# CHAPTER III

## SPECIFICATION FOR FINE AGGREGATE FOR CONCRETE

### 3.1 Construction Sand in General

The term sand is used to describe naturally granular materials of a certain grain size. It is used for building purpose are usually siliceous in composition and and should be as free from impurities as possible. They should contain no significant quantity of silt or clay (less than 3% by weight; in coarse aggregate it should not exceed 1%), since these need a high water content to produce a workable concrete mix. This in turn leads shrinkage and cracking on drying. Furthermore clay and shaley material tend to retard setting and hardening, or they may spoil the appearance. If sand particles are coated with clay they form a poor bond with cement and produce a weaker and less durable concrete. The presence of feldspars in sands used in concrete has sometimes given rise to hair cracking, and mica and particles of shale adversely affect the strength of concrete. Organic impurities may adversely affect the setting and hardening properties of cement by retarding hydration and thereby reduce its strength and durability. It should be pointed out that the test outlined in 812:1975 for the estimation of organic content, although it can be used as a guide, should not be regarded as providing conclusive evidence of

the presence or absence of harmful material. Organic and coaly matter also cause popping, pitting and blowing. If iron pyrite occurs in sand then it gives rise to unsightly rust stains when used in concrete. The salt content of marine sands is unlikely to produce any serious adverse effects in good quality concrete although it will give rise to efflorescence. Salt can be removed by washing sand.

Sands are used for building purpose to give bulk to concrete, mortars, plasters and renderings. For example, sand is used in concrete to lessen the void space created by the coarse aggregate. A sand consisting of a range of grade sizes gives a lower proportion of voids than one in which the grains are of uniform size. Indeed grading is probably the most important property as far as the suitability of a sand for concrete is concerned.

However, sand deposits in the study area contain no significant of silt, clay and organic matter. Thus this study will be dealt mainly with the grading and mapping of the sand in the study area.

## 3.2 Grading of Fine Aggregate

As afore-mentioned, grading is the most important property as far as the suitability of a sand for concrete is concerned. Four grading systems, the American National Standard of American Soceity for Testing and Mineral

(ANSI/ASTM), British Standard Institute (BS.) Indian Standard (IS.) and the Thai Industrial Standard Institute (TIS.) will be reviewed.

### 3.2.1 American National Standard of American Society for Testing and Mineral (ANSI/ASTM) C 33-80

The ANSI/ASTM recognises one grade of sandsand for concrete (Table 3.1)

Table 3.1 Fine aggregates (ANSI/ASTM)

| Sieve | Perccnt Passing |
|---|---|
| 9.5 mm (3/8 in) | 100 |
| 4.75 mm (No. 4) | 95 to 100 |
| 2.36 mm (NO. 8) | 80 to 100 |
| 1.18 mm (No. 16) | 50 to 85 |
| 600 m (No. 30) | 25 to 60 |
| 300 m (No. 50) | 10 to 30 |
| 150 m (No. 100) | 2 to 10 |

The minimum percent shown above for material passing the 300 and 150 microns sieve may be reduced to 5 and 0 , respectively if the aggregate is to be used in air-entrained concrete containing more than 400 lb of cement per cubic yard (237 kg/m3) or in nonair entrained

concrete containing more than 500 lb of cement per cubic yard (297 kg/m3) or if an approved mineral admixture is used to supply the deficiency in percent passing these sieve. Air entrained concrete is here considered to be concrete containing air entraining cement or an air-entraining cement or an air-entraining agent and having an air content of more than 3 %

### 3.2.2 British Standards Institution Specification for Aggregate from Natural Sources for Concrete BS.882

BS. 882(1973) recgnises four grades of sand which can produce good quality concrete (Table 3.2)

Table 3.2 Fine aggregates (BS.882, 1973)

| BS.410 test sieve | Percentage by weight passing BS sieves. Grading Zone 1 | Grading Zone 2 | Grading Zone 3 | Grading Zone 4 |
|---|---|---|---|---|
| mm. | | | | |
| 10.0 | 100 | 100 | 100 | 100 |
| 5.0 | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 | 30-70 | 55-90 | 75-100 | 95-100 |
| micron | | | | |
| 600 | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 | 5-20 | 8-30 | 12-40 | 15-50 |
| 150 | 0-10* | 0-10* | 0-10* | 0-15* |

Note: For crushed stone sand , the permissible limit is increased to 20 %. The 5 % tolerance permitted by 5.2 may , in addition , be applied to the percentages in light type.

The commonly used proportions of one part of fine aggregate to two parts of coarse aggregate, i.e. a fine aggregate percentage of about 33 % by weight of the total aggregate, are not always the most suitable for making concrete of high strength and good durability.

To make concrete of the best quality with the range of aggregates allowed, the mix should be suitably designed and the proportion of fine aggregate in the mix should be reduced as the fine aggregate grading becomes finer.

For example, in an investgation using an irregular shaped gravel of 20 mm. maximum size and a natural sand , concrete mixes of 1:6 proportion by weight were found to require the same water/cement ratio and to have the same work ability and strength , when the sand was graded to lie in the middle of Grading Zone 1, 2 , 3 and 4 if the sand contents were approximately 45, 35 , 30 , and 25 % by weight respectively.

The most suitable proportion of fine aggregate to be used for a particular cement / aggregate ratio will, however, depend on the actual grading , the particle shape

and the surface texture of both the fine and the coarse aggregate. In particular ,the correct design of the mix becomes approaches the coarser limit of Grading Zone 1 or the finer limit of Grading Zone 2. The suitability of a given fine aggregate for use with the available coarse aggregate should always by ascertained , this being especially important in respect of reinforced concrete structures.

### 3.2.3 Indian Standard IS:383-1970 Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Second Revision)

The Indian Standard recognises four grades of sand (Table 3.3) which is very similar to the BS. 882. The grading of fine aggregates shall be within the limits given in table 3.3 and shall be described as fine aggregates, Grading Zone I, II, III and IV. Where the grading falls outside the limits of any particular grading zone of sieres other than 600 microns IS sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve size on the coarse limit of Grading Zone I or the finer limit of Grading Zone IV.

Table 3.3 Fine Aggregates (IS.383_1970)

| IS Sieve Designation | Percentage Passing For | | | |
|---|---|---|---|---|
| | Grading Zone I | Grading Zone II | Grading ZoneIII | Grading Zone IV |
| 10 mm. | 100 | 100 | 100 | 100 |
| 4.75 mm. | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 mm. | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 mm. | 30-70 | 55-90 | 75-100 | 90-100 |
| 600 microns | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 microns | 5-20 | 8-30 | 12-40 | 15-50 |
| 150 microns | 0-10 | 0-10 | 0-10 | 0-15 |

Note:For crushed stone sands the dermissible limit on 150 microns IS. Sieve is increased to 20 percent. This does not affect the 5 percent allowance permitted in 4.3 applying to other sieve sizes.

Fine aggregate complying with the requirements of any grading zone in this table is suitable for concrette but the quality of concrete produced will depend upon a number of factor including proportions.

Where concrete of high strength and good durability is required, fine aggregate conforming to any

four grading zones may be used, but the concrete mix should be properly designed. As the fine aggregate grading becomes progressively finer, that is, form Grading Zone I to IV, the ratio of fine aggregate to coarse aggregate should be progressively reduced. The most suitable fine to coarse ratio to be used for any particular mix will, however, depend upon the actual grading, particle shape and surface texture of both fine and coarse aggregates.

It is recommended that fine aggregate conforming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

### 3.2.4 Thai Industrial Standard Institute TIS. Standard for Concrete Aggregates TIS.566-2528

The TIS. system is adopted from the IS. and ASTM systems.



Scope

1.1 This standard require type characteristic, sampling and testing for mass concrete.

1.2 This standard cover the requirements for aggregates, crushed or uncrushed , derived from natural sources, rocks , gravel and sands , for use in the production of concrete for normal structural purposes

including mass concrete works.

Definitions

For the purposes of this TIS. for thesis; the following definitions apply :

Fine aggregate

Aggregate mainly passing a 4.75 mm. and containing only so much coarser material.

Size and Grading of Fine Aggregate: The grading of given in table 3.4 and shall be described as fine aggregate, grading Zone I, II, III and IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 microns by a total amount not exceeding 5 percent, It shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron or to percentage passing any other sieve size on the coarse limit of Grading Zone I or the limit of Grading Zone IV.

Table 3.4 Fine Aggregates (566-2528)

| Sieve Desigation | Percentage Passing for | | | |
|---|---|---|---|---|
| | Grading ZoneI | Grading ZoneII | Grading ZoneIII | Grading ZoneIV |
| 9.5 mm. | 100 | 100 | 100 | 100 |
| 4.75mm. | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36mm. | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18mm. | 30-70 | 55-90 | 75-100 | 90-100 |
| 600 microns | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 microns | 5-20 | 8-30 | 12-40 | 15-50 |
| 150 microns | 0-10 | 0-10 | 0-10 | 0-15 |

Remarks

1. For crushed stone sands the dermissible limit on 150 microns. Sieve is increwased to 20 percent. This does not affect the 5 percent allowance permitted in applying to other sieve sizes.

2. It is recommeded that fine aggregate conforming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascentain the suitablity of purposed mixproportions.

It can be concluded that in any concrete mix, consideration should be given to the total specific which

has to be lubricated by the cement paste to produce a workable mix. The specific surface of a Zone 4 sand, because it is finer, is greater than that of a Zone I sand. However, similar specific surfaces, and heace similar workabilities, can be achieved by altering the proportions of the fine and coarse aggregate (BRS Digest 108, 1958). This means that it is not necessary to increase the water-cement ratio and therefore there is no loss in the strength of the concrete produce.

In this study the Grading Zones of TIS-566-2528 is adopted.