Abstract

This study is about expansive reactions in concrete and their effects in dams. This topic is very interesting due to the great number of structures of this type that exist in the world and the important problems of operability caused by these phenomena.

We will study three types of reactions: the alkali-silica reaction (ASR), the alkali-carbonate reaction (ACR) and the sulphate attack, whether internal or external. ASR and ACR are also known as alkali-aggregate reaction (AAR) since they take place when the aggregates react with the alkalis of the intermediate solution of cement.

These three reactions are very complex including numerous factors, special relevance has the water of an external source. For this reason, dams are the concrete structures more susceptible to suffer these attacks, since they are in permanent contact with the water of the reservoir.

There are many cases of dams affected by this type of phenomena in the whole world, only in the data of ACRES International there is information of 100 dams affected by the alkali-aggregate reaction. But there can be more if we consider those which are not considered in this information or have not been identified yet and dams affected by sulphate attack.

Effects in the dams are very important and include loss of strength due to internal cracking, surface cracking, increase of permeability, changing dimensions, load transfers and problems with the mobile elements. However, the development is slow and there is no risk of rapid failure in a dam that is often inspected.

Time needed to develop changes very much depending on the type of reaction, the type of dam and the characteristics of it, and can range from a few years to decades. The most usual symptoms that suggest that there is taking place one of these reactions are the presence of reaction products (gel in ASR case and ochre tonality in case of oxidation of sulphurous aggregates), map cracking and movements in the body of the dam upwards and toward upstream.

We can find these reactions in two stages: the first one is when a dam is projected and the aggregates are potentially reactive and the second one is when in exploitation is stated that these phenomena are developing. In both cases, there exist a series of performances that can be carried out and that will minimize the effects of the expansions.

In project phase there are two possibilities, which can be combined too: using cement with low alkali content or using additions. The most usual additions in these cases are pozzolans (ground granulated blast furnace, microsilica and flying ashes), but in the same way there exists the possibility of using lithium compounds or air entrainment.

When the dam is in exploitation, the possible performances would vary depending on the aim. If we try to stop or slow down the reaction development, we would carry out passive performances as the waterproofing and the injection to avoid the presence of water into the body of the dam. If the reaction has provoked problems in the operability of the dam or is destabilizing it, active actions would be taken. These can consist of the execution of slot cutting to relieve tensions or the installation of anchorages to stabilize the dam.

In this study is also included information of many cases of dams studied exhaustively to be able to have concrete information of structures in which the reaction has been identified positively. This is very important for a technical expert in dams who has to face up to this problems.