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VADYM ABYZOV*

The role of construction materials in modern landscape design

Abstract
The article deals with the peculiarities of application, along with traditional, new building materials and products in the landscape design of the urban environment. The techniques and perspectives of their use in contemporary landscape design and compositions are highlighted and examples are given.

Keywords: landscape design, traditional and new building materials and products

1. Introduction

The main means of creation of landscape compositions is the harmonious combination of hydrographic, relief, plant and other natural and artificial elements, such as geoplastic, water devices, decorative coatings, small architectural forms and other elements of landscaping and arrangement of territories. The combination of natural and artificial components of the environment, in accordance with a certain artistic design into a holistic spatial composition, is a major task in the formation of objects of landscape design. Their aesthetic quality and efficiency of improving the urban environment largely depends on the material and technical means of its implementation, among which a significant role belongs to construction products and materials.

Problems of landscape design of the urban environment were covered in many scientific works and are in close connection with the general scientific programs and processes, which are united by the concepts of "Sustainable Development" [1–5]. Aspects of the implementation of the urban environment in the system of material entities and the introduction of architecture and design of modern building materials in recent years paid more and more attention by various authors, mostly material scientists [6–13]. At the same time, the problems of the effective use of certain building materials in the design of the architectural environment were not considered comprehensively.

The purpose of this article is to highlight the peculiarities of application, along with traditional, new innovative building materials in the modern landscape design.

2. The main part

According to the latest most informative publications and textbooks devoted to modern building materials [6–10], the classification of building materials is carried out on various features, including by origin, chemical composition, features of technology and purpose. By the features of the use of building materials and products during the formation of objects of landscape design of the urban environment and the peculiarities of their technology, it is possible to distinguish the following groups: natural stone materials; ceramic materials and products; materials and products from wood; metal materials; concrete and reinforced concrete; glass and other materials and products from mineral melts; polymer materials. Among them, it is possible to attribute the first four positions to the traditional conditionally, and the last to the innovation ones. Let's consider in a concise way the features and prospects of their use in landscape design.

Natural stone is widely used in the organization of landscape compositions. At the dawn of human civilization, the artistic elaboration of natural and artificial elements of the environment and landscape art objects, ranging from the Ancient World and the Middle Ages, the greatest embodiment got it in natural stone. Despite the use of other natural and synthetic materials in the new and modern history of architecture and landscape design, it is unique "taste" of color and texture of natural stone range provides special artistic and figurative characteristics to the environment of streets and parks, city squares and boulevards, parks and estates.

The main and most ambitious landscape art objects were and still are the palace and temple complexes, agoras and villas, various buildings of cultural, entertainment, commercial, and domestic purposes. The use of natural stone as bearing structural and finishing material for various facilities, buildings and systems is spread wide. As an example should be taken two outstanding examples of architectural and landscape ensembles – Alupka and Livadia Palaces in Crimea that appeared composite cores of similar terrain parks. The-

* Vadym Abyzov, Prof., Dr. Sc./Hab. Ing.-Arch., Kyiv's National University of Culture and Arts, Kijev, Ukraine, e-mail: vaddimm77@gmail.com

se masterpieces of architecture and landscaping art are organically combined with the general design plan of external and internal environment of parks. A typical natural stone is used in almost all media of landscape design: ground plastic of relief, water arrangements, decorative surfaces, small architectural forms, elements of decorative art and beautification.
Natural stone is unsurpassed material for the formation of ground plastic of landscape objects. Plastic forms of earth and rock gardens can be used in the formation of various spaces, limiting and marking the territory. The picturesque mounds and hills of the surroundings that limit water bodies, divide them in certain areas, form the identification spaces for different purposes, creating memorable images. Macro relief shapes, slopes, retaining walls, craters, canyons – carry out zoning areas and art images in the best way, create a comfortable enclosed spaces of various functional purpose (ill. 1).
Ground plastic of landscape decisions of traditional and modern small gardens in the Chinese and Japanese styles is impossible without the use of natural stone in a variety of artistic and stylistic compositions. This is due to the fact that Far Eastern landscape art based on the reproduction of wildlife scaled in some way. Banks of natural and artificial ponds, rock gardens, different mounds and hills are arranged using natural stone. Many European parks is impossible without open and closed spaces, cascades and grottoes. In the application of various aquatic devices that enhance the imagery landscape compositions, natural stone is most indispensable material. To arrange decorative fountains and pools the use of the processed natural stone is more typical. For this purpose, you should choose a stone of beautiful shape, according to their purpose should serve as a local accent in the space environment of the park. Natural stones are fixed with mortar when making thresholds. The formation of various picturesque streams, waterfalls, cascades, streams of water, usually carried out by varying forms of stones and their installation.
The type and nature of the coating, which is a necessary component of forming the landscape compositions is of aesthetic value. Therefore, in parks, gardens, park alleys often apply a coating of dissected elements or plates of natural stone, stony paths with plants between the stones. Pathways and courtyards, patios can also be lined with natural stone. One of the options for quick placement of outdoor areas – patios, terraces, verandas – a ready-made kit, consisting of selected stone slabs of different sizes from 30x30 cm to 90x60, thickness 2.5–3.5 cm, made of limestone, sandstone, slate. Natural stone is used for the formation of diverse functionality and spatial characteristics of small architectural forms. The most common is the placement of decorative stone walls and pergolas, consisting of several stone arches connected by a wooden lattice.
Depending on the total plan the natural stone is used in the design of pavilions, benches and other elements of improvement, and for a variety of three-dimensional sculptures and monuments. The usage of, for example, marble or granite for sculptures and landscaping elements of parks is common for many prominent monuments of landscape and palace art in Europe.

Ceramic materials and products play an important role in creation of objects of landscape design. This most ancient artificial stone material, along with natural stone, was widely used in landscape art from the time of the Ancient World. Famous temples, palaces, worship and manor buildings and structures that are based on various variations and technology of ceramic materials, as well as other elements of landscape architecture and design, widely used in all stages of historical development of art and architecture.
Pottery significant advantage compared to natural stone is more simplified capabilities of transportation because of its modular standardization and small size of items. These circumstances are important for those regions where the deposits and mining of natural stone are missing. This material is also characterized in the exterior design with the ability to create integrated artistic and imaginative landscape and composite solutions based on respect for stylistic unity of the building development ensemble and landscaping through the use of modular sizes of ceramic products. For example, the use of ceramic facing brick in the decoration of buildings and small architectural forms in the regeneration of the surrounding area was an important means of aesthetic subject-spatial compositions both historically and in modern practice of the formation of urban environment. The experience of development and comprehensive improvement of Khreschatyk Street in the city of Kyiv is worth the special attention, as its urban planning and landscape composition is the outstanding global model of construction and design of object-spatial environment.
Plastic possibilities of ceramic products provide interesting examples of relief, creating amphitheatres and summer stages for cultural and educational activities and theatre performances. The use of bricks, ceramic tiles and other ceramic products for staircase is common enough and is an important functional element of relief processing. While making design the landscape designer determines not only the location of the stairs in strict accordance with the direction and intensity of pedestrian traffic, but thoroughly develops the form of steps, the rhythm, the number of marches, perhaps alternating with ramps and a small playground. Decorative properties of ceramic products, such as colour, shape, size of elements, and figure of surface are essential in creating a harmonious landscape composition. And compared to natural stone, ceramic materials are more common in regular style landscape environment with geometric grid plan and straight road terracing and clear contours of water objects. The ceramic bricks have got widespread use in the shaping of small architectural forms as structural and decorative material. They are used for bearings of benches, development of decorative walls, pergolas, pavilions, sunshades, as well as for various small business services. In combination with bricks, tiles are also often used to cover roofs and creating various canopies. The use of various types of majolica, terracotta, and glazed tiles facilitates the achieving of high aesthetic parameters regarding color, shape and texture. These ceramic products are used extensively for items of decorative and applied art of landscape design, especially for decorative panels, walls and carpet tracks [11].

ill. 1. Natural stone and wood in the recreational area of Mallorca. Photo V. Abyzov

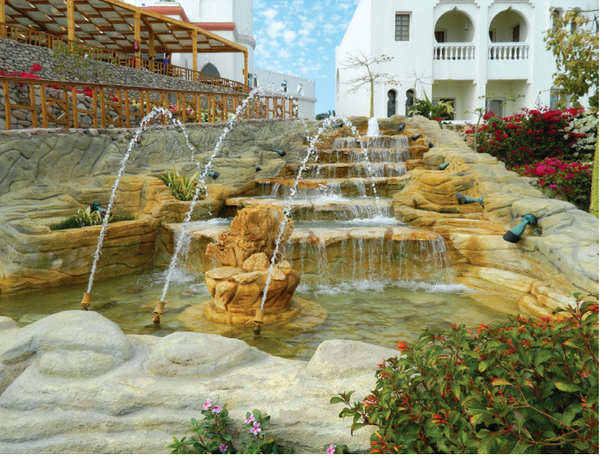
Wood, as well as natural stone, are widely spread building materials, that were used by mankind since antiquity. The availability of wood in forest rich areas and its undeniable advantages, such as certain strength and lightness, the ability to keep warmth in winter and coolness in summer contributed to the common use of this material in buildings and structures of different purpose.
History of landscape art is full of examples of the outstanding religious buildings, wooden houses, pavilions, gazebos, where wood is an excellent construction, finishing and decorative material. The most interesting examples are unique Slavic churches and Far East (Chinese, Japanese, Indochina) Buddhist temples and pagodas, where handy color processing discovers the tectonic features of the wooden structures and materials. The best architectural monuments of such artistic works are included in the UNESCO World Heritage list, and among the objects in this list there is the joint Ukrainian-Polish nomination for the Carpathian wooden churches.
Despite some constructive advantages of stone and concrete materials in the processing of the land surface, the use of wood in the form of horizontal and vertical structural elements provides good artistically-figured advantages in the arrangement of landscape design (ill. 1). At the same time, some types of wood, such as oak, hornbeam, beech can be used for a long period of time as bearing elements of structures that are resistant to the effects of air and water. The unique urban and suburban landscapes of the St. Petersburg, Amsterdam, Zhou Zhuang, and others are unique examples of above. Modern technologies of the creation of modified wood, wooden glued constructions of different contours provide new opportunities for the creation of various types and forms of landscape objects. All this is manifested in the implementation of modern wooden structures of summer park scenes, benches and other small architectural forms, fences, sculptural compositions (ill.2a,b).

ill. 2a. Summer theaters in wooden structures. Kiev. Photo V. Abyzov
ill. 2b. Summer theaters in wooden structures. Kielce. Photo V. Abyzov

Metal materials and products are used for the engineering constructions in the form of girders, arches, trusses, frames, domes, frames, towers; as well as the light steel thin-walled quickly mounted structures; installation of roofs (copper, aluminum, zinc-titanium in the form of metal tile and profile decking), drain sewerage systems, staircases, pavilions, buildings, facades (using smooth, corrugated, structural sheets, panels, cassettes with aluminum and steel), small architectural forms, lighting, street furniture, fences, etc. If the metal has traditionally been used in residential and public buildings as the main load-bearing structures, then lately it is more common as a facing material in the form of a variety of texture and color sheet materials. Aluminum composite panels most widely used in buildings of cultural, entertainment and commercial purposes. In addition, interesting solutions of exhibition and trade pavilions, summer theatres and restaurants, engineering constructions and bridge crossings are known, where the metal supporting structures at the same time work as active compositionally structure-creating decorative elements (ill. 3).
At the same time, for such items of geoplastics as terraces, ramps, stairs, bridges, etc. as the protective material namely metal products are used. Their color, the nature of the processing, artistic structure is combined with a general composition plan of landscape work of art. While often used artistic forging, which can be the connecting aesthetic and artistic tool for a variety of objects and elements of landscape design: fencing, small architectural forms and street furniture, fences, gates, gratings, etc. Practically an indispensable material is metal in the shaping of various lamps, fixtures and other lighting elements of internal and external environment. The strength and durability of metal materials are successfully used in the structures of visual communications – advertising boards, stands, showcases, etc. When creating landscape compositions using small architectural forms it is very important to ensure the unity of the stylistic solutions, and in many ways this may contribute to the application of the plastic properties of metal products and artistic forging. Along with the traditional bronze for the sculptures of landscape design other metal materials are used also – alloys of non-ferrous metals – copper, aluminum, brass, titanium, that have high corrosion resistance and ductility. The new technical and operational quality of metal materials is opening the further perspectives and creative possibilities of their use in landscape design.
The use of metal products in small architectural forms deserves the special attention – small scale structures and devices for seasonal and year-round use, designed to serve the population in the urban and natural environment. They can be stationary or transforming and have, as a rule, utilitarian, artistic, and decorative purpose, or only decorative. The utilitarian buildings typically include gazebos, public transport stops, trade and information kiosks, automatic trading devices, shading structures, lights, benches and other urban furniture [6,9,10].
Constructional advantages **of concrete** are known since the times of ancient Rome, where the widespread distribution of this unique building material was of revolutionary importance to the world of architecture. The use of mortar mixtures for the brick vaults gave to mankind the new form – the arch; and later its spatial derivative – the dome. The next defining moment in architecture and design there was a combination of the steel reinforcement with the concrete and widespread use of **reinforced concrete** in the first half of the twentieth century. Later the use of concrete and reinforced concrete came into landscape design. Structural and decorative features of these materials were reflected in the buildings of residential, public and industrial use, as well as in the infrastructure of the cities in the construction of bridges, aboveground and underground crossings, stadiums, etc.
Concrete and reinforced concrete allow to create flexible forms; they are the most cost-

ill. 3. The pedestrian bridge (Helix Bridge) in Singapore. Metal structures and polymeric materials. www.arhinovosti.ru/2012/04/14/peshekhodnyjj-most--helix-bridge-ot-cox-architecture-i-architects-61-singapur/

-effective materials for arrangement of ground surfaces and slopes, retaining walls, stairs, ramps, terraces, hills, etc. At the same time these materials obtained a successful use in the simulation of natural landforms, embedding of various enterprises of domestic and cultural-entertaining character into relief. The widespread distribution of concrete and reinforced concrete have in the arrangement of various aquatic zones in landscape design (waterfalls, cascades, etc.). The latter often have interesting decorative characteristics of sculptural forms. And these materials are used either as structural, forming the changes of the water flow in a few levels, so as decorative. In case of absence of natural stone or its high cost to implement design projects modern technologies allow to create landscape compositions that nearly impossible to distinguish from the compositions of natural materials (ill. 4). The most common is the use of concrete and reinforced concrete for construction of open and closed decorative and swimming pools.
The main type of decorative coatings of artificial materials in landscape design is a variety of artificial stones from concrete with different and pigments. Easy handling, they have great multi-variant use by size, texture, and color. Overlaps of concrete plates are characterized by diversity and affordability. *Shaped paving elements* (SPE) have recently most widely spread as road surfaces in landscape design. They differ in a variety of shapes and colors, that expands the design possibilities when implementing new architectural solutions. Despite the widespread use of SPE, the *concrete sidewalk plates* are still used for installation in different economic zones and areas. They are made of heavy and fine-grained concrete and used for installation of prefabricated coverings of sidewalks, pedestrian zones, garden-park and pedestrian paths, public transportation and petrol stations[8].
The widespread use of concrete and reinforced concrete have gained in the creation of small architectural forms – the main artificial means of landscape design. The use of concrete and reinforced concrete for the decorative-applied art of landscape elements is common, and in the first place, considering the high plasticity of these materials, for the creation of modern spectacular sculptural compositions. Diversity of use of three-dimensional decorative sculptures, their constructive, color and compositional solution depends on how they will be placed in combination with vegetation, relief, pedestrian streets and walkways, patio areas, etc.
During the centuries-old history of the architecture and design, glass received the most widespread and large-scale implementation as constructive, and rather constructive-protective and architectural-decorative material. In addition to the traditional use of glass in a variety of buildings and structures, in the landscape design it also was skillfully used in compositions of greenhouses and winter gardens of palace complexes since the Renaissance.
Nowadays, due to the rapid development of new technologies the glass usage acquires new possibilities. Along with traditional protective functions of the geoplastic tools, such as the establishment of microclimates, protection against dust, wind, and sun, glass products can be used actively as spatially organizing facilities. Elevated characteristics of strength and new static and dynamic qualities of glass allow its usage while arranging the ramps and stairs, terraces and amphitheaters, etc. Terraces and stairs are the most common functional elements of landscape processing, which play an important role in the composition of space. The creation of these important compositional elements of the landscape of transparent glass gives new feeling and aesthetic impression [9,11,13]. Considering the fact that glass can perform the function of bearing horizontal structures, it is also possible to organize bridge transitions and overlays of various form of runs. Transparent glass floorings can perform a purely decorative function, but also can have a functional purpose. As an interesting example we may call the clear glass ceiling over archaeological excavations of ceramic soldiers in the first and the ancient capital of China – Xi'an. The museum



ill. 4. Concrete and reinforced concrete in the landscape of the hotel complex in Sharm al-Sheikh. Egypt. Photo V. Abyzov
ill. 5. The design of a glass house in the natural landscape by the plan of architect Carlo Santamborgy. „Clever glass" in modern architecture // Young Scientist. – 2013. – 4. – P. 86-88. – URL https://moluch.ru/archive/51/6513/ (reference date: 31/03/2018)

and research complex is organized in such a way that the flow of tourists moves on the over ground level, directly observing archaeological excavations, carried out just under their legs.
Decorative coating is a necessary component of the arrangement of many landscape compositions. Such decorative features of coatings as a color, shape, the size of the elements, their figure are essential in building a harmonious landscape composition. Glass products with a variety of colors and textured processing skillfully used as in monolithic implementation, so as individual plate elements, such as panels with glass-crystalline material or smalt mosaic glass. Glass products can also be widely used to mimic marble, opal and other natural materials. Interesting opportunities offers the use of glass in the arrangement of fountains and various water surfaces and decorative pools. Glass products are used as structural and decorative material at shaping of a variety of small architectural forms. Recently, the creation of various sculptural compositions both transparent and opaque glass gets to spread. A significant role in the arrangement of space using glassware play elements of monumental-decorative art. Mosaic smalt glass is widely used nowadays for fixing decorative pictorial panels and reliefs. The high development of scientific and technical progress and the implementation of nanotechnology in the future open up more aesthetic and artistic-figurative use of glassware in landscape art while creating offbeat landscape compositions and bold creative design ideas (ill. 5).
Polymeric materials thanks to efficiency, manufacturability and high plastic properties gained the wide spread in the architecture and design of the environment. One of the main means of shaping the landscape is geoplastic, which involves the use of polymeric materials that can mimic the texture and pattern of other materials, including natural stone. Note also the significant efficiency of application of these materials and reduced labor intensity of construction by reducing transportation costs and installation compared to natural stone. High plastic features of polymers also contribute to the development of means of modelling the relief in landscape design.
Considering the low water absorption and high water impermeability, polymer films and rolled materials are most frequently for any other materials used for waterproofing of water bodies in landscape design. At the same time, considering the chemical resistance, low abrasion and a wide range of artistic and decorative processing possibilities of polymeric materials, they may increasingly be used as a material for decorative finishing of the various pools and reservoirs, fountains, swimming pools, etc. (ill. 6). Despite the fact that the designers try to use mostly natural decorative elements (stone, wood, plants, trees, ponds), modern landscape objects may operate only by attracting technical means, for example, a system of artificial reservoirs, automatic watering, lighting. Landscape construction nowadays is impossible without such modern materials like geotextile, films, varnishes, adhesives and other polymeric products, allowing to minimize the effort needed to maintain proper form.
In geoplastics objects for strengthening of artificial hills special materials are used – geonet (roll net material with polymer threads coated with protective layer with the same size holes from 2.5 up to 40 mm) and geogrid (3-D cellular structure with plastic straps, fastened as a checkerboard). For fast greening in that case the roll lawn is applied. The artificial grass lawn, which is made in the form of roll tufted carpet by using polyethylene filaments attached to a frame tissue, can sometimes be useful for the design of the landscape. Artificial gardening can be used for decorating the industrial areas, centers of leisure, corporate gardens, patios, recreational areas, balconies, hanging gardens, recreational areas on the roofs. Flexible polymeric curbs that are not destroyed, not rot, are quite strong, chemically stable and resistant to temperature are used to decorate flower beds, paths and lawns distinction in landscape design.
Design development of recent times is the vertical greening of buildings and structures; which technology was suggested by the French designer P. Blanc. For the arrangement of such ecosystem a metal frame with a thin waterproof polymer frame is used, covered with polymer felt, and a system of plants feeding. Application of polymeric materials allows improving the reliability and durability of the structure and protects the building from moisture. Polymeric materials, featuring durability and high waterproofing properties, are used when constructing green terraces on the roof of the building. Vegetation layer on the roof lowers its heating and dust content of air, protects the structure from ultraviolet rays, and provides extra heat insulation for roof in winter. On the other hand, green roofs can perform the function of recreation area, and involve the use of the garden furniture and small architectural forms, which are also often made of lightweight polymer materials [9,11].
The arrangement of a variety of recreational spaces and zoning in landscape design is done not only using natural forms – embankments, mounds, hills, but also by creating closed or half-closed space by using vandal-proof polycarbonate plastic, which performs the function of delimitation and protection. Plastic structures can get widespread use in zoos and other landscape objects, where simultaneous combination of review and protection features is necessary. Cellular polycarbonate 4 – 40 mm thick panels are widely used for the creation of city lights, translucent canopies, roofs, etc. The widespread use of this translucent material, strong enough, with low thermal conductivity and resistance to solar radiation, can be observed not only in such small objects of landscape design as transportation stops, shelters, shop windows, exhibition halls, but also in the massive buildings of the urban design – greenhouses, hothouses, various winter gardens, roofs of summer cinemas, entertainment centers and sports areas and playgrounds (ill.5).
Seasonal plastic street and garden furniture in the form of chairs, tables, sofas, benches play an important role in creating the design of the environment of summer entertainment places, the terraces of cafes, restaurants, shops, exhibitions, etc. Wicker furniture made of polymeric rattan, that is strong, resistant to the environment and durable enough, gained popularity recently. The basis for the production of this kind of products is the development of fibres and ribbons on the basis of a mixture of polyethylene of high and low pressure. Fibreglass based on acrylic polymer and glass fibre, which allows to obtain products of complex configuration, featuring high physical and mechanical properties and durability, is used for outdoor furniture and installations.
Sun protection systems, that often also perform functions of protection from the weather, wind and of decoration of urban landscape and façade of buildings can be made of polymeric materials, including fabrics made of high-strength polyester and polyvinyl chloride. Such systems include awnings, canopies, and marquees (sliding hinged structures over the windows and external doors) and Reflexol – roller blinds installed outside the premises. Metal frame awning structures, obtained using advanced polymer fabrics allow to create the temporary buildings of different shapes, size and purpose – tent hangars, pavilions, open-air markets, sports facilities, sta-

ill. 6. Organization of an artificial lake using polymeric materials in the natural landscape; https://justpondliners.com/collections/commercial-use

ges, circus tents, summer cafes, tennis courts, sports grounds. The advantages of such structures are the rapid erection and installation on any territory, the ease of installation and minimum costs. High physical-mechanical and decorative properties of polymeric materials allow to effectively use them to arrange elements of monumental-decorative art and sculptural compositions of landscape design. The wide range of color and texture processing of organic concrete that allows to create a variety of aesthetic and attractive composition, contributes to this also (ill. 6).

3. Conclusion

Modern traditional and latest innovative building materials such as *natural stone materials, ceramic materials and products, materials and products from wood, metal materials, concrete and reinforced concrete, glass and other materials and products from mineral melts, polymer materials play* an important role in contemporary landscape design and are the main means of creating harmonious and expressive landscape compositions and formations.

The set, combinations and general artistic image of the use of building materials in the objects of landscape design should be determined by the urban planning, functional, and lay out features of the designing areas in conjunction with the environmental compositional and spatial design. With all the diversity of their possible artistic and decorative solutions, an essential condition is the achievement of the stylistic unity of the overall composition of landscape design.

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