Introduction of new technology of fixing traditional colors in the Smolensk architecture (Russia)

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The author presents characterization of the basic ways how to fix colors of architectonic monuments. The author discusses principles of working out a chromatic card of traditional architecture colors in a historical city. Chromatic peculiarities analysis of an external architecture decor of Smolensk (Russia) built between 12th and 20th centuries is presented. The author concludes by suggesting the realization plan discussing financial and economic substantiation for the introduction of new technology of fixing colors of architectural city objects.

Keywords: Architecture, color, colorization, tradition, color fixing, color reconstruction.

Introduction

One of the major stages of modern colorization of the city creation is to study cultural and historical traditions of color use in a given district or region. Each historical city has its own unique color characteristics. Color palette changed under the influence of social, economic and cultural-aesthetic factors. However, nowadays the analysis of historical palettes of Russian cities architecture has a descriptive character and it appears extremely difficult to define color properties in its verbal designation. In the following text is presented the actual development and introduction of the systematized and reliable way of fixing traditional colors of city architecture.

Color fixing architecture monuments

Color fixing architectural monuments plays an important role in the course of their preservation. This problem has been studied previously - for example in the papers of Efimov (1990), Griber (2008), Hawel (2002), Lenclos (2003), Noury L. (2008) or Servantie (2007). Each object in each building period possesses some unity of the color architectural decision. Time always brings some changes to a monument, and due to its historical development original shape appears then to be irrevocably lost.

That is why the definition of initial color ensemble, and also color stratifications of the subsequent building periods is a problem of extreme importance. Only the given fixing will allow to judge later what was a construction before like and accordingly and what was removed or added during a restoration. Monument fixing also allows to present the documentary bases for the restoration project without which its scientific approbation and the statement is impossible. Finally it is necessary to underline that the process of fixing never represents a purely technical procedure, and becomes the integral and important part of monument study.

In defining colors of various forms, the initial color layer has significant role since it is bears chronological connection with the form. The pigments, resistible to aggressive environments, were not applied always and they are often subject to decomposition caused by light or active chemical compounds contained in the air. It is accepted to fix also the subsequent color layers, since they allow tracking color treatment of forms of each art epoch visually during long time. For this reason, the big role in color fixing is played by historical-bibliographic and historical-archival research and other iconographic sources.

Color fixing of architecture monuments is usually produced by verbal descriptions; building images in the whole, its parts and fragments in drawings and water colors; removals of outlines and stumpages from separate elements and details, also by artistic and detailed documentary photographing.

A special role in color fixing is played by drawing which helps to convey the general shape of a
construction. In order to present color relations of separate parts of an object and colorization of its furnish as an addition to drawing the water color and other kinds of painting. The truthful transfer of a local color is important here. Color effects created by changing illumination should be considered. Documentary water colors are mainly used for orthogonal images, especially for interiors. Thus are not limited to the coloring of the necessary parts of the drawing or drawing, but constitute cooler color selection, in comparison to the represented coloring and the original. Cooler color scheme depending on the original invoice becomes a water color, distemper or oil.

Digital codes became one of modern ways of color fixing. The practice of color schemes creation and color fans for fixing traditional colors of various districts is extensive enough by geography. Such experience is in Portugal, France, India, and Norway. In Portugal with support of the government the color scheme, based on traditional colors, which were used in historical city districts when buildings in a city were painted with chalk, is developed for one of areas of Lisbon Largo do Chafariz do Dentro. Similar researches have been held by F. and M. Kle for new cities of East Lille, L. Sivik (1989) -for Stockholm and the Goteborg. In Russia, color palettes of Moscow and St.-Petersburg are developed with application to international color system Natural Color System (NCS) and used within the limits of long-term programs on colorization of the cities.

**Figure 1. Fixing types: on the left above - crocks, on the right above - drawing, on the left below - photo, on the right below - measured technical drawing**

The NCS system of colors developed in 1979 allows to unequivocally specify colors and shades. The basis of NCS is made by six “pure” base colors: white (W), black (S), yellow (Y), red (R), blue (B) and green (G). The NCS system gives the opportunity to present the fixed colors in the form of three-dimensional model (in color space), in a horizontal projection (on a color circle) and in a vertical projection (on a color triangle).

The color space is three-dimensional model of color fixing. For easier perception the Color space shares on two two-dimensional models: a color circle and a color triangle. The color circle represents a horizontal cut in the middle of the color space where four chromatic base colors are located on a circle in the form of a compass. Every quadrant between two base colors is divided into 100 identical grades. The triangle represents a vertical cut of color space. At the base of a
triangle lies the grey scale from white (W) to black (S), at the top of the triangle there is a shade in the maximum concentration of color in any color triangle given have an identical shade, but differ on tone, i.e. on degree of prevalence black or concentration of a chromatic color.

Figure 1. Fixing types: on the left above - corks, on the right above - drawing, on the left below - photo, on the right below - measured technical drawing

Thus, the order of colors used in NCS, is based on affinity of the set shade to six base colors. For example, in allocated on the Figure 2 a color shade 1050-Y90R is characteristic for many historical Russian cities, the code number 1050 designates nuance (10 specifies in the relation to black color, and 50 - that the color concentration is equal 50%), alphanumeric combination Y90R designates a shade, which consists of base colors yellow and red with 90% prevalence of red.

**Colorization of Smolensk**

Smolensk, a city built on coast of Dnepr in 863, became object of research. The intensification of building which is characteristic for the majority of the Russian cities today, involves consolidation of their central part, including historical. It allows to speak about the necessity of forming a new view on the architectural objects, based on an individual approach to design. In this case creation of the non-standard decision is based on application of variety of composite principles and receptions, including use of a rich color palette. Almost in all cases, color use is not proved to lead to the separation of color relations at the organisation of the city environment. Owing to this, color pictures of cities cardinaly change. In connection with peculiarities of modern architecture the problem of creation of a harmonious color picture of a city became actual. The existing today’s situation of coloristic chaos can be corrected, having studied historical and modern features of the color environment of Smolensk after having created a technique of fixing city color features.

The thesis that each city has a special color phonation makes a research starting point. Each city, as well as a person, is an individual and has distinctive features. The individuality of a city is shown in its stories, which is reflected in architecture. Each city has a unique image, which arises not only thanks to a social infrastructure and features of a landscape, but also architecture, both historical, and modern. Color plays an important role in creation of a city image. It bears powerful emotional effect at perception of the architectural form, but cannot influence without other art means of expression and properties of forms. Besides, properties of the form and space formation of a city color picture develops on the basis of external factors: a natural environment, color culture, technology.

During direct field works on gathering samples of color, photos and descriptions colorization of separate quarters and all city as a whole has been established. Not only the general, characteristic for colorization tendency cities, but also color deviations were analyzed. Results of field research of Smolensk color image have been added by the data of polls which have provided the idea how inhabitants perceive color of the native city.

According to studied archival and iconographical materials, ancient Smolensk was a wooden city. Its color image was created by soft auburn and grey-silvery tones of various local tree species. As a material for building were used coniferous breeds (pine, fur-tree), and also elm, aspen, oak. Till the 18th century the shape of Smolensk was formed by rather poor in color constructions. Stone temples towered over a wooden housing estate and had white, slightly pinkish general coloring.
Color of a brick (painting under brick or of the brick itself) underlined decorative elements. Harmony of white semitones was not broken by lead silvery coverings of roofs.

On a boundary of the 18-19th centuries basically that part of a city which for today is central was formed. Merchant houses and manors in classical style were under construction this time. These constructions have brought in a city new color tone: yellow, yellow-orange, white.

The last third of the 19th century is the beginning of the 20th centuries is characterized by variety of the objects created in different styles. For the beginning of this period domination of eclecticism in which were used yellow, light orange, pink, yellow-orange, red-orange colors is characteristic. The last decade of the 19th century is a hobby time and domestic folk art: national folklore, a wooden carving, ornaments in “Russian style”.

In the middle of the period, buildings in a modernist style were under construction. They were erected mainly from a brick and a tree, and some had grey, grey-violet and blue shades in coloring.

Color schemes have fixed changes of color depending on illumination and atmospheric conditions mainly in cloudy weather.

In the beginning of the 20th century the style varies: decorative “eclectic” facades and picturesque forms of a modernist style give way to simplicity of new style of the Soviet epoch - to constructivism. In this period forms of constructivism which has a grey palette are imposed on facades of many reconstructed buildings.

The following period (the 30s of the 20th century - the first half of the 50s of the 20th century) is characterized by constructions in style of neoclassics, or “a Stalin empire style”. In the coloring of the buildings of this period mainly grey, yellow, yellow-orange shades were used.

Between of 1960s and 1980s was the time of an exclusive state building complex. Mass industrial construction was conducted. The architecture of new areas is characterized by monotony, dullness and imperfection of construction.

As to the present stage in its limits it is possible to allocate three tendencies of development of a city architecture as a whole:

1. The first is the development of suburban territories and building of new areas at which designing various shades and color gamut of the objects which are settling down in it are applied;
2. The second replacement of low constructions by high-rise objects. Prompt growth of a city generates such problem as interactions disharmony of architectural objects among themselves within the limits of city space at level of color characteristics;
3. The third - by working out of a color score of facades of modern constructions use of finishing materials of white, dark blue and beige color, and also glass-setting - dark blue, blue and brown shades.

It is noticed also that there is a general principle of color usage depending on appointment of constructions. Historically in coloring of residential buildings of a city yellow, ochre-yellow, pinkish colors prevailed basically. Public buildings, usually offices, were traditionally painted in dark grey and light grey colors.

On the basis of the analysis of the description of architectural objects and building materials applied to in archival sources, periodicals, the literature of regional studies, works of art, and also by means of a sounding of a paint layer color of architectural objects is defined on samples and fixed by the ten-character code number describing a shade of color (namely: quantity black and chromaticity) and its tone. At making up schemes for the first time for the analysis of historical colors of Smolensk is used the Natural Color System (NCS) as a standardized color system. NCS is successfully applied to a designation of colors of facades of buildings in Moscow and St.-Petersburg as previously mentioned. Color schemes of architecture of Smolensk of the period of the Middle Ages (12-17th centuries), pre-revolutionary (18-19th centuries) and the Soviet period (20th century) are developed. The allocated colors are presented in a horizontal projection (on a color circle) and in a vertical projection (on a color triangle) separately for three periods.

The result of realization of the project is the “Smolensk color palette” catalogue fixing 100 basic traditional colors of Smolensk architecture. The catalogue represents a way to keep colorful gamut of historical city districts and affinity of today’s colors to traditional, to provide uniform system of coloring of all buildings and constructions of a city and can be included in the long-term program on colorization of the cities.
The financial and economic substantiation of new technology for fixing traditional colors

On the whole, the plan of introduction of new technology of fixing traditional colors of a historical city includes seven stages.

1. The first stage: Designing of new technology of fixing traditional colors of Smolensk architecture. Within the limits of the given stage there is a distinction of the periods of a development of the city, definition of the factors influencing formation of a color picture of a city. It is necessary to define color of architectural city objects. Therefore, we have to use a biographic method which represents reconstruction of its color shape at various stages of development. To do that we would need to follow the previous research of regional studies, to study periodicals, references, archival materials (studying of documentary certificates on coloring, descriptions of the architectural constructions which have remained of architectural projects), picturesque and graphic products, photos, cards with views of Smolensk.

Then it would be necessary to use also sociological methods of document analysis, using both traditionally accepted ways of documents analysis, and formalized mathematic content-analysis procedures. Practical methods of research - a reasoning of a paint layer of architectural constructions by city restoration workshops, carrying out of natural inspection and photo fixing are also possible.

The selection of optimum system of code fixing of color becomes the result. The result is represented in the form of complex of tables and schemes which characterize naturally-climatic features in a city, the materials used throughout development of architecture, and components of color culture.

2. The second stage: Working out. At the given stage collecting the visual and graphic information on the investigated environment is carried out. This stage includes several consecutive steps.

The first step - research. Characteristic features definition for a color picture of architectural elements of a city - carrying out natural inspection and photo-fixing. Graphic construction of development of streets, namely, drawing of facades of architectural objects, display of their basic elements and details. Drawing up of a table “Color characteristics of street” in which the basic elements of a facade reflecting character of a color score of objects are allocated. Color of a plane of a facade, a roof, glass-setting, entrance group and decorative details: a frame of windows, columns, eaves, drainpipes. Color correlations of elements are defined according to a percentage parity with a total area of an element within the limits of a facade. In a case when the historical object “accumulates” on modern, the analysis of elements occurs by levels. The result is graphic development and tables.

The second step is grapho-analytical. Construction of diagrams and schemes which illustrate color characteristics of development of historical and modern parts of city streets. In a basis of construction of diagrams the percentage parity of color filling of architectural objects lays down. Sectors represent graphic display of architectural objects of development of city street and are an indicator of the area of color filling of a facade of architectural object.

Color combinations are shown in comparison of sectors colors of the diagramme, in revealing of their contrast on various qualities. Not only one color, but namely color combinations of which the surrounding coloristic reality finally is formed are under discussion. The scheme of dominating colors of Smolensk where on a horizontal axis colors settle down, and on vertical - a percentage parity of colors becomes result of this stage. The scheme allows to compare indicators and to reveal dominating shades.

3. The third stage: Introduction. Staff training on using the given system is carried out. The result is represented in the form of the report of participants added with the data of sociological interrogation and supervision.

4. The fourth stage: Completion. Taking into account results of the previous stage there is a technology completion. Result - an electronic palette of traditional colors of Smolensk architecture - the visual scheme which is displaying coloristic features of architecture at all stages of a development of the city and providing guidance on to a color picture for today.

5. The fifth stage: Test operation. At the given stage system operation in “real time” is made. The result is represented in the form of the report of participants while adding data from sociological interrogation and supervision.

6. The sixth stage: Completion. Taking into consideration results of the previous stage there is a definitive completion of technology.
7. The seventh stage: Working operation.

The Financial and economic substantiation of the project has shown that the residential buildings which have served 50-100 years and more, make a considerable part of available housing of Smolensk. Many of them represent capital multi-storey constructions, suitable on a technical condition for further operation while being subject to mass reconstruction and repair.

The reconstruction purpose is to increase or change of functional, constructive and aesthetic properties of buildings. At housing estate reconstruction social and town-planning problems, and also economic and technical efficiency of its realization are comprehensively considered. Town-planning problems span from reconstruction of many city buildings, through improvement of the city environment, increase of architecturally-spatial qualities of building, perfection of a network of the main streets, the areas, transport and pavements to streamlining systems of the engineering and technical management (or municipal services).

Monument repair means periodical maintenance work, carried out by usual building methods. Thus, as a rule, the basic structure of a monument is mentioned in the minimum degree. The main kinds of repair work - change and coloring of roofs, completion of losses of plaster and walls painting renewal.

Special focus must be paid to the maintenance of monument original color safety and its elements even if it leads to known increase in price and delays due to higher workload.

By manual finishing, painting works in particular, the great attention is given to preservation steam-proofness of walls owing to what the oil paint and other covering form a dense film are strictly limited, and the preference is given to limy, glutinous and si-organic colorful coverings.

At the same time, increased requirements are shown also to indicators of durability of restoration materials.

Economic efficiency of card application of historical colors is defined under the formula (1):

\[ E = (E_e - E_v) \cdot V, \]  

(1)

Where, \( E_e \) - Expenses for total of repeated colorings for 25 years of operation at exact reproduction of a color code; \( E_v \) - Expenses for total of repeated colorings for 25 years of operation at visual reproduction of color of a surface; \( V \) - Volume of an offered variant introduction.

The following requirements were considered during the calculation process: Building norms and rules 3.04.01-87 “Isolating and finishing coverings”; Collection of the state element budget norms 2001; The Instruction on technology of coloring of interiors and facades of under construction and reconstructed inhabited and public buildings (VSN 45-96); “Technical recommendations about preparation of external protecting designs of inhabited and public buildings under furnish at their reconstruction and repair” (TR 79-98).

Service life of buildings (constructions) is accepted for 25 years recognizing that with possible essential change of technology of the basic manufacture, the pulling down of a building or its serious reconstruction is possible.

Quantity of layers in a covering and its thickness were determined according to the State element budget norms on repair-civil works (GESN No.62, Painting works). Service life of compared coverings is accepted on the basis of Building norms and rules of 3.04.01-87 “Isolating and finishing coverings”.

Expenses on initial and repeated colorings were defined by GESN tables: table 62-19 “Coloring the earlier painted facades using limy structures” (column 62-19-1), table 62-21 “Oil coloring of earlier painted facades” (column 62-22-7), table 62-26 “Coloring paintings on the prepared surface of facades” (column 62-26-10). A measuring unit used in each case was 100m² painted surface.

Calculations show that application of the uniform catalogue of historical architecture colors of Smolensk appears reasonable. Such approach provides possibility for exact reproduction of a color code and, therefore, the material will resist better to climate influence and keep its chromatic properties quite longer.

The approached calculation of economic efficiency in introduction the new technology of fixing color at coloring of the inhabited four-storeyed three-access house (a total area 1229 m²; the floor space 2200 m², without apertures with corners 2 596 m²) using vinyl-chloride brings \( E = (1792.98 -1344.74) \times 2596 = 1 163 631.04 \) Roubles.
Conclusion

Thus, economic benefit of the project is expressed in decrease in expenses for inexpedient repainting of architectural objects through saving money on repeated repaints paying the painters.

The Financial and economic substantiation of the project using software product Project Expert 6.1 has shown that at prospective duration of the investment project 2.5 years or 30 months, that a static time of recovery of outlay will make 16 months, the discounted period will be equal to 17 months at the rate of discounting of 12.5%, inflation of 12% and the rate of refinancing of 11%.

Economic efficiency of the project is characterized by presence of the net income and value of internal norm of profitability above the set rate of discounting that characterizes a stock of financial durability of the project.

The new traditional colors fixing technology used for Smolensk architecture is supposed to be applied in architectural bureaus of Smolensk and the Smolensk region in respect to the original renovated color or according to neighboring buildings located in the historical centre and new city districts. The catalogue of colors “Smolensk color palette” will be used by architects and builders in the sphere of monument protection and their sanitation, at registration of building passports, and also domestic and foreign manufacturers of paint and varnish materials. The design documentation is prepared, reception of the license for a chromatic card of traditional colors of Smolensk architecture is supposed.

References