

# **DRY BUILDING MIXES FOR REPAIR OF CONCRETE AND MASONRY STRUCTURES**

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## **Abstract**

The complex of the questions connected with development of dry mixes - modified compositions on a portlandcement basis is considered in the article. Such materials are applying for repairing of concrete and masonry structures by an injection. Also the basic requirements to material and the group of parameters - criteria of quality are described.

## **1. Introduction**

Last time in many branches the rate of physical deterioration of structures has reached critical volume questions of their repair are more and more urgent. That is why the production rate of dry building mixes for structures repairing by the industry of building materials has increased considerably. Such tendency also is caused by change of the modern building market structure where the main part of building works are carried out by a plenty small enterprises which do not possess technological equipment and the qualified experts of a necessary level. At the same time, a major factor of competitiveness of the small building enterprises is the ability to ensure a high level of works' quality.

This problem can be solved with the help of application of a dry building mixes complex having the following advantages:

- The significant part of technological operations is transferred from the operation site to the material producing enterprise where the advanced highly technological equipment and highly skilled experts are concentrated.
- Reduction of influence of the human factor on producing works quality.
- Opportunity of advanced technologies application for executing a small volume works.

Now wide nomenclature of dry building mixes used for various kinds of works are produced by industry. On the basic functional assignment they can be divided into the following basic groups: repair, plaster, floor, waterproofing, decorative etc.

In the article the complex of the questions connected with development of dry mixes - modified compositions on a portlandcement basis is considered. Represented materials are applying for repairing of concrete and masonry structures by an injection.

## **2. Application of dry building mixes for structures repairing by injection**

### **2.1. Area of application**

Repair - restitution works carried out by injection will be applied in the following cases:

- At appearance in concrete and masonry structures of force cracks caused by deformations of a structure, for restoration of integrity broken on blocks by cracks structure, providing their joint work and homogeneous perception of loading.
- At destruction of a material caused by insufficient carrying ability for restoration of destroyed material's body integrity.

### **2.2. Features of works' technology**

The main advantage of the given repairing system is the opportunity of works production without use of the special equipment and compactness of required operational space that is especially important at realisation of small volume repair works and in the constrained conditions of existing manufacture.

Injection grouts are prepared directly on an operation site by the manual electrotool or small batcher from one component dry mix. Injection is made with help of low-power compressors or self flowing (depending on conditions), without necessity of high pressure creation, that considerably simplifies system.

## **3. Methodology of a material's development**

### **3.1. Requirement to a material**

Proceeding from specificity of a repair work method the complex of the requirements to technological and physic-technical parameters of developed grouts is generated, main of which are the following:

1. Low viscosity of a grouts, with property saving on required level during the certain period of time. Required for providing of qualitative filling of damages.
2. Absence bleeding and sedimentation processes - infringement of uniformity of the grout's characteristics. Described material is high flowing that is why it is declined to display bleeding and sedimentation which can become the reason of spalling occurrence, decrease of durability of top layer of a cement composition paste and its destruction (fig. 1), that results in decrease of a material's work contact area in a crack. Also, the formed heterogeneity can become the reason of own pressure occurrence in a material caused by different deformation ability of layers on height (for example, shrinkage deformations of a top layer are increased as a result of its greater water contents and losses of a moisture further [1]). The development of process getting a critical level causes occurrence of a cracks grid on a surface of a material (fig. 2) and further destruction. One more aspect of negative influence of sedimentation processes is the problem of a pollution of technological equipment.

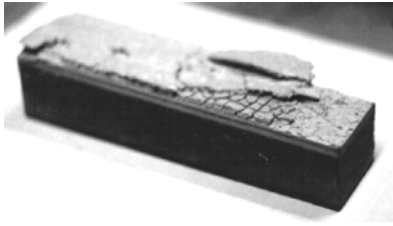


Fig. 1. Spalling and destruction of surface layer of a material caused by sedimentation processes

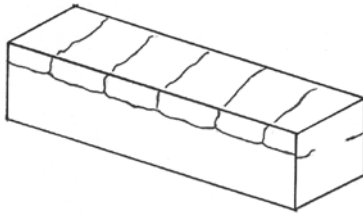


Fig. 2. Cracks pattern on 40x40x160 mm prism caused by material's sedimentation and non-uniform own deformations

3. Shrinkage deformations absence or control expansion of a cement paste. Because of the given repair material is high disperse cement composition without using of forming a skeleton aggregate, indemnification of significant shrinkage deformations which can take place is necessary. The performance of the requirement is necessary for prevention of an opportunity of repeated occurrence of a structure's body destruction in a liquidated defect's zone.
4. High rate of strength development at early ages.
5. Required level of adhesive for providing of contact durability with "old" concrete, for restoration of structures' integrity.
6. Corrosion resistance of a material.
7. Compatibility of repairing system material with a material of an under repair structure. Agrees [2], the compatibility is defined as physical, chemical, electrochemical and deformation balance of the characteristics between a repair material and material of a under repair structures that provides ability of a structure after repair to resist to pressure caused by action of bodies deformations, chemical and electrochemical influences without failures and damages during the nominated period of time.

### 3.2. Complex of properties modifiers

The achievement of a necessary level of described above properties is possible by the application of the modifying admixtures complex:

- Water-reducing and plasticizing admixtures influencing on reological property of a grouts – superplasticizers.
- Regulators of setting and hardening rate of a cement paste.
- The additives raising water retain ability of a grouts.

- The admixtures providing shrinkage deformations' indemnification or nominated expansion without occurrence of significant internal pressure.

At use of a modifiers' complex in a dry mix, their compatibility has the significant influence on the grouts and pastes properties. Because of dissolution for all of admixtures occurs the same time there is a probability of action efficiency decrease caused by the negative influence of one admixture to another. Other aspect is the problem of the contradiction of some technological requirements to a material (for example, reological property and water retain ability) that can be solved by an optimum combination of each component concentration.

### **3.3. Tests methods complex**

For definition of admixtures - modifiers influence on properties of a material, their efficiency and conformity of the modified structures to the showed requirements, the complex of tests methods providing system approach to quality control of a developed material was generated.

The complex consists of the following tests:

- Definition of viscosity of a grout (at  $t=0, 15, 30$  min) with the help of viscosimeter.
- Definition of sedimentation processes availability (at  $t=30$  min), it is defined as a difference of densities of the selected grout samples from different levels.
- Definition of strength parameters: compression strength and tensile strength (tensile strength can be consider as an indirect parameter of internal pressure and local cement paste destruction).
- The rate of own deformations definition (shrinkage and expansion) during the time and depending on losses of a moisture. Modelling of a material's behaviour depending on losses of a moisture on samples - prisms  $40 \times 40 \times 160$  mm with the module of an open surface  $m=1,125$  (completely open surface) and  $m=0,125$  (hydroisolated surface, except for end faces).
- Water retract definition (as indirect characteristic of corrosion resistance of a material). Definition of porosity parameters of a paste as a water retract kinetic parameter.

### **Conclusion**

Because of in many branches the rate of physical deterioration of structures has reached critical volume questions of their repair are more and more urgent. The application of dry building mixes allows to carry out high quality repair work and the same time technological process of repair work producing becomes simpler considerably.

At designing a dry mix - base of repair system, the analysis of factors that can influence on repair system work and structure state as so as opportunity of change them during the time is necessary.

Given in article system of a material parameters - criteria of quality, methods of their definition, allows to estimate behaviour of a grout in a structure to ensure reliable and durable work both repair system and structure as a whole.

## References

1. Вплив вологовтрят ремонтного матеріалу на його деформаційну сумісність з матеріалом конструкції / Зінкевич А.М., Пшінько О.М., Савицький М.В. // Сб.науч.тр.: Строительство, Материаловедение, Машиностроение; Вып. №21. – Дн-ск: ПГАСиА, 2002.-С.97-102.
2. Morgan D.R. Compatibility of concrete repair materials and systems // Construction and Building Materials, 1996, Vol.10, No.1.- PP.57-67.