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CONCRETE-DESIGN

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Abstract: *Present paper introduces a new interpretation of concrete, demonstrating some extreme possibilities of this rigid material such as a design element. In the first part a brief overview of the previous achievements are shown. The second part of this paper focuses on the relationship between concrete and fashion.*
The „typCon" studio was founded in the Institute of Construction Management of the Szent István University, Ybl Miklós Faculty of Architecture and Civil Engineering. The new developments, researches and formulas related to concrete design elements are also introduced.

Keywords: *lightweight concrete, expanded glass granulate, fibre reinforcement, self-compacting concrete, concrete jewel*

1. INTRODUCTION

The thinking on the concrete is currently changing. This change is closely linked to the development of the concrete technology.

Wide range of professionals are looking for the possibilities that have not yet been implemented or introduced. Sometimes the solutions are surprising, however the related articles are generally only report the outcome of the progress.

1.1. Possibilities of outdoor application

Some concrete elements used in cities and urban traffic are created for mainly practical reasons (for example: separators, etc.), others are used due the high density of the concrete (for example: various road blocker or deflector elements).

The contemporary, aesthetic concrete fences reflect the development of the concrete technology and formwork technique (Figure 1.). Landscape architecture also often uses concrete tiles as routes. High variety of patterned floor tiles can be found (for example: fishbone, grid, irregular, wood pattern... etc.). The monotonic grey colour of the concrete can be changed with colouring either the surface or the material itself.

The originally simple-designed flower pots and garden benches have gone through a spectacular change. The main aspect of the previous design was the purposefulness, however nowadays the aesthetics also became important.

Figure 1. Concrete fences: past and present [1]

1.2 Indoor application

Interior designers, architects and artists are constantly looking for new opportunities for the application of each material. In case of concrete, sometimes the natural raw robustness is highlighted, in other cases designers seek to recreate the otherwise everyday used object from this unusual material.

Some of the most important elements of the official premises are the reception table and the divider units. The formerly used traditional units - in some places - were replaced by LitraCon blocks or other design walls (Figure 2.).

Figure 2. C3 Atelier (Budapest) - reception desk and design wall

The shelves and shelving units used in offices can be created from concrete. Formerly a different technique called gypsum-concrete has been developed for this purpose, with which panels and built-in cabinets could be installed. Various examples of this technology can be observed in special databases (Figure 3.).

Figure 3. Shelf variations [2]

Examples of seating units should also be mentioned: Perhaps the Swiss designer Stefan Zwicky recreated the classic Le Corbusier LC2 armchair as a tribute to the great architect. (Figure 4.)

Figure 4. The classic LC2 armchair and the concrete design [3]

Other armchairs look like ordinary grey leather furniture, however made of concrete. The concrete chairs and other furniture can be also made of concrete, although there is no denying the fact that they are not very comfortable.

The concrete smoking tables are already gaining more and more popularity, and the shelves mentioned earlier might have considerable market share, sooner or later appearing in the private sector. Besides office and other home furniture presented above, specific area of the topic is the solutions for sanitary ware and wet spaces (bathroom...), however the scope of this article does not fit for detailed description of these various developments.

1.3. Other elements

In previous chapters the solutions were grouped that nowadays appear surprisingand new. The ‘extreme’ design elements usually appear in showrooms and conferences.

In the C3 Atelier showroom in Budapest a concrete chandelier (Figure 5.) can be observed. The installation is a good example of the cooperation between different fields and artists: achievements of concrete technology, electronics and glass techniques are combined in this artwork.

Figure 5. Concrete Chandelier

The following objects are used daily, but recreated from concrete. For example clothes and other additional elements, such as concrete coffee machine, or the most common data medium, the USB flash drive made of concrete can be purchased. An architect designer even rethought the widely known LEGO units. (Figure 6)

Figure 6. Everyday object made of concrete [2,4]

The concrete jewelleries constitute a separate category. A number of designers and studios had introduced such modern accessories, with sometimes astounding solutions. Henceforth, the paper focuses on this topic.

2. ‘JEWELLERY’ MADE OF CONCRETE

Jewels have always been used in accordance with the level of sophistication of the current era - it is a historical fact. Necklaces, pendants, rings have appeared in prehistoric times, used for mainly sacred purposes. Later they became symbol of social rank.

Concrete in today’s sense is ‘only’ 150 years old. As a design accessory it was used since the end of the 20th century. These items could not be literally called jewels, because they usually have nothing in common with the precious metals or gemstones.

The concept of ‘jewel ‘today received a new interpretation. Our daily materials - for example paper, textile...- are added to the classic materials (gemstones, gold, silver...) or entirely replacing them.

The concrete jewels are usually ordinary grey coloured, however the new inventions, like colouring are widely used by designers. The general approach of the design is to connect a metal cap and the concrete part, but creating it entirely of concrete is also possible (Figure 7.).

Figure 7. Encounter of stainless steel and concrete, or only concrete ring designs [5]

Reconsidering the possibilities of application of the concrete led the teachers and students of the SZIE-YMÉK Institute of Construction Management, who founded the “typCon” Studio nearly one year ago. Their goal is on the one hand to show the natural external and internal beauty of the concrete, on the other hand to create new object which can be used in daily life. Taking these two aspects into account, the ‘Concrete-design’ project had been started, which innovative solutions are now introduced. In addition to the colour grey, the collections contain coloured items and the same time taking advantage of the internal structure of the material. Below these research and development works are introduced.

2.1. Choosing the technology

There are basically two possible technologies to create concrete jewels: casting or traditional mechanical surface shaping. Each technique has its advantages and difficulties.

The casting technology was made possible by the results of concrete technology and formwork technique. The procedure is essentially to fabricate the negative form of rubber into which appropriate quality material is poured (usually self-compacting concrete). The final product is obtained with minimal post processing.

The procedure considered as traditional is creating standard 40x40x160 mm^3 concrete prisms in a steel formwork. The required consistency concrete is poured into these forms and stored till solidification. After post-treatment, the formwork is detached and the prisms are cut. The final form is achieved by drilling, cutting, grinding, polishing and other manufactoral techniques.

2.2. Concrete formulas

Basically normal and lightweight concrete formulas were created. Two types of lightweight concrete aggregates were applied [6,7]. The proper consistency of the fresh concrete was considered, as well as using fibre reinforcement to improve the post processing properties.

The elaborated compositions are shown in No. 1 table, the fresh concrete characteristics are presented in the No. 2. table.

Normal concrete (NC) Sample No. 1.	**Lightweight concrete**	
	„A” (Sample No. 2.) LC-1	**„B” (Sample No. 3.) LC-2**
CEM I 42,5 R	CEM I 42,5 R	CEM I 42,5 R White
Grain and sand d_{max}=8 mm	Sand and granulated clay d_{max}=8 mm	Expanded, granulated glass d_{max}=4 mm
		Metacaolin
	Limestone powder	Limestone powder
		Plastic fibre (pP)
Water	Water	Water
	Additive	Additive
		Inorganic colouring

Table 1. Formulas

	Normal concrete	Lightweight concrete	
		„A”	„B”
w/c coefficient	0,6	0,57	0.58
Designed bulk density [kg/m³]	2.260	1.800	1.100

Table 2. Fresh concrete characteristics

2.3. Colouring material

The following requirements were established concerning the colouring materials:

- the consistency of the fresh concrete should not be affected by it,
- the solidifying of the concrete should not be affected by it,
- to provide permanent colouring,
- not to have any adverse effect on the human body,
- the potential chemical processes should not affect the binding of the concrete or other properties related to application.

While studying the related articles [8,9,10] the authors did not assume, that the choice of colouring material is not a simple task itself. Even deciding the main colours is a complex question (additive colour mixing, blending, subtractive mixing, pigment/colour/blending). The latter technique - pigment mixing - was chosen, which contains three colours: blue, yellow and red.

Red colouring

Some of the many options were eliminated in the first place, for example: the lead oxides are toxic, the mercury sulphide is not resistant of limestone or UV light. The different iron sulphides were considered at last. The red iron oxide (Fe2O3) is acid-, alkali- and light resistant. It has good solvent- and heat resistance too and an intense colouring effect.

Yellow colouring

From the myriad options (chrome yellow, cobalt, cadmium yellow, etc.) yellow iron oxide colour was chosen, as it met the expectations. The iron oxide hydrate [FeO(OH)] has high hiding power, good alkali-resistant however weak against acid. At 130°C it loses its bounded water and transforms into red colour. This colouring agent is widely used in the construction industry (concretes, mortars, plaster). Its pH value is 3,5-7.

Blue colouring

Similar to the cobalt blue (Thenard-blue), the cobalt-chromium-alumina-based paint is a powder based paint. Its heat stability is over 800°C. It is moderately resistant against alkali and acid, with a pH value 7,5-9. It has a good light resistance.

2.4. Results of the investigations

The planned and the completed data of the concrete samples are shown in the No. 3 Table.

	Designed bulk density, kg/m³	Actual bulk density, kg/m³
Sample No. 1 (NC)	2.260	2.282
Sample No. 2 (LC1)	1.800	1.842
Sample No. 3 (LC2)	1.100	1.120

Table 3. Bulk density of the fresh concrete

Physical parameters:

The bending- and tensile strength (Tonitech testing tool) temporal values are presented on the Figure 8. The compressive strength values (Instron 2308 universal testing device) are described on the Figure 9.

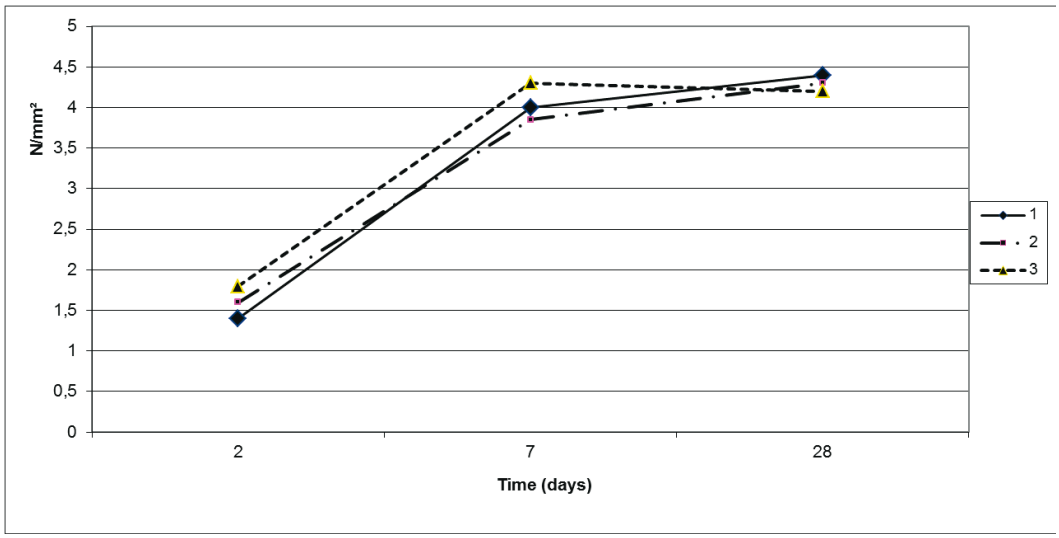


Figure 8. Values of tensile strength (1- NC, 2-LC1, 3-LC2)

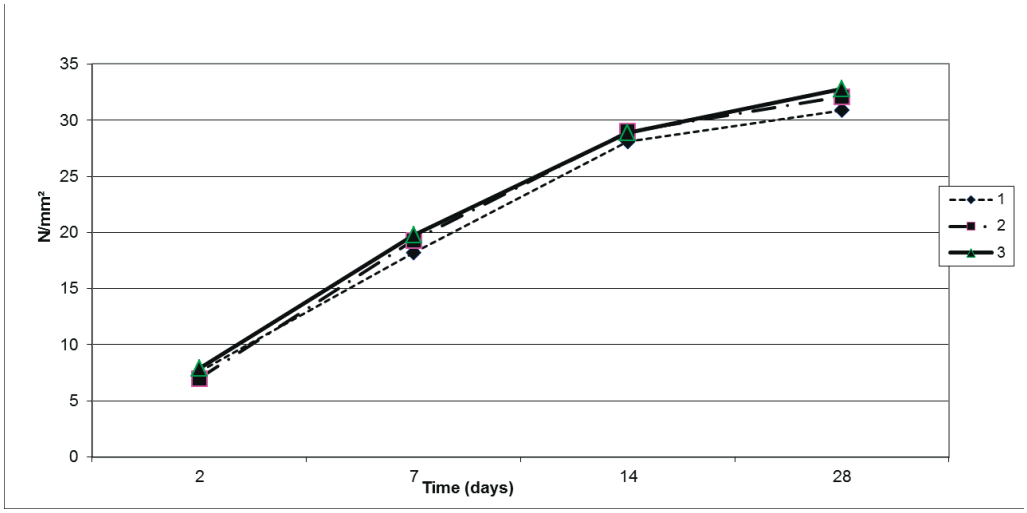


Figure 9. Values of compression strength (1- NC, 2-LC1, 3-LC2)

2.5. Compatibility

In addition to the physical parameters the chemical reactions of the aqueous solutions of each concrete samples were examined. The pH values were reasonable to investigate, because the jewels were even if not permanently, but in connection with human skin.

The values are introduced in the Table 4.

The human body fluid is nearly pH neutral (pH=7). The body fluids however have different values, from which the sweat and the skin itself is important in this case. [11]

The pH value of the fresh concrete is approaching the higher region of the alkali values (pH= 13,0-13,5). However the concrete surface is affected by carbonation, which chemical reaction lowers this value nearly to pH neutral level (red tint trial for determining carbonation).

	pH values
Human body	4 -7,5
blood	7,3 - 7,45
saliva	6,5 - 6,9
perspiration	5,6 – 6,8
Fresh concrete	13,0 – 13,5
Testing of the samples for pH adjustment: the freshly shredded concrete in 20% aqueous solution	
Samples	
Sample No. 1	12,1
Sample No. 2	11,9
Sample No. 3	12,7

Table 4. pH values

2.6. Selection of the typCon Studio Collection

The presented concrete jewels are all unique pieces (Figure 10-12). Their uniqueness is resulted by the different production techniques, and the different materials used to add to the traditional concrete (Figure 10. a,c,e,g).

One of the simpler types is where colouring materials and lightweight aggregates are added to the basic concrete formula (Figure 10.b). The internal structure of the concrete is emphasised by simple geometric forms, referring to the rigidity of the material. In case of the piece made from white concrete (Figure 10.d) by the structured surface the inhomogeneous nature of the concrete was brought even more into prominence - showing the sceptics that the concrete can be beautiful, even elegant accessory.

Creating the pieces decorated with metal wires (Figure 10.a,c,f) were proved to be exciting challenges, as a rigid and a tough material were connected. On the one hand the wire meant to frame the concrete as a decoration, on the other hand it served as a tool to turn the raw appearance of the concrete into a modern jewel.

The concrete bracelet assembled with leather (Figure 12.b) shows a more natural style, encouraging the further combination of these two materials.

When jewels are mentioned, the glittering lights and sparkling surfaces are expected. Using Swarovski crystals to decorate concrete results this fashionable sight (Figure 10.g), thus these pieces can be worn on special occasions, not only for casual outfits.

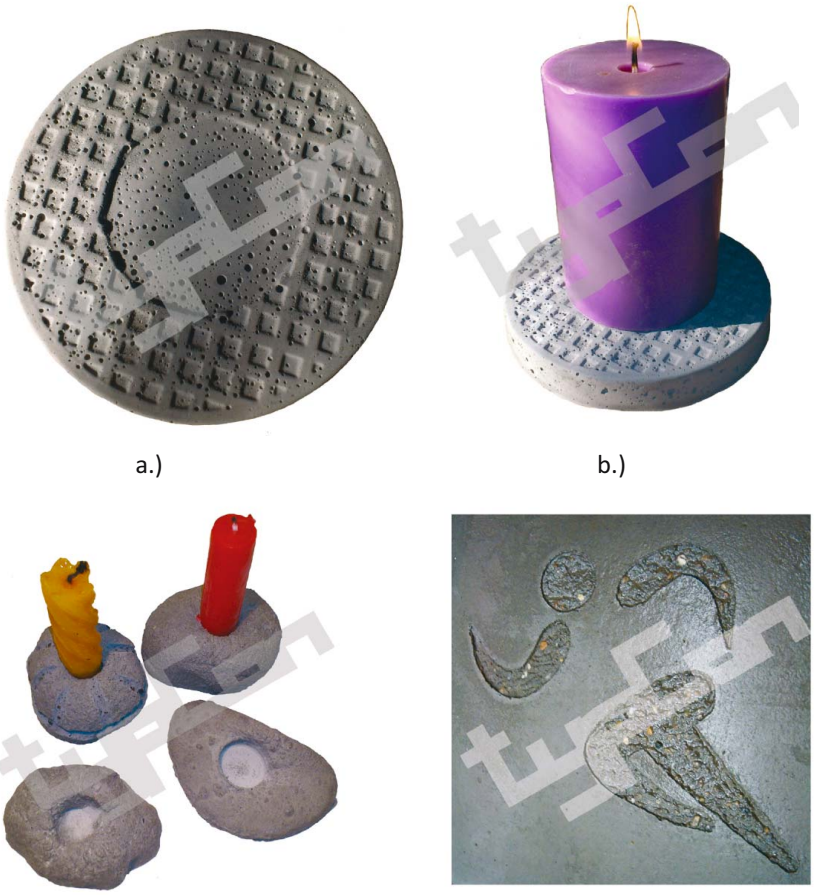
Other examples for the everyday objects made of concrete are the candlestick variations (Figure 11.a,b,c), in which case the varied forming and surface pattern possibilities of the concrete were not hid but emphasised. The sport logo created for a special order (Figure 11.d) uniqueness was achieved by brush technique.

a.) b.) c.)

d.) e.)

f.) g.)

Figure 10. Pendant variations



a.) b.)

c.) d.)

Figure 11. Other design objects

a.) b.)

Figure 12. Bracelets

3. SUMMARY

Present paper aims for introducing the concrete - as a structural material - from a different perspective, using it as a design element. During the development of the concrete technology the term “visible concrete surface” was introduced which has opened up the wide range of possibilities to use it as a material of an unusual solution.

In the first part the results of the previous researches were summarised demonstrating that the innovative solutions have already been created to expand the opportunities to use concrete for aesthetic surfaces. A growing number of architects, designers and artists chose concrete for their masterpieces.

A brief introduction of the application possibilities were made, showing both indoor and outdoor examples. Sometimes extreme ideas of application can be found in related articles.

The second part of the article is introducing the research works of the typCon Studio founded in the Institute of Construction Management, Szent István University, Ybl Miklós Faculty of Architecture and Civil Engineering. Members of the studio investigate primarily the possible connections between concrete and fashion. They aim for presenting the internal structure of the concrete in an aesthetic form, while testing various different production methods.

The final part introduces the results already achieved, showing few of the collection pieces of the typCon Studio which reflect the wide range of production possibilities and ideas using concrete as a design material.

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