Appendix 9.2 Measures to control alkali silica reaction

a) The contractor shall either use non-reactive aggregates (as defined in sub-clauses (b) or (c) below) or restrict the content of equivalent sodium oxide in the mix.

b) Coarse aggregates and fine aggregates that each contain at least 95% (by weight) of one or more of the rock or artificial types in Table - 11.2.1, shall be considered to be non-reactive, provided they are not contaminated with any opal, tridymite or cristobalite or contain a total of more than 2% (by weight) of chert, flint or chalcedony taken together.

Table - 9.2.1 Aggregate Types

Air cooled blast furnace slag	Granite
Andesite	Limestone
Basalt	Marble
Diorite	Microgranite
Dolerite	Quartz
Dolomite	Schist
Expanded blast furnace slay/clay/shale/slate	Sintered pulverised fuel ash (pfa)
Feldspar	Slate
Gabbro	Syenite
Gneiss	Trachyte
	Tuff

In the case of quartz it shall not contain quartzite or more than 30% (by weight) highly strained quartz. The quartz shall be classified as highly strained if the petrological examination of thin sections of grains give an average undulatory extinction angle of more than 25 degrees. The extinction angle shall be measured on at least 20 separate grains.

c) When the proportion of chert or flint is greater than 60% (by weight) of the total aggregate is shall be considered to be non-reactive provided that it contains no opal, tridymite or cristobalite.

d) Feldspar, quartz, chalcedony and opal, tridymite or cristobalite are minerals.

e) The petrolgraphical examination of aggregates for alkali silica reaction shall be carried out by the specialist consultant engineer.

f) When the coarse and fine aggregates are not accepted as wholly non-reactive the amount of equivalent sodium oxide shall not exceed 3.0kg in any cubic metre of concrete.

g) The equivalent sodium oxide content of the cement shall be taken as that of the proposed quantity of cement in the mix, with 10kg of cement added for each cubic metre of concrete to allow for tolerances in batching. For Portland cement the acid-soluble alkali content shall be used and for slag and pulverised fuel ash the water-

soluble alkali content.

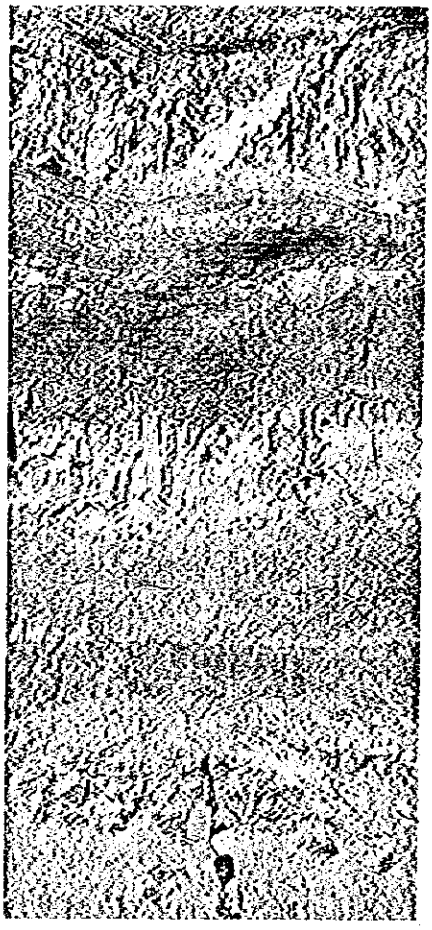
h) The acid-soluble alkali content of the portland cement shall be taken as the average of 25 daily determination of equivalent sodium oxide, plus twice the standard deviation for the period in which the cement was manufactured. The specialist contractor shall submit to the specialist consultant engineer test certificates furnished by the cement manufacturer giving the results of these tests.

l) The specialist contractor shall submit to the specialist consultant engineer test certificates giving the water-soluble alkali content of any slag or pulverised fuel ash to be used.

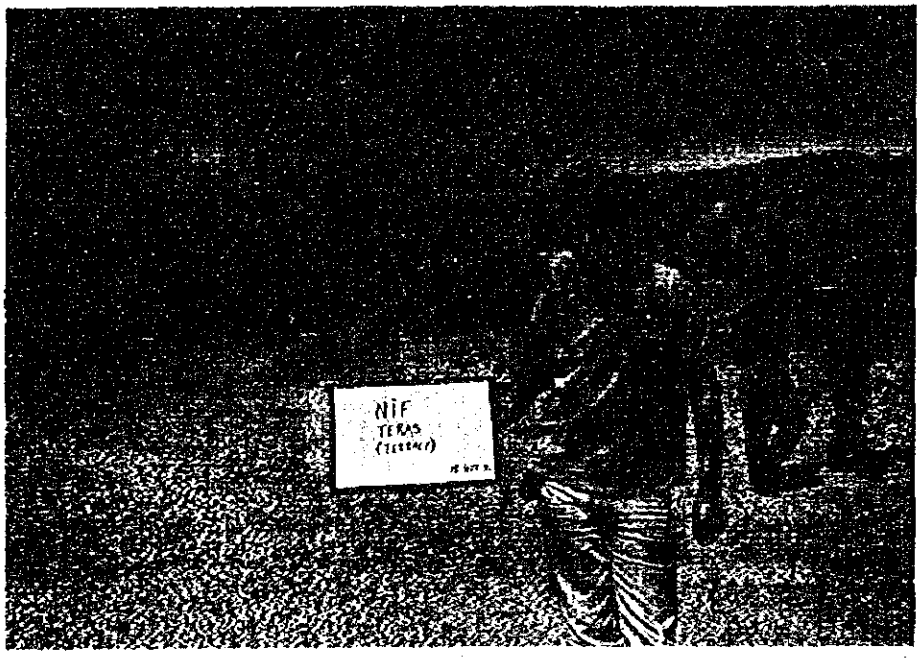
j) The equivalent sodium oxide (Na_2O) in the mix shall be calculated from the equivalent sodium oxide ($Na_2O+0.66\ K_2O$) in the cement (including slag and pulverised fuel ash), the chloride ion (Cl ion) in the aggregate and the amount equivalent sodium oxide (Na_2O) in any admixtures or water to be used in the mix as follows:

Eq. Na_2O (Concrete) = Eq. acid soluble Na_2O (cement, admixtures and water) +
Eq. water soluble Na_2O (slag and pfa) +
0.76 Cl ion (aggregates).

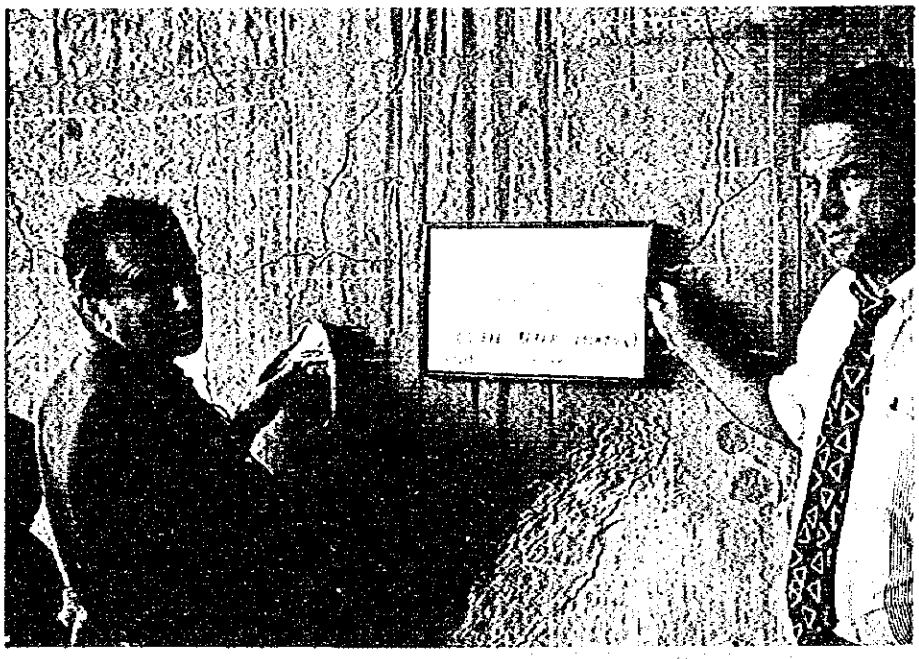
k) The equivalent sodium oxide content of the coarse and fine aggregate shall be calculated from the quantity of chloride ion present.

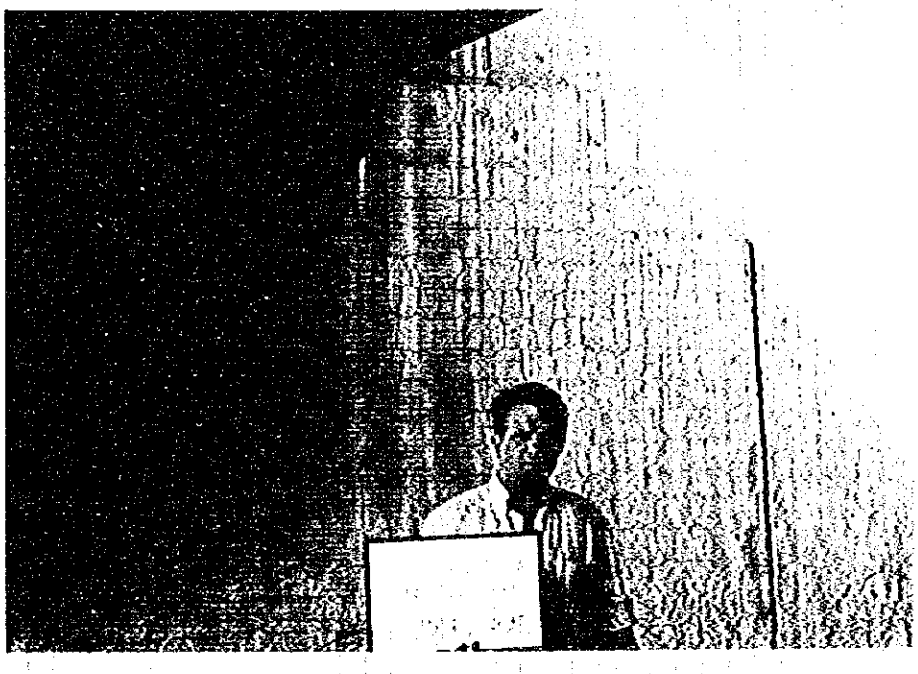


THE STUDY ON THE MAINTENANCE AND REHABILITATION of HIGHWAY BRIDGES in THE REPUBLIC of TURKEY AUGUST, 1996 ORIENTAL CONSULTANTS COMPANY LIMITED in association with JAPAN OVERSEAS CONSULTANTS COMPANY LIMTED	Figure - 9.2.1 Sand Sample Nif Teras

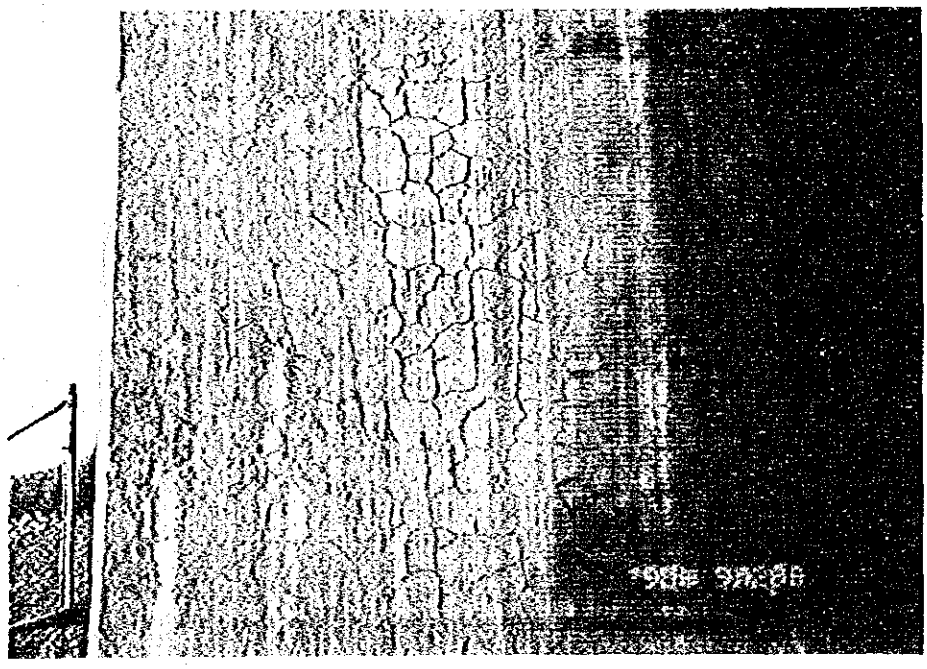


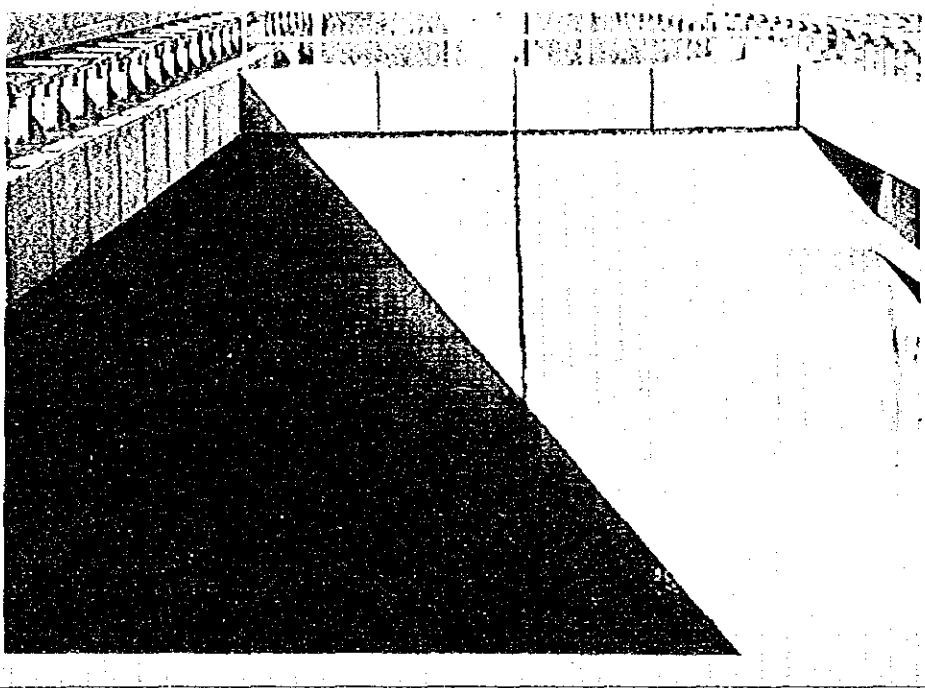
THE STUDY ON THE MAINTENANCE AND REHABILITATION of HIGHWAY BRIDGES in THE REPUBLIC of TURKEY AUGUST, 1996 ORIENTAL CONSULTANTS COMPANY LIMITED in association with JAPAN OVERSEAS CONSULTANTS COMPANY LIMTED	Figure - 9.2.2 Sand Sample Nif Teras Figure - 9.2.3 Sand Sample Location of Nif River





THE STUDY ON THE MAINTENANCE AND REHABILITATION of HIGHWAY BRIDGES in THE REPUBLIC of TURKEY AUGUST, 1996 ORIENTAL CONSULTANTS COMPANY LIMITED in association with JAPAN OVERSEAS CONSULTANTS COMPANY LIMTED	Figure - 9.2.4 Locating steel pier to drilling Note large cracking on pier Figure - 9.2.5 Cracking at Buca Mortarway Bridge





THE STUDY ON THE MAINTENANCE AND REHABILITATION of HIGHWAY BRIDGES in THE REPUBLIC of TURKEY AUGUST, 1996 ORIENTAL CONSULTANTS COMPANY LIMITED in association with JAPAN OVERSEAS CONSULTANTS COMPANY LIMTED	Figure - 9.2.6 Cracking at Abutment Buca Motorway Bridge Figure - 9.2.7 Cracking at Abutment Buca Motorway Bridge