DEFECTS IN CONCRETE DAMS

GROZA Othilia-Mariana¹, TODA Cornel²

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This paper is a brief presentation of some "weaknesses" that may occur in the concrete dam structure. In the early phase of these defects, they are not a threat to safety operation of dams, but in time and if not corrected it can become a problem.

INTRODUCTION

Deterioration of the concrete surface is a harmful modification or concrete which can cause his destruction. In most cases the initial crack is both a cause and an effect of deteriorating concrete. The concrete surfaces exposed to atmospheric agents of change in the action, infiltration, chemicals or other items, the cracks lead to further deterioration. At the same time, cracking is an indication that the concrete damage occurs.

MATERIAL AND METHOD

1. Defects in Concrete

1.1. Structural Cracks endanger the structural integrity of an item. Structural cracks are often in some parts of the dam where the concentration of efforts appear, for eg:

- corner opening;
- areas with large temperature gradients
- discontinuities in the foundation caused by different materials, change the alignment or movement in the foundation or slopes.

Structural cracks (figure 1) are often irregular, running at an angle to the major axis of the dam and can change direction abruptly. These cracks are usually open and are often accompanied by movement of adjacent concrete observable crack.

Opening tends to increase as a result of continuous requests and creep of concrete. Cracks along the joints so badly treated may occur due to

¹ Ph.D. Lecturer Eng., University of Oradea, Faculty of Architecture and Constructions, e-mail: om_groza@yahoo.com, Romania
² Junior Eng., S.C. Hidroelectrica S.H. Oradea, e-mail: cornel.toda@hidroelectrica.ro, Romania
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structural movements, changes in size or chemical reactions. If they were not provided by design, could represent a danger for the integrity of the dam and it is recommended monitoring them.

1.2. Interlamelare Cracks to contraction on drying (figure 2).

When concrete is exposed to cycles of wetting and drying, it expands and contracts. During this process there are changes in volume, and inside the concrete develops tensile stresses that cause cracking. Due to drying shrinkage cracks are generally fine and shows no signs of movement. They are usually shallow, but can be several meters long. On drying shrinkage cracks often occur immediately after the installation, as the water evaporates and grout material contracts.

These cracks do not usually go too far deep, and it wouldn’t represent a danger to construction.

Fig. 1. Structural cracks irregular vertical displacement

Fig. 2. Cracks in joints

2. Surface’s Defects

Decay is the deterioration of concrete into tiny particles, or crushing due to certain causes.

- Spalling (figure 3) is the loss of pieces of rock, concrete or a surface, usually due to compression, impact or abrasion.

Cutting edge often appear at the concrete element (eg along cracks, joints and corners or near the embedded objects).

Cutting may be due to various causes:

- blows to the concrete;
- alteration under the action of atmospheric agents;
- internal pressure (for example, from a corroded reinforcement bar near surface);
• expansion of the mass concrete.

Although the surface areas of concrete cutting is not represent such a serious problem, cutting can lead to secondary phenomena.

![Fig. 3. Cutting along a crack](image)

- **Efflorescence** is a storehouse of mineral salts being deposited on the surface of concrete. Efflorescence is caused by water from joints and cracks, which through dissolving formed the hydroxid or calcium carbonate deposited on the concrete surface. As the water evaporates, (on) the surface it is forming a hard deposit, white calcium (calcite). As calcium is extracted from the concrete around the joint, the opening can be increased. This leads to increased infiltration and more rapid deterioration. However, it should be noted that the dissolution and extraction of calcium may be a process of self repair. In some cases, calcium may be deposited around the joint so that it seals the opening against infiltration.

- **Drummy concrete** is concrete that has a goal, a separation or other weakness in the concrete. Drummy concrete is detected by the characteristic sound when hit by a clamp.

- **Cone cracks** are small portions of the surface concrete to crack due to internal pressure, leaving a shallow conical depression.

- **Pitting corrosion** results from the development of relatively small holes in concrete surface. It is caused by the decay off.

- **Exfoliation** is in the form of flakes or a peeling concrete surfaces [1].

3. **Other Common Causes of Concrete Deterioration**

- Inappropriate combination of concrete components.

- Chemical attack: the attack of sulphates, acid attack and alkali-aggregate reaction.
Sulphate attack is a chemical reaction and / or physical sulphates in the water between the soil and concrete. The reaction causes expansion or dilation of concrete, leading to disintegration. Concrete attacked by sulfate is light and easily detaches when hit with hammer. Other typical symptoms include sulphates attack cracking, chipping, staining and decay.

Acid attack is usually the result of bacterial action on hydrated calcium hydroxide from cement, limestone or dolomite aggregates. In most cases the reaction results in washing water soluble compounds. Acid attack symptoms may include efflorescence, cracking, chipping and discoloration.

4. **Metal Pitting**

When the concrete is deteriorating water can reach at the valves and can cause their corrosion. Oxide is formed during the corrosion results in an increase in volume which causes cracking and chipping of the concrete layer above. Rust is the most common form of pitting (figure 4).

Surface defects have a progressive character, while remaining constant, being constant in time.

![Fig. 4. Metal pitting](image)

5. **Interns Defects**

- **Segregation** is a gap left in concrete when the mortar fails to fill the spaces between particles of coarse aggregate. Segregation is caused by poor implementation practices, such as improper mixing of concrete, segregation due to improper methods of formal work or inadequate vibration after casting molds.

An alkali-aggregate reaction is an unwanted chemical reaction between cement and aggregates that cause an abnormal expansion and cracking. There are two main types of alkali-aggregate reaction: alkali-carbonate reaction and alkali-silica reaction. Early indications of these reactions include cracking of the network, usually concentrated in areas that
are exposed to moisture, efflorescence, a substance like a gel in the pores, cracks and openings in concrete in case of alkali-silica reaction.

- **Stratification** is the separation of concrete too wet or too vibrated in horizontal layers, with the location of material by size becoming smaller at the top.

Stratification leads to the formation of irregular strength concrete, creating weak areas and slide deployment areas.

6. **Local Defects**

- **Damage from the impact**
  Sometimes, deterioration of the concrete surface is due by the mechanical impact. For example, the impact with a truck, boat, truck or scree slope damage, or splinter a portion of the concrete surface. Although these claims are local, they may lead to other damage, such as altering under the action of atmospheric agents allowing moisture to penetrate into concrete.

- **Movements** (figure 5) may be caused by factors such as: compaction or displacement slopes or foundation, settling or movement, chemical reactions in concrete, structural behavior of the dam, other applications for exceptional magnitude (e.g., under pressure, earthquakes, extreme variations in temperature).

There are two main types of movement in a concrete dam:
- Deviations of alignment means any variation from the original configuration of the structure.
- Differential movements occur when part of a structure moving to another part adjacent.

**Fig. 5. Drift and shift differential**

- **Infiltration through joints and cracks**
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The main causes are: the existence of fissures, open joints, seals damaged, pipes that allow the flow, damaged or defective concrete.

Signs of infiltration can vary from a damp or wet surface to concentrate the water flow. The most common signs of infiltration at a concrete dam are downstream of the dam parament moisture on the moisture in the galleries, smudging or sediment deposits along joints and fissures, or flowing water springing from the joints or cracks parament downstream flows important galleries channels, drainage system and îndrenuri.

Infiltration could have as result a quickly deterioration of concrete, cement concrete washing, mass loss and a reduced structural strength.

Seepage (infiltration) through the foundation and slopes can be caused by the following conditions:

• foundation damage;
• seal broken veil;
• insufficient foundation drains or clogged;
• rolling joints or openings in the foundation or the slope;

The signs which indicate infiltration may include:

• wet areas on the slopes or downstream of the dam foundation
• vegetation growth in the downstream of the dam lake;
• the instability of the slopes downstream of the dam
• AMC measurements indicating negative pressure values that exceed the accepted account.

Seepage consequences include: under high pressure and differential movements in dam foundations solubilizing materials, instability (slip) with the possible collapse of slopes and foundations in some cases [2].

CONCLUSIONS

These defects, if they will not be corrected in usefull time can become a serious problem for the security of the concrete dam; for example now it is been observed that there are some infiltrations at the dam from Tileagd. Soon will start the process of rehabilitation.

REFERENCES
2. *** ISPH Bucureşti (1984), Accidente la construcţii hidrotehnice.