanical processing of wall panels and sidings. Adhering to this,
compared to ordinary plastering, labour expenditures lowered down more than 4 times, the cost goes down 40% and astringent substances are spent 8 times less.

2. The progressive solution of these wet processes of interior plaster works is wide usage of sheeting materials. Rationally joint with mastic this way saves 45% of extra labour if compared to simple plastering; moreover, working period is reduced 1.5-2 times/ The sheeting finishing cost at present is more than plastering work 18-62% (depends on the sheeting joint method).

3. The most efficient way to reduce labour costs while processing interior plastering works is to transfer the separate processes in plant production as much as possible. For instance, manufacturing surface panels is ⅓ of all labour intensity (32-39%) and that is compared to monolithic plastering reducing total labor costs for 58-64%; and on building site labour cost may be even 74-77% less.

4. For successful and qualitative usage of industrial methods of interior finishing in high-rise construction there is a need to create digest-catalogues of architectural concepts of residence areas, rooms, offices, public spaces with sheet materials, fabricated architectural details and prefabricated finishing of the wall panels, sidings and layers. These proposals must be attached to the approved typical samples of mass housing construction.

5. Improvement in quality of construction and assembly works may provide for better quality of technical and economical performance in the processes of interior finishing of domestic premises.

6. Prime objectives of further rationalisation concluded from the article above are following:
   1. Elaboration of theoretical base in organisational and technological methods of processing the finishing works in high rise construction;
   2. Elaboration and production release of new types of moldings and semi manufactured goods;

As a conclusion it’s necessary to add that full transformation of finishing processes into manufactured conditions, as well as further improvement of mecanisation methods in terms of assembly of combining blocks of engineering and technical equipment in high-rise construction will lead to less cost and labour intensity and significantly speed up the time processing and quality of finishing works.

References
[1] Sychev S A 2016 Forecasting of innovative solutions and technologies of prefabrication construction Vestnik grazhdanskih inzherenov 1(54) pp 97-102
[2] Generalova E M, Galstian K E 2015 Analysis of the existing regulatory framework for high-rise construction in Russia Traditsii i innovatsii v stroitel'stve i arkhitekture. Arkhitektura i dizain: sbornik statei (Samara: SGASU) pp 52-55
[3] Oleinik P P, Brodskii V I 2015 Construction management as a type of works affecting safety of facilities Promyshlennoe i grazhdansko stroitel'stvo 7 pp 71-75
[4] Tuskina V M 2015 Prospects of construction of affordable and comfortable housing on the basis of steel frameworks Promyshlennoe i grazhdansko stroitel'stvo 6 pp 43-46
[5] Mushinskiy A N, Zimin S S 2015 Construction of Unique Buildings and Structures (Rus) 4(31) pp 182-193
[6] Boafo F E, Kim J H, Kim J T 2016 Performance of Modular Prefabricated Architecture: Case Study-Based Review and Future Pathways SUSTAINABILITY vol 8 6 558 DOI: 10.3390/su8060558
[7] Svajlenka J, Kozlovskva M, Spisakova M 2017 The benefits of modern method of construction based on wood in the context of sustainability International Journal of Environmental Science and Technology vol 14 8 pp 1591-1602 DOI: 10.1007/s13762-017-1282-6
[8] Olmati P, Sagaseta J, Cormie D, Jones AEK 2017 Simplified reliability analysis of punching in reinforced concrete flat slabbuildings under accidental actions Engineering Structures vol 130 pp 83-98 DOI: 10.1016/j.enstruct.2016.09.061
[9] Marjaba G E, Chidiac S E 2016 Sustainability and resiliency metrics for buildings - Critical review Building and Environment vol 101 pp 116-125 DOI: 10.1016/j.buildenv.2016.03.002
[10] Han Y J, Zhu W Z 2016 The Development of Modular Building in China 2016 International Conference on Applied Mechanics, Electronics and Mechatronics Engineering (AMEME) (Beijing, PEOPLES R CHINA) pp 204-207