



WORK GUIDELINE No. 6

Concrete segregation repair

CONTENTS

- 1 Purpose**
- 2 Scope**
- 3 Definition**
- 4 Preliminary conditions**
- 5 Safety precautions**
- 6 Personnel**
- 7 Materials for concrete segregation repair**
- 8 Procedure of concrete segregation repair**
- 9 Quality assurance**
- 10 Enclosures**

1 Purpose

The purpose of the present WG No. 6 is to unify the approach to repairing defects called concrete segregations (nests).

Conditions to be fulfilled before of concrete segregation repair, and general instructions for the repair of local concrete segregations are provided.

2 Scope

In the present WG No. 6 repair of concrete segregations (nests) in reinforced concrete structural members such as piers, abutments, beams, carriageway slabs, etc. is considered.

3 Definition

Segregation or a nest is an area of major porosity on the concrete surface or in the concrete interior, which visually differs from the remaining surface (surface non-homogeneity). Individual mineral aggregate grains with insufficient quantity of hydrated cement and voids among those grains can be noticed. Within a heterogeneous concrete composition, grouping and setting apart of individual concrete components have taken place due to different cohesiveness (separation of heavier particles or flowing away of cement laitance).

Causes leading to the segregation phenomenon both in the concrete and on the concrete surface are not discussed in this guideline.

In view of the porosity depth and structure, segregation can be divided in the following types:

3.1 Surface segregation

Surface segregation occurs on the surface and does not extend to the concrete interior by more than the dimension of the maximum grain of 3.1 cm.

3.2 Depth segregation

A macro-porosity of concrete structure occurs inside the concrete or through the entire cross-section of a structural member.

3.3 Fine-grained segregation

A uniform surface porosity maximum 5 mm deep. Only cement laitance and fine grains are missing.

3.4 Coarse-grained segregation of major porosity

Such segregation type occurs when certain grain size of mineral aggregate, and cement laitance are missing in the concrete.

4 Preliminary conditions

The following preliminary conditions shall be fulfilled before concrete segregation repair works:

4.1 Identification of segregated areas

4.1.1 When segregation is noticed on the concrete surface after striking the formwork, the supervising Engineer shall be informed immediately.

4.1.2 Segregation depth and extent shall be assessed. The segregation depth shall be assessed by cutting-out the concrete at not less than three locations in the segregation area. The segregation extent shall be assessed by hammering and by ultrasonic examination of the segregation surrounding area. The established area of porosity shall be marked with a colour chalk.

4.1.3 Record of presence of segregation shall be kept. It shall comprise the following data:

- Project/structure name, structural member location;
- Casting date;
- Concrete grade;
- Segregation depth and extent;
- Description of segregation.

5 Safety precautions

Taking account of the location (height above ground) of segregated areas to be repaired, adequate safety requirements shall be met: placing scaffold, protective railing, protection from falling pieces during cutting-out the concrete, etc.

Structural members where concrete segregation has taken place must not be loaded before to completion of the segregation repair.

6 Personnel

Only skilled workers who have already been engaged in the repair works of the same or similar kind may only carry out concrete segregation repair works. Before the works, all the personnel shall be instructed in all the particularities concerning both repair works and quality requirements.

7 Materials for concrete segregation repair

7.1 Materials for concrete segregation repair

- Adhesion coat: SINIT L.A. 2S (Epoxy Liquid Adhesive 2S)
- Coarse mortar: SINIT #108 MORTAR (30 mm of thickness in a single layer)
- Very fine mortar: SINIT #108 MORTAR FF(3 mm of thickness in a single layer).

8 Procedure of concrete segregation repair

Surface segregation (of maximum depth of – 4 cm, i.e. up to the reinforcement) with emphasized single-size aggregate texture shall be repaired in accordance with the following instructions:

- Removal of concrete to reach a sound and solid concrete;
- Moistening of concrete surface up to saturation;
- Application of the adhesive coat [SINIT L.A. 2S](#) in accordance with the manufacturer's instructions;
- Application of the coarse micro-reinforced repairing mortar [SINIT XXX](#) in accordance with the manufacturer's instructions. Maximum mortar thickness applied to vertical and ceiling surface in a single layer amounts to 2.5 cm;
- Surface finishing after the coarse mortar has hardened; fine micro-reinforced mortar [SINIT XXX](#) in a thickness of up to 2 mm shall be applied;
- After-treatment of repaired surfaces by moisturizing, which shall last at least 4 days ([covering with wet felt and PVC foil](#)).

Depth segregation extending to maximum 2/3 of the concrete thickness shall be repaired in accordance with the following instructions:

- Removal of concrete in the segregation area to a depth of at least 2 cm;
- Execution of boreholes to consent placing of injection tees. Boreholes shall be so depth as to reach the sound concrete. Borehole diameter shall be [12 mm](#), and they shall be spaced at 15 to 25 cm intervals;
- Blowing out of the boreholes;
- Inserting metal injection tees;
- Slight moisturizing of the surface;
- Sealing of surfaces with micro-reinforced coarse mortar. The latter shall be after-treated by moisturizing, which shall be completed two days before injecting, however it shall last not less than 4 days;
- Testing penetration between injection tees by of compressed air;
- Injection with a low viscosity epoxy resin [SINIT INJECTION 1](#). Injecting shall commence at the lowest tee. The valves of other tees shall remain opened;
- Removal of metal tees by cutting;
- Surface finishing with fine micro-reinforced mortar [SINIT XXX](#);
- After-treatment by moisturizing for not less than 4 days.

Depth segregation through the entire cross-section of structural members of substantial porosity among grains shall be repaired in compliance with the following instructions:

- Cutting-out of concrete on both sides to a depth of 2 cm;
- Drilling \varnothing [18 mm](#) of [10 cm](#) depth boreholes on both sides and spaced at [25 cm](#);
- Blowing-away and slight moisturizing of the surface;
- Inserting PVC pipes;
- Sealing the surface with coarse micro-reinforced mortar [SINIT XXX](#);
- Testing penetration between pipes by of compressed air;
- Injection with [cement swelling injection compound](#) starting from the lowest pipe;
- Removal of metal tees by cutting;

- Surface finishing with fine micro-reinforced mortar [SINIT XXX](#);

Considering the fact that the segregation texture is locally changing, each individual condition shall be estimated on the bridge structure itself, and the number of injection spots shall be specified.

Depth segregation through the entire cross-section of structural members of minor porosity among grains shall be repaired in accordance with the following instructions:

- Cutting-out of concrete on both sides to a depth of 2 cm;
- Drilling \varnothing 12 mm of 5 cm depth boreholes on both sides, and spaced at 15 cm;
- Blowing-away and slight moisturizing of the surface;
- Inserting injection tees;
- Sealing the surface with micro-reinforced mortar [SINIT XXX](#);
- Testing penetration between injection tees by of compressed air;
- Injection of a low viscosity epoxy resin [SINIT INJECTION 1](#) starting from the lowest tee;
- Removal of metal tees by cutting;
- Surface finishing with fine micro-reinforced mortar [SINIT XXX](#);

Considering the fact that the segregation texture is locally changing, each individual condition shall be estimated on the bridge structure itself, and the number of injection spots shall be specified.

9 Quality assurance

The following shall prove the concrete segregation repair quality:

- A quality certificate for repair mortars and injection resins shall be submitted before the works;
- Repaired surfaces shall be examined by ultrasound;
- A core extending through the entire structural member thickness, or to certain depth only, measuring 50 mm in diameter, shall be taken by drilling-out in the repaired area as directed by the supervising Engineer;
- Three prisms of 4 x4x16 shall be made from the micro-reinforced repair mortar daily for the current control needs;
- Once a day a sample of injection compound shall be taken: epoxy resin shall be poured into a mould of 10x10x100 mm, whilst cement injection compound into a can measuring 100 mm in diameter, and 100 mm in height.

10 Enclosures

Fig. 1: Repair of concrete surface segregation

1st step: Reinforced concrete structural member

- Identification of segregation
- Reporting to supervising Engineer on present condition
- Assessment of segregation extent and depth
- Ultrasonic examination of surrounding concrete
- Keeping a record
- Acquirement of approval to perform repair works

Concrete is segregated on the surface (surface segregation – not deeper than up to the steel reinforcement)

2nd step:

- Cutting-out of segregated concrete up to a sound and solid substrate
- Moisturizing the surface up to saturation
- Application of adhesive coating
- Damage re-profiling with micro-reinforced mortar

Adhesion coat

Re-profiling

Finishing layer

3rd step:

- Visual inspection and eventual ultrasonic examination
- Record of concrete segregation repair

Fig. 2: Repair of concrete segregation in depth (however not through the entire cross-section)

1st step:

Reinforced concrete structural member

- Identification of segregation
- Reporting to supervising Engineer
- Assessment of segregation extent and depth
- Ultrasonic examination of surrounding concrete

Area of concrete depth segregation

- Keeping a record

- Request of approval to perform repair works

Steel reinforcement

2nd step:

- Surface chiselling out of segregated concrete up to a depth of 2 cm
- Drilling \varnothing 12 mm boreholes up to a depth of sound concrete, spaced at 15 cm
- Inserting injection tees
- Sealing of surface with micro-reinforced mortar
- Injection with epoxy resin
- Removal (cutting) of tees
- Surface finishing

Boreholes

Surface sealing with [repair cement mortar](#)

3rd step:

- Visual inspection and occasional ultrasonic examination

- Record of concrete segregation repair

Fig. 3: Detail of inserting injection tees

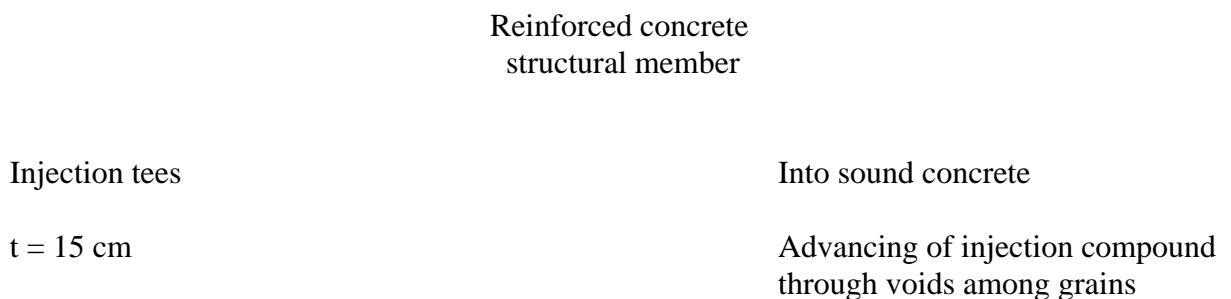


Fig. 4: Repair of concrete segregation through the entire cross-section

1st step:

- Identification of segregation
- Reporting to supervising Engineer
- Assessment of segregation extent and depth
- Ultrasonic examination of surrounding concrete
- Keeping a record
- Request of approval to perform repair works

Injection tee

Surface porosity sealing with [cement mortar](#)

2nd step:

- Drilling \varnothing 12 mm boreholes on both sides up to a depth of 6 cm, at 15 cm interval.
- Inserting injection tees
- Sealing of surface and tees with [cement mortar](#) (???) (concrete surface to be slightly moistened previously)
- Pause lasting two days until mortar hardens
- Injection
- Removal (cutting) of tees
- Surface finishing with [cement mortar](#) (???)

3rd step:

- Visual inspection of surfaces and occasional ultrasonic examination
- Carrying out other activities to prove the quality, if so required by the supervising Engineer
- Record of concrete segregation repair.