

Anti-corrosion protection of metals

Doroshenko Alexandra Yuriivna

Doroshenko Alexandra

Ukraine, Kyiv, State University of Infrastructure and Technology. Kyiv Institute of Railway Transport. Department of Building Structures and Constructions.

State University of Infrastructure and Technology

Associate professor, PhD in Engineering Science.

sane4kador@gmail.com

Improvement in quality and service life of concrete steel constructions by means of research of interaction of concrete form and cement concrete

Abstract

In this article we consider issues associated with improvement in quality and service life of concrete steel constructions. With aim to ease separation of concrete from concrete form or form, and also to protect metal moulds from corrosion they use concrete form release, which provide significant reduction of costs of hand work at removal of concrete form of constructions of cast reinforced concrete; full elimination of labor costs on depuration of concrete form panels from stuck concrete; increase of service life and turnover of concrete forms; obtaining of in-situ reinforced concrete constructions with high quality of outer surfaces.

Key words: cement concrete, concrete form releases, concrete form, service life, reliability.

Cast-in-situ and built-up constructions of concrete and ferroconcrete are the main, basic constructions in housing, industrial, hydraulic engineering, road and other spheres of construction engineering.

Every year in the world they establish and fit in hundreds of millions of cubic meters of cast-in-situ and built-up concrete and ferroconcrete. Analysis of literature sources, and also of national and foreign construction engineering practice gives opportunity to state that role and meaning concrete and ferroconcrete as main constructional materials will rise steadily in the future.

Analyzing complex engineering process of building in-situ reinforced constructions, we should not that the most important and labor-intensive engineering processes are formwork activities. Their labor intensity fluctuates from 40 to 55% of total labor intensity of building cast-in-situ constructions, and cost is accessed respectively in 30-45 %.

In a complex of formwork activities the important technological operation is laying of release on a surface of concrete forms with aim to ease removal of concrete form, reducing of wear of concrete form panels and increase in quality of outer surfaces of ferroconcrete constructions, increase of turnover of concrete form.

Examination of national construction engineering showed that the concrete forms used and concrete form systems are far from perfect; the formwork activities are labor intensive and have high cost, and cast-in-situ constructions, especially their outer surfaces after removal of concrete form require multicost-intensive afterremoval of concrete form of finishing up. Significant number of national concrete forms have imperfect inefficient moulding surfaces. Usage of such concrete forms in combination with low-grade, and for this reason inefficient releases, as it often happens in real world, lead to negative results and big unproductive expenditures.

Releases, which are inherent technological components, play a key role in technology of in-situ reinforced constructions. Efficient releases ease removal of concrete form, improve quality of concrete surfaces, reduce expenditures on their afterremoval of concrete form finishing up. Critical bonding between concrete and poorly lubricated and not lubricated concrete form at all is approximately on 70...100% increases labor intensity of removal of concrete form. In relation to usage of inefficient release concrete form panels overgrow with crust of cement, which requires their additional purification. Thanks to high bonding, the big concrete form removal efforts, mechanical shear on the concrete form at its purification from stuck concrete, 70 % of concrete forms fail prematurely.

As a result of using insufficiently efficient releases or their irrational use on surface of cast-in-situ constructions excess roughness and porosity, grease stains, cracks and flay marks of concrete come up, which require additional expenditures on their correction and finishing up.

Underestimation of importance of such working operation as application of lubricant on the concrete form, reckoning of it to category of secondary ones, and sometimes and not necessarily leads to significant unproductive expenditures, contributes to premature wear of concrete form panels, reducing in 1,5...2 times their turnover, reduces quality of surfaces of in-situ reinforced constructions.

The concrete form must provide the set sizes and form of the construction, which is being built; must be solid, hard and constant in working position and at the effect of all the production loads; to have minimal adhesion of surface with concrete; to be industrial, saving and technological in the assembly and disassembly, and also not to present problems at installation of stiffener and concrete mixture

pouring; produced in accordance with requirements of standards or specifications on the concrete form of specific types.

Strength and quality of producing of cast-in-situ constructions, and also labor intensity of concrete form and finishing works, service life and cost of the concrete form depend on deformability of the concrete form. Besides distortion of surface, breaking of geometric dimensions and other deviations at spongy concrete form there are pits and air bubbles being formed at concrete consolidation.

All the couplings of the concrete form are recommended to perform as quick ones; they must be sufficiently air-tight and proof. Welding seams and also sharp angles and edges must be machined.

In order to produce elements of the concrete form a wide variety of materials is used. For the concrete form soft woods is used (pine, spruce, larch), hardwoods (birch and alder), waterproof veneer, steel, plastic, ferroconcrete and grouted boards, wood chipboards (WCB) and wood fiberboards (WFB), polypropylene with fillers. Supporting members of the concrete form are made mainly of steel and aluminum alloys, and this allows to achieve their high turnover.

The value of bonding of the concrete mixture with the concrete form achieves several kp/cm^2 . This makes works on removal of the concrete form even harder, impairs quality of the concrete surface and brings about early wear of the concrete form panels.

Adhesion and cohesion of the concrete, its setting and porosity of the surface of the concrete form affect the bonding of the concrete with the concrete form.

Adhesion is understood as the one conditioned by molecular force between surfaces of two diverse contacting bodies. In the period of contact of the concrete mixture with the concrete form some favorable conditions are being created for adhesion to show itself. A bonding agent (adhesive substance), which in this case is concrete mixture, is in plastic state in the period of setting. In the process of consolidation of concrete by vibration its ductility property increases even more, with the result that the concrete mixture closes with surface of the concrete form and integrality of contact between them increases more.

Concrete sticks to wooden and steel surfaces of the concrete form stronger than to the plastic ones due to weak wettability of the latter ones. In table 1. there are meanings of standard bonding of the concretes with some concrete form materials.

Materials	Standard bonding of the concretes at the age of 1 day, kp/cm ²			
	Heavy concrete		Expanded-clay concrete	
	B 12,5	B 7,5	B 12,5	B 15
1	2	3	4	5
Steel without refinishing and without lubricants	1,85	1,31	1,81	2,41
Steel with lubricant	0,47	0,35	0,39	0,45
Pine sliced	1,25	1,12	1,17	1,32
Waterproof veneer	1,15	1,08	1,11	1,22
1	2	3	4	5
Wood chipboard	1,20	1,16	1,18	1,20
Textolite	0,29	0,20	0,24	0,26
hardened paper	0,57	0,42	0,52	0,56
Polytetrafluorethylene-4	0,19	0,13	0,14	0,15
Glass-reinforced polyester	0,31	0,23	0,24	0,26

Table 1. Standard bonding of the concretes with some concrete form materials.

Breakaway effort of the concrete form, k_p , is determined by formula

$$P_{om} = K_c \cdot O_H \cdot F_{u\theta} \quad (1.1)$$

where O_H is a standard bonding, kp/cm^2 ;

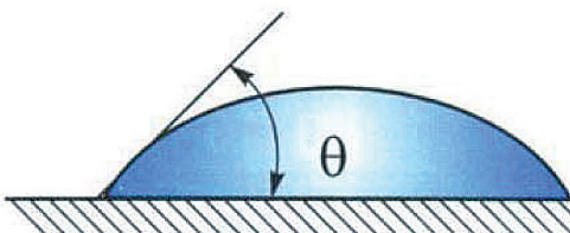
$F_{u\theta}$ is an area of the panel broken away, m^2 ;

K_c is a coefficient, that takes into account hardness of panels.

Wood, veneer, steel without refinishing and glass reinforced plastics are wetted good enough and bonding of the concrete mixture with them is pretty big, the concrete mixture bond less with low wetted (water-blocking) hardened paper and textolite.

Limiting wetting angle (fig.1) of hairline steel is bigger than in a raw one. However, bonding of the concrete with the hairline steel decreases. This may be due to the fact that on the edge of concrete and elaborated surfaces integrality of contact is higher.

a)



b)

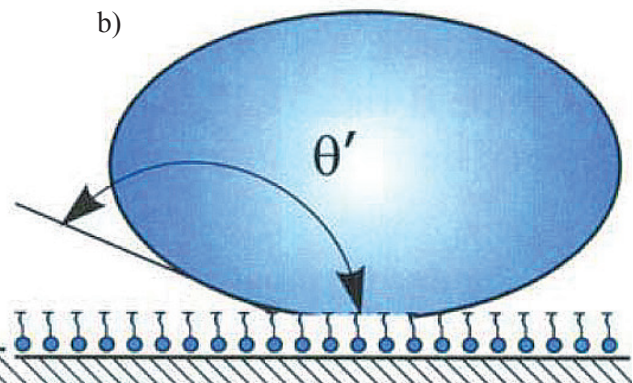


Fig.1. Limiting wetting angle of different surfaces: a – hydrophilic; б – hydrophobic (with lubricant)

At putting on the surface of the lubricant it is hydrophobized, which acutely diminishes adhesion.

Shrinkage loss undermines adhesion and bonding. The more value of shrinkage loss in attaching concrete layers, the more probability of occurrence in area of contact shrinkage tears, which weaken bonding.

Cohesion in contact pair concrete form – concrete should be understood as tension strength of attaching layers of concrete.

Roughness of concrete form surface increases its bonding with the concrete. The reason is that roughened surface has a big area of contact comparing to smooth one.

Highly porous material of the concrete form also increases bonding, as cement grout, penetrating into pores, at vibrocompaction forms points of reliable coupling.

There can be three options of breakaway at dismantling of the concrete form. In the first scenario adhesion is pretty small, and cohesion is pretty big. In this case the concrete form is being broken away explicitly on the area of contact. The other scenario – adhesion is bigger than cohesion. Upon that the concrete form is being broken away by adhesive(concrete). The third scenario – adhesion and cohesion by their values are almost identical. The concrete form is being broken away partially on area of contact of the concrete with the concrete form, and partially – on the concrete itself (mixed or combined breakaway).

At adhesive breakaway the concrete form is removed easily, its surface remains clean, and surface of the concrete has a good quality. Therefore it is necessary to set on provision of adhesive breakaway. For this purpose the concrete form is being carried out from smooth poorly wetted materials or put some lubricants on them and special antiadhesion coating.

The lubricant for the concrete form is applied to machine different types of the concrete form and metal moulds to ease separation of the concrete from the concrete form or form, and to protect metal moulds against corrosion as well. At using of the lubricant separation of the concrete from the concrete form is being improved, quality of the outer surface is improved by means of reduction of number of defects, labor efforts on mold cleaning are being reduced, remarkably term of use of the concrete form is being extended. There is a number of severe requirements to the lubricant concrete form. The lubricant for the concrete form and forms should not enhance corrosion of elements of the concrete form, emit vapors destructive to human health. Qualitative lubricant for the concrete form does not leave spots on surface of the concrete, which later can show through finish. For usage at winter time it is necessary to use lubricants, which do not freeze.

Depending on composition, law of action and running abilities, lubricants for the concrete form are classified into four groups: aqueous slurries; hydrophobized lubricants; lubricants – concrete hardening retarders; combined lubricants.

Law of action of aqueous slurries and hydrophobized lubricants is based on the fact that there a protective film is being formed on the surface of the concrete form, which lowers bonding of concrete with the concrete form.

The combined lubricants are mix of concrete hardening retarders and hydrophobized emulsions. At producing of lubricants they add sulfite-cellulose liquor (SCL), naphthenate soap. Such lubricants plasticize the concrete of the immediate zone, and it is not wrecked.

The lubricants – concrete hardening retarders – are being used to obtain a good texture of the surface. To the moment of removal of the concrete form strength of these layers is somewhat lower than one of the basic mass of the concrete. Immediately upon removal of the concrete form structure of the concrete is being uncovered by wash spray. After such cleaning we get a beautiful surface with equal exposure of the big filler.

There such substances as the petroleum base oil ones which related to emulsol type became especially popular due to their rather low cost. The lubricant for the concrete form “Emulsol” is biodegradable and does not leave dark greasy markings on the surface of the products. For this reason such products look attractive, they are easy to plaster, which significantly affects quality assessment of the products made.

Therefore application of efficient antiadhesive concrete form lubricants provides:

- significant reduction of costs of hand work at removal of concrete form of constructions of cast reinforced concrete;
- full elimination of labor costs on depuration of concrete form panels from stuck concrete;
- increase of service life and turnover of concrete forms;
- obtaining of in-situ reinforced concrete constructions with high quality of outer surfaces.

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