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Quality consideration of building and renovation works while forensic structural inspections to determine the volume and cost of construction

Currently, forensic methods and regulations in the field of construction do not explain how quality of work affects the procedure of forensic examinations and research related to determining the work scope.

While carrying out building and renovation services, it is possible to control provided construction and renovation services, establish their physical volume and quality. While research, forensic expert can identify violations of building codes, as well as determine the cost of refurbishment or elimination of defects made providing services.

The scoop of performed works is determined by geometric parameters of construction elements, established during field surveys using design and as-built documentation.

While carrying out field surveys, it is necessary (along with the determination of service scope) to pay attention to the compliance of the work performed with the requirements of building codes.

The article outlines problematic issues and provides a list of basic indicators determining the scoop and quality of the construction works carried out, indicated in the reporting documentation drawn up by contractors based on results of activities in the field of construction. Actual issue arising in the establishment of the scoop and cost of construction work is considered that quality does not meet the requirements of regulatory documents in the field of construction.

It is explained how the quality of the work performed affects the results of research related to the determination of the actually completed volumes of repair, building and renovation and construction work.

Keywords: work quality, actually completed construction work, defects, working scope, engineering and technical staff.

Formulation of Research Problem. While forensic structural inspections, forensic experts often have to address issues related to determining quality of renovation works and further consideration (not taking into account) of these

service scoop and their cost while determining performed building services as of forensic research.

Quite often, forensic science institutions receive court applications and rulings when construction customers are faced with the problem of poor quality renovation (construction services), namely ordered services do not correspond to those actually performed or performed with defects. Usually builders do not admit their guilt, refuse to eliminate deficiencies or compensate for losses, citing the fact that service was provided in the amounts specified in the design and reporting documentation.

Analysis of Essential Researches and Publications. Well-known research papers: *Methods for establishing the actual volume and cost of provided building works on reporting documentation* (registration code 10.6.17) and *Methods for determining quality of building and installation works* (registration code 10.6.01) do not fully disclose the correlation between construction quality and renovation services and the scoop of services taken into account (in accordance with the relevant budget standards) in reporting documentation.

Currently, there are no explanations in forensic methods and normative documents in the field of construction as to how quality of services affects the procedure of forensic examinations and researches related to the scope determining of such works.

Article Purpose. Substantiation and systematization of theoretical knowledge on conducting forensic examinations related to determining actual scope of building and renovation works through analyzing regulations in the field of construction that regulating requirements for service quality.

The main purpose of this type of forensic structural inspections is to protect the property and non-property rights of the construction customer. While providing construction services of any scoop and scale, there is a risk that contractor services for certain reasons does not meet the requirements of construction standards, as well as technical contract conditions.

Main Content Presentation. Forensic structural engineering or forensic research on building and renovation works is carried out to resolve disputes that arise between customer and contractor or the service provider on the site.

If construction facility forensic structural inspection was not carried out immediately before commissioning construction facility it can cause some risks for the customer in the future (for example, a contractor can refuse to recognize violation of the order and quality of building works in case of problems with the construction facility arose during its direct operation by the customer). Therefore, the causes of these problems are treated in terms of violation of operating conditions. In this case, dispute between the customer and the contractor is already considered in court and this can require forensic structural inspections:

- pre-trial forensic structural inspections conducted by one of the parties to the dispute while preparation of arguments in their favor on the eve of hearing;

- forensic structural inspection carried out according to court decision.

Forensic examination allows you to control the repair services, determine the scope and quality of performed works. While research, forensic expert can identify violations of building codes, as well as determine the cost of repairs or elimination of defects committed while service providing.

Checking the scope helps to identify the following violations:

- overstated reports on service scope;
- registration of fictitious works;
- replacement of materials with cheaper ones;
- reducing service quality (for example, applying one coat of paint instead of two provided by the documents);
- overestimation of the number of materials, components (doors, sinks, electrical or piping fittings, etc.);
- incompleteness of construction facilities, separate stages of works.

The main purpose of construction scope inspection is to check the scope and cost of paid or presented for works on fully completed and commissioned facilities.

In addition, control over:

- compliance of the object with its characteristics and purpose, provided by the approved design and estimate documentation;
- completeness of provided services adopted under acceptance certificate;
- operational readiness of commissioned facility.

The purpose of measuring works is to clarify actual geometric parameters of building structures and their elements, determine their compliance with the project or deviations from. Instrumental measurements specify the spans of structures, their location and step in the project, size of the cross sections, height of the premises, marks of the characteristic nodes, distance between the nodes, etc. According to the results of measurements, projects are made with the actual location of structures, sections of buildings, drawings of working sections of load-bearing structures and joints of structures and their elements.

Calculation of service scoop is carried out on the basis of completed structural elements and work types. The sequence of calculations should be such their preliminary results can be used for further calculations. It is recommended to calculate the service scoop in the following sequence: holes in the outer walls (windows, doors, gates); internal openings (doors, gates, transoms); foundations; earthworks; frame; walls; partitions; floors; overlapping; coating; roofing; stairs; porch; external equipment; interior decoration; other works.

For substantiating the scope and composition of performed work, acceptance certificates and concealed works acceptance certificate are used. In default of such acts, service scoop can be calculated from the working drawings. If it is impossible to determine the work scope during control measurement, these works are not taken into account. If necessary, forensic expert has the right to request disclosure of such works.

If there are no acceptance certificates, forensic expert carries out control measurements of performed works in kind, compares obtained results with the approved design documentation.

Calculation of performed work is carried out on the actual plane (volume, length) of the element under research.

Many technical indicators of the quality of repair work are included in state construction standards, technical conditions, etc.

The repair quality depends not only on performance indicators but on appearance of the completed facility object or its element (part).

Construction quality is a set of product properties that meet certain requirements in accordance with its purpose. Construction quality is determined by assessing overall architectural and artistic solutions, the technical level of design solutions, design and technological parameters, as well as quality of construction products, semi-finished products and materials.

Product quality indicator is a quantitative characteristic of one or more product properties considered in accordance with certain conditions of its manufacture and operation or use.

The reasons for quality inconsistency of provided services with requirements of building codes and standards is great number, namely: contractor's desire to speed up work by simplifying some construction procedures, contractor's ignorance, use of unskilled builders or poor quality building materials, theft of building materials. One point is clear, regardless of the reason for the contractor's negligent attitude to his work, only customer suffers.

Execution quality depends on established technology and quality control. Quality control is carried out by engineering and technical outsourcing staff (internal control) and the customer, author's supervision and bodies of the State Construction Inspectorate (external control). Engineering and technical outsourcing staff is obliged to systematically monitor compliance with project requirements, building code while construction and installation work. Components of such control are input operating and receiving. The results of all these types of control should be recorded in the registers that daily record the basic data on performed work, materials used and other important points which service quality depends on.

While determining quality level, relative characteristics of the quality of works or products are compared with corresponding basic indicators. Indicators reducing quality of construction products include:

- appearance deterioration of products leading to the need to perform additional work to improve their quality;
- reducing strength and stability of individual structures, products and buildings in general;
- reduction of operational qualities of buildings.

Quality management is systematic control and influence on conditions that should ensure quality. Quality management includes: accounting for possible sources

of defects; identifying ways to prevent them and the factors that affect quality. Impact of quality management can be organizational, sociological, technological, aimed at improving or maintaining a certain high level of product quality. Influence of management can extend to increasing the number of products which will already be managing not only quality but quantity of manufactured products.

Estimates, terms of reference, and other supporting documentation related to construction work often include the terms: *improved* or *high-quality* finishing.

According to building code it is established to distinguish three species (classes) of furnishing: simple, improved and high-quality. Each type of decoration implies compliance regulations determining maximum possible deviations from the design values or conditions adopted for relations between the parties by default.

According to building code, works are classified in accordance with certain types of works, include: plaster, painting with the use of oil, casein, glue and emulsion mixtures.

For example, a simple plaster is applied in one layer with or without grinding. Grinding is performed without applying an additional layer of fresh solution with polyurethane or foam graters without any spraying and lids. The cover layer is necessary for grinding, therefore for it use fine-grained or sifted mix. Apply the cover after leveling the soil and grind fresh or after drying (10—60 minutes). Layer thickness: up to 3 mm ¹.

Improved plaster is applied in three layers: spraying, priming, cover. The improved plastering is put manually or in the mechanized way, and level as a rule horizontally and vertically. Maximum clearance while checking accuracy of the 2-meter rule is 2.5 mm, for the entire height of the wall is 5 mm.

The main difference between high-quality plaster and improved one is work accuracy. The number and thickness of the layers are the same, except that total thickness of the tent is allowed to increase by 5 mm. Permissible deviation of 2 mm per 2 m of height/wall length or 3 mm for the entire height. These are limit values, in modern construction deviations are within 1 mm.

While painting of plastered walls with water mixes (performance of painting works) corresponding class of furnishing provides surface preparation, simple painting, namely: surface cleaning, its priming, filling of cracks and sinks, dedusting and directly painting; improved painting in addition to the provided service for simple painting, partial lubrication of irregularities twice, grinding of such places by the number of layers, priming of each lubrication layer, the second priming of all surface; high-quality painting, in addition to provided services for improved painting, continuous filling in twice with grinding of each layer and additional (third) continuous priming.

¹ ДСТУ-Н Б А.3.1-23:2013. Настанова щодо проведення робіт з улаштування ізоляційних, оздоблювальних, захисних покриттів стін, підлог і покрівель будівель і споруд (СНІП 3.04.01-87, MOD) : затв. наказом Мінрегіонбуду України від 18.07.2012 р. № 326. [Чинний від 01.01.2014]. Вид. офіц. Київ, 2013. 39 р.

In other words, while conducting field surveys of performed works, related to determining the actual service scoop, it is necessary to pay attention to how the work is done: whether it can be considered a certain species (class) of work (*simple, improved, high quality*) works on plastering or painting of surfaces, arrangement of coverings of floors, roofs, etc.

Availability of deviations of the plane from the horizontal and vertical, the number and size of irregularities on the surfaces while plastering, plastering work affect the affiliation of the work to one of three types (classes) of finishing: *simple, improved, high quality*.

State construction standards provide for relevant requirements for other works.

Thus, high requirements concerning durability, aesthetics and observance of sanitary and hygienic norms and quality are put forward to works on floor arrangement. Clearances between the control two-meter rail and the floor surface to be inspected shall not exceed 4 mm.

In case of performance of facing works by ceramic, glass-ceramic and other similar tiles, the surface should have a deviation from a vertical no more than 2 mm on 1 m. The deviation of an arrangement of seams from a vertical and horizontal (on 1 m of length) in facing 2 mm is provided.

Deviation of the plane of all field of a surface of false ceilings on a diagonal, vertical and horizontal (from design) is allowed 1,5 mm on 1 m.

Roof coverings should meet the following requirements: have sufficient water resistance; provide uniform normalized temperature and humidity of air in rooms; prevent condensation formation on the ceilings and in the thickness of the structure; to accept without destruction the normalized load; meet requirements of building codes for quality.

Arranging a roll roof, the panels should be glued in the direction of:

- from the lowered sites to the raised with an arrangement of cloths on length perpendicularly to a water drain at slopes of roofs to 15 %;
- Runoff for roof slopes over 15 %.

The panels should be laid overlapping by 100 mm (70 mm across the width of the panels of the lower layers of the roof with a slope of more than 1.5%).

While inspecting the filling of window and door openings of external walls, it is necessary to pay attention to quality of nodes adjacent to the walls.

While design and implementation of adjacent nodes should comply with requirements of regulations approved in the prescribed manner.

The design of connection units and technology of installation of window or door blocks must meet the requirements of the project and ДСТУ-Н Б В.2.6-146:2010¹.

¹ ДСТУ-Н Б В.2.6-146:2010. Конструкції будинків і споруд. Настанова щодо проектування і улаштування вікон та дверей : затв. наказом Мінрегіонбуду України від 15.11.2010 № 444. [Чинний від 15.11.2010]. Вид. офіц. Київ, 2010. 68 р.

While arranging adjacent nodes, it is necessary to comply with the following conditions:

- closing of assembly cracks between products and jambs of apertures of wall designs should be dense, tight, calculated on endurance of climatic loadings outside and conditions of operation indoors;
- construction of adjacent units (including the location of the window unit by the slot depth) shall prevent occurrence of cold bridges, that cause condensate formation on the inner surfaces of window openings;
- operational characteristics of structures of junctions and applied materials (heat and sound insulation, vapor and air permeability) should meet requirements stipulated by current regulations;
- sealing of seams from premises should be more dense than from outside;
- while choosing the filling of mounting slots, it is necessary to take into account the operational temperature changes of the overall dimensions of the products;
- polymer composites used for installation work should obtain a hygienic conclusion of the health authorities about possibility of their use in construction.

Building elements where it is necessary to carry out quality control:

- alignment of ceilings and walls;
- installation of different sizes and contents of window and door structures;
- arrangement of a floor covering;
- installation of such communications as: ventilation, electricity, heating, water supply, etc.

Forensic expert controls whether all communications have been concluded in accordance with the project documentation and whether actually performed works correspond to the design and estimate and reporting documentation.

While inspection of the water supply system, forensic expert pays attention to reliability of the used fasteners, as well as to tightness of the connecting system. Existence of even the slightest leak can later lead to the breakdown of the tap and flooding of the entire room.

While leveling walls or ceilings, it is necessary to use specific tools that will help to identify any existing shortcomings. Upon completion, forensic expert checks the smoothness of the walls and ceilings.

All violations are detected during the works, controlling compliance of construction services with regulations and instructions.

It is possible to control quality of planes by means of spirit level, a plummet and goniometer.

Deviation from the above requirements while operation of building (premises) can cause a decrease in thermophysical and insulating properties of enclosing structures.

Therefore, before calculating the scope of work, it is necessary to understand in detail the drawings, clarify correlation between individual parts of working

drawings, clearly present those works that are not depicted in the drawings (exterior and interior, partition material, floors, etc.), study textual material of the project, get acquainted with drawings of standard knots and details with catalogs of the products which have found application in this project, requirements of the state building code and standards regulating quality of works.

Thus, for example, in case of availability of estimated norms in acceptance certificates from high-quality plastering by a solution of walls, the result should to meet requirements stipulated by building standards for these works.

In other words, service quality should meet the parameters specified in the building codes and the estimated standards stated in reporting documentation.

Therefore, while forensic examinations and researches to determine compliance of actually performed works with reporting documentation, works that have deviations from the state building codes and standards cannot be accepted as performed one and need to be finalized (according to requirements of the mentioned standards) as for quality of provided service within the measures to eliminate recorded defects.

Conclusions. The given theoretical and practical aspects of forensic examinations, related to the determination of actual scoop and quality of building and renovation works can be used in forensic practice to optimize forensic research.

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Урахування якості ремонтно-будівельних робіт під час проведення судових будівельно-технічних експертиз із визначення обсягів і вартості будівництва

Станом на сьогодні в експертних методиках і нормативних документах у галузі будівництва відсутні роз'яснення щодо того, як саме якість робіт впливає на порядок проведення експертиз та експертних досліджень, пов'язаних із визначенням обсягів таких робіт.

Будівельно-технічна експертиза дає змогу проконтролювати проведені ремонтні роботи, визначити обсяги та якість виконаних робіт. У процесі дослідження експерт може виявити порушення будівельних норм, а також визначити вартість відновлювального ремонту або усунення дефектів, яких будівельники чи ремонтники припустилися під час виконання робіт.

Обсяги виконаних робіт обраховують за геометричними параметрами елементів будівництва, які визначають за допомогою натурних обстежень із використанням проєктної та виконавчої документації.

Під час проведення натурних обстежень необхідно (паралельно з визначенням обсягів робіт) звертати увагу на відповідність виконаних робіт вимогам будівельних норм за якістю.

Окреслено проблемні питання та наведено перелік базових показників, за якими потрібно визначати обсяги та якість проведених будівельних робіт у звітній документації, складеній підрядниками за результатами діяльності в галузі будівництва. Також розглянуто актуальну проблему, яка виникає під час визначення обсягів і вартості будівельних робіт, що за якістю не відповідають вимогам нормативних документів у галузі будівництва.

Роз'яснено, як впливає якість проведених робіт на результати досліджень, пов'язаних із визначенням фактично виконаних обсягів ремонтно-будівельних і будівельних робіт.

Наведені авторами теоретичні та практичні аспекти проведення судових експертиз, пов'язані з визначенням фактично виконаних обсягів та якості ремонтно-будівельних і будівельних робіт, можна застосувати в експертній практиці для оптимізації експертного дослідження.

Ключові слова: якість робіт, фактично виконані будівельні роботи, дефект, обсяг робіт, інженерно-технічний персонал.

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**Учёт качества ремонтно-строительных работ
при проведении судебных строительно-технических экспертиз
по установлению объёмов и стоимости строительства**

В настоящее время в экспертных методиках и нормативных документах в сфере строительства отсутствуют разъяснения относительно того, каким образом качество проведённых работ влияет на порядок проведения экспертиз и экспертных исследований, связанных с определением объёмов работ.

При проведении строительно-технической экспертизы имеется возможность проконтролировать выполненные ремонтные и строительные работы, установить их физические объёмы и качество. В процессе исследования эксперт может выявить нарушения строительных норм, а также определить стоимость восстановительного ремонта или устранения дефектов, допущенных при проведении работ.

Объёмы выполненных работ определяют по геометрическим параметрам элементов строительства, устанавливаемым при осуществлении натурных обследований с использованием проектной и исполнительной документации.

При проведении натурных обследований, необходимо (наряду с определением объёмов работ) обращать внимание на соответствие выполненных работ требованиям строительных норм по качеству.

В статье изложены проблемные вопросы и приведён перечень базовых показателей, по которым определяют объёмы и качество проведённых строительных работ, указываемые в отчётной документации, составленной подрядчиками по результатам деятельности в области строительства. Также рассмотрена актуальная проблема, возникающая при установлении объёмов и стоимости строительных работ, по качеству не соответствующих требованиям нормативных документов в сфере строительства.

Разъяснено, как влияет качество проведённых работ на результаты исследований, связанных с определением фактически выполненных объёмов ремонтно-строительных и строительных работ.

Ключевые слова: *качество работ, фактически выполненные строительные работы, дефекты, объёмы работ, инженерно-технический персонал.*

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Contributors

The authors contributed solely to the intellectual discussion underlying this paper, case-law exploration, writing and editing, and accept responsibility for the content and interpretation.