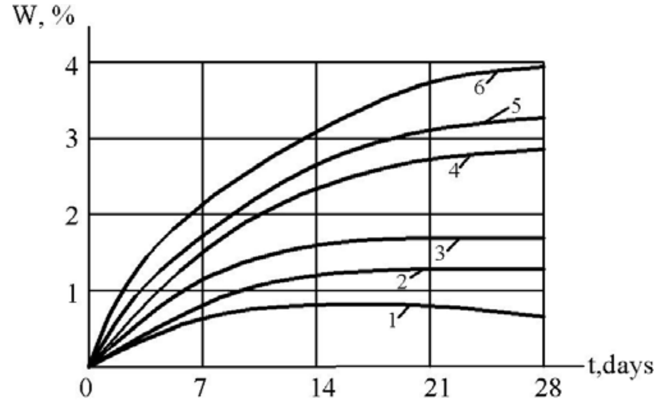


**Figure 1. Kinetics of concrete water absorption:**
**1, 2, 3 – Polyvinylchloride (PVC) content 0.5; 0.75; 1.0 and waste of coke-chemical production 4.5; 4.25; 4.0, respectively: 4, 5, 6 – without additives; W/C – 0.2; 0.25; 0.3, respectively**

As it can be seen from the presented data, the content of the complex additive leads to the 2.0–4.0 times reducing of water absorption which indicates decreasing porosity of the concrete. To determine the contribution to the .kinetics of water absorption, macro- and micro-pores there has been studied the structure of concrete on an optical electron microscope with resolution of x1000. The samples of the modified oligomer-polymeric additive did not contain macro-pores with sizes >200 μm as compared to the unmodified ones. The micro-pores of the modified concrete contained an oligomer additive. Macro-pores with sizes of 150–200 microns of concrete, as it has been supposed, at the stage of crystallization, are occupied by PVC macromolecules on which there are grafted Portland cement particles introduced with dry mixing of cement with PVC. After mixing with water, the cement particles grafted onto the PVC surface become new crystallization centers, and the crystal growth proceeds in the macro-pores volume. Migration of PVC macromolecules into macro-voids in the area of coverage of the filler (sand) contour is due to the difference in the PVC density and hardening concrete from the moment of coagulation to the formation of the crystallization structure. Apparently, the kinetics of crystallization of cement in the concrete mixture and in the macro-pores volume proceeds at different rates which explains the migration of WCP to the region of cracks and capillaries. The occupying of macro- and micro-pores of concrete by mobile molecules of the oligomer and polymer is also due to the development of internal stresses during formation of the crystallization structure of concrete. Unlike plasticizers and water repellents that envelop the aggregate particles and migrate to less crystallized regions, macromolecules of the oligomer and polymer under the impact of internal stresses participate in the structuring of the concrete. The processes of crystallization of cement particles grafted onto the surface of PVC macromolecules contribute to the formation of a micro-granular structure in defective areas of concrete. The mechanism of occupying defective zones by low-molecular products during crystallization (the doping effect) is known for crystallizing polymers. This indicates the formation of a fine-crystalline structure with optimal packing in the volume which causes increasing the deformation-strength characteristics of the material. Structural plasticization, i.e. occupation of the volume of submicrocracks by oligomers is also observed when both crystalline and amorphous oligomers are solidified. Thus, we assume that the crystal growth mechanism, both for organic and inorganic polymers, is similar. Migration to defective zones (pores, cracks, capillaries) of low-molecular and low-viscosity particles of WCP as a result of all-round compression during hardening of cement is confirmed by the parameters of the water absorption kinetics.

Figure 2 shows the results of testing concrete at the age of 28 days for compressive strength and frost resistance.

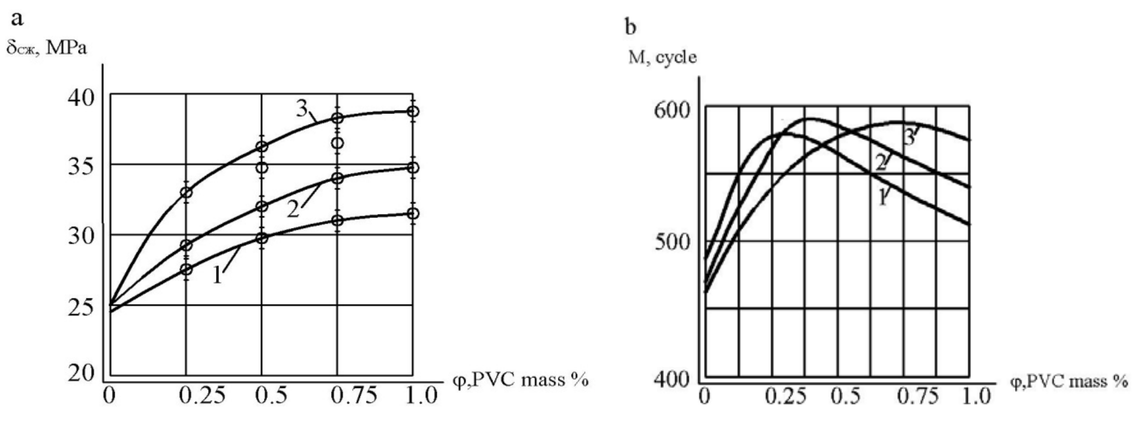


**Figure 2. Concrete compression strength and frost resistance dependence on additives content: WCP content 1 – 3.0, mass %; 2 – 4.0 mass %; 3 – 5.0 mass %; formulation I, $W/C$ = 0.25, to the effect of the 5 % water solution of sodium sulfate ($Na_2SO_4$).**

The test results are shown in Table 2.

***Table 2. Results of the studies.***

| Concrete | W/C | Concrete compression strength, t month | | |
|---|---|---|---|---|
| | | 1 month | 2 months | 3 months. |
| I | 0.2 | 27/25 | 27/18 | 25/12 |
| II | | 31 | 30 | 29 |
| III | | 35 | 35 | 32 |
| I | 0.25 | 27 | 22 | 20 |
| II | | 31 | 27 | 23 |
| III | | 35 | 30 | 26 |
| I | 0.3 | 27 | 20 | 18 |
| II | | 31 | 25 | 19 |
| III | | 35 | 27 | 21 |

Note. Denominator: indicators of concretes without additives.

The obtained results testify to the sufficient corrosion resistance of the studied concretes.

Thus, in the complex of physical and mechanical properties, resistance to sulfate corrosion and frost resistance, the studied concretes based on structurally modified concrete can be used for producing pile foundations arranged in conditions of highly saline soils.

# 4. Conclusions

1. The use of structural modifiers based on experimental data makes it possible to produce high quality concrete: strength higher by 20–30 %, corrosion resistance by 80–85 %.

2. The use of structural modifiers increases water-tightness to class W11–W12 and, as a result, reduces by 85–90 % capillary suction and water absorption which is caused by formation of the secondary crystallization structure of cement stone in defective areas of concrete;

3. Concretes modified with oligomer-polymeric additives exclude sulfate corrosion of concrete and anodic corrosion of metal reinforcement.

4. Adjusting the macro- and microstructure of concrete increases the structural uniformity of concrete which increases the speed of ultrasonic waves by an order of magnitude and in turn increases the continuity of the concrete.

5. Structural modification of concrete in the process of hydration of cement permits to increase the strength indicators of heavy concrete.

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# Модифицированные бетоны для производства свайных фундаментов

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**Ключевые слова:** модифицированные бетоны; добавки; железобетонные свайные фундаменты; стойкость к воздействию агрессивных сред; сульфатная коррозия; водонепроницаемость; долговечность бетона; грунтовые воды.

**Аннотация.** В работе рассмотрены вопросы структурной модификации тяжелых бетонов олигомер-полимерными добавками. Установлено, что кристаллизация цементного камня протекает на макро – и микроуровнях. Макропоры заполняются продуктами кристаллизации частичек цемента, привитых на поверхности макромолекул поливинилхлорида (ПВХ). Миграция макромолекул ПВХ и олигомеров отходов коксохимической промышленности (ОКП) в дефектные зоны протекает за счет возникновения внутренних напряжений в процессе твердения и объемного сжатия, что обуславливает закрытие макро и микропор, а также трещин и капилляров. Таким образом, по комплексу физико-механических свойств, стойкости к сульфатной коррозии и морозостойкости исследуемые бетоны на основе структурно-модифицированного бетона могут быть использованы для производства свайных фундаментов устраиваемых в условиях сильно засоленных грунтов. Представленные результаты экспериментальных исследований свидетельствуют о достаточной коррозионной стойкости исследуемых бетонов.

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