Summaries of the specifications and recommendations in 12 european countries were published in 1995 in CEN Report CR1901.

Tests to evaluate potential alkali-silica reactivity of aggregates

Many test methods have been proposed for identifying potential reactivity of aggregate all over the world. These may be classified into three types:

• **petrographic examination** – identifying the types of minerals in aggregate or concrete section by observation using microscope or other aid by an experienced petrographers. This method can give suggestions as for whether the aggregate is potentially reactive or not. Because the uncertainties involved in the test, the method is generally used as a screening test as a part of an investigation.

• **chemical analyses** – used to identify potential reactivity of aggregate, for example, evaluation of aggregate reactivity by measuring the amount of dissolved silica and the reduction of alkalinity in the reaction alkali solution.

• **expansion tests** – mortar bars or concrete prisms are made using the aggregate to be investigated. There specimens are then put in to a specified condition and the expansion of the specimens are measured. Since at normal climate conditions the reaction will take at least a few years or even decades to complete, measures to accelerate the reaction are commonly adopted for such tests, so in such a condition the AAR and its expansion complete within a few months up to one year [4].

All the methods have their limitations. Some succeeds in identifying reactivity for certain aggregates whereas fails for others – so it is difficult to ascertain an aggregate is absolutely non-reactive. At the moment, the main issue is to be able quickly determine the reactivity of an unknown aggregate.

French methods for evaluating aggregates reactivity for NPP structures

The alkali content of aggregates shall be controlled in order to limit the total alkali content of the concrete [5]. The recommendations relating to protection against the alkali-reaction are contained in FD P 18-464 [5]. The classification regarding ASR shall be made by a specialized laboratory, in accordance with these recommendations and in accordance with: FD P 18-542 [6] and NF P 18-454 [8].

Each type of aggregate (and aggregate combination) proposed to be used in the concrete shall be classified as (Figure 1):

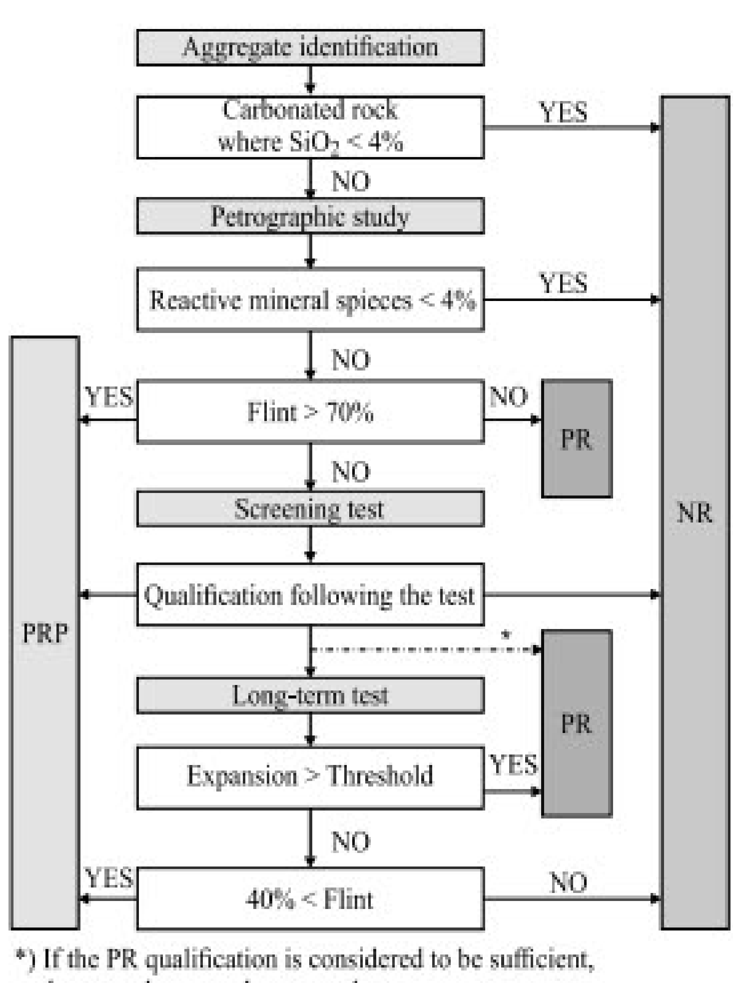
■ non-reactive (NR) – describes aggregates for hydraulic concretes which, whatever their conditions of use, will not cause alkali-reaction problems

■ potentially-reactive (PR) – aggregates likely, under certain conditions, to cause alkali-reaction problems;

■ potentially reactive with pessimum effect (PRP) – aggregates which, although rich in reactive silica, can be used with no risk of problems, provided that their use meets the conditions described in FD P 18-464 [5].

Nonqualified (NQ) aggregates shall not be used.

Screening test uses a greatly accelerated procedure capable of diagnosing, in less than one week, the reactivity of the alkalis in an aggregate which is NR, PR or PRP – reference method is accelerated autoclave test on mortar (5 days). Long-term test is a diagnosis procedure which, although accelerated in comparison with the reaction kinetics observed on constructions, is sufficiently close to actual conditions to take into account the effective sensitivity of the aggregates. Expansion test on concrete samples is taken at: 1, 2, 3, 4, 6 and 8 months.



*) If the PR qualification is considered to be sufficient, the procedure may be stopped

Fig. 1. Sequence of tests for identifying aggregates reactivity [2, 6]

Rys. 1. Kolejność oznaczeń reaktywności alkalicznej kruszyw [2, 6]

The prevention level (in accordance with [5]) respect to ASR shall be *level C* (where no risk of appearance of any damage is tolerable, such as exceptional constructions, nuclear power stations, prestige monuments, etc.). Aggregates shall be natural as defined in EN 12620 [15], at least comply with EN 12620 and with code B of NF P 18-545 section 10 [9] that calls for FD P 18-542 [6].

NR aggregates shall be used in principle. However, in consideration of the local deposits, the use of PR or PRP aggregates is permitted but in the case where the concrete mix contains at least one aggregate or mixture classified PR or PRP by a specialized laboratory, one of the following conditions shall be respected for thenominal concrete mix [16]:

■ where: Tm (Na_2O eq.) in the concrete mix is ≤ 1,4 kg/m^3, the nominal concrete mix is accepted;

■ where: 1,4 kg/m^3 ≤ Tm ≤ 2,5 kg/m^3, the concrete mix is accepted if the test for non-reactivity described in FD P 18-464 [5] is successful;

■ where the concrete mix includes a cement or binder with a slag content ≥ 60%, or a fly ash content ≥ 40%, or also where a ternary cement or binder have a fly ash and slag content such that [(amount of ash/40)+(amount of slag/60)] ≥ 1:

– if the active alkali content of the cement or binder is < 0,75% Na_2O eq. and Tm is ≤ 2,5 kg/m^3: no additional requirement;

– if Tm > 2,5 kg/m^3, the concrete mix is accepted if the test for non-reactivity described in FD P 18-464 [5] is successful.

Tm is the average active alkali content of the nominal concrete mix. It equals the sum of the active alkali introduced by each constituents (aggregates, cement, admixtures, etc.) in terms of the percentage of equivalent sodium oxide (%Na_2O eq. = 0,658%K_2O + %Na_2O).

The binder contributes to Tm on the basis of its alkali content averaged throughout one year. For long lasting works, the variation of active alkali content shall be measured at least every year. Where aggregates are deemed to be PR, the qualification test shall include a non-reactivity test of the nominal concrete mix. This test shall be carried out using aggregates which are representative of those to be used in production.