Table 1. Engineering Use of Consolidated and Unconsolidated Rock

Unit No.	Unit Name	Evaluation of Sample Tested in Relation to Variations within Unit*	Summary and Evaluation of Test Data**	Construction Material Suitability***										Remarks
				Concrete Aggregate	Asphalt Pavement	Surfacing, Wearing Course	Heavy Riprap	Ashlar Masonry	Light Riprap, Rubble Masonry	Embankment, Fill, Subgrade	Granular Material for Stabilized Base	Binder	Other	
1	Beach deposits	Representative of sands only. Much of unit is gravelly.	No tests for specific uses were made. Material contains a high percentage of soft coral and shell fragments. Some deposits are gravelly and contain durable particles, but most beach deposits consist chiefly of poorly graded sand.	Poor 1/	Fair to poor 1/	Fair to poor	---	Good 2/	---	Good 3/	Poor 3/	---	Good for blending sand for fine aggregate	1/ Material is poorly graded, requires some washing. 2/ Beach rock and coral-reef rock make good dimension stone; easily shaped; hardens on Exposure. 3/ Binder is essential to improve stability.
2	Alluvium	Tests made on alluvial clay soil of southern Okinawa, not representative of unit.	Test No. B was made on an undisturbed sample. Test No. A was made on remolded and compacted B material. Bearing capacity is poor and is only slightly improved by compaction.	Good to poor 1/	---	---	---	---	---	Fair to poor 2/	---	Good to poor 3/	---	1/ Gravel deposits of acceptable size and quality are few, inaccessible, and confined mainly to the mouths of a few principal streams in northern Okinawa. 2/ Applicable to average material. Local gradations containing more sand and gravel make better fill material and have greater stability. 3/ Clayey soils much as samples used in Test Nos. A and B are restricted to southern Okinawa.
3	Residual clay	Representative of most of unit.	Test No. C is a channel sample from the deep portion of this unit. Test No. D is an undisturbed sample. Compaction at optimum moisture content increases unit weight and improves the bearing capacity, but shear strength and cohesion are low.	---	---	---	---	---	---	Poor 1/	---	Good to fair	Good for brick and tile.	1/ Somewhat improved by careful compaction. Greatly improved by blending with granular material.
4	Clayey granular material	Average material of unit.	Test No. F was made on an undisturbed sample. Test No. E was made on a channel sample of material similar to Test No. F. The sandy clay portion of this unit is plastic, has a low unit weight, and fair bearing capacity.	---	---	---	---	---	---	Good to fair	---	---	Locally used for brick and tile.	
		Decomposed gravel, not representative of unit.	Test No. G was made on a channel sample of gravelly material from a different location in the unit. The decomposed gravel has only a fair bearing capacity, because it contains a high percentage of weathered particles.	Poor 1/2/	Poor 1/2/	Poor 2/	---	---	---	Fair	Good to fair	---	---	1/ Excessive overburden and poor quality make exploitation impracticable; processing would involve thorough washing and scrubbing to recover only limited volume of aggregate, with excessive waste. 2/ Gravel particles are soft and decomposed.
5	Limy granular material	Representative of most of unit.	Test No. H was made on a 12-ft. channel sample taken from a quarry. Specific gravity is somewhat low and absorption is high; abrasion loss is high; unit weight is low. Density is increased by compaction. Bearing ratio is excellent, with negligible swell.	Poor 1/	Fair to poor 2/	Fair to poor 2/	---	Good (some portions) 3/	---	Very good 4/	Very good 4/	---	---	1/ Hardened zones crush easily but produce much powdery fines. 2/ Compacted material cements itself on exposure. Good for combat construction and for light-duty pavement. 3/ Material hardens rapidly and gains strength upon exposure. 4/ Probably the best subgrade and base-course material on Okinawa; extensively used by the Military.
6	Coralline rubble	Representative of most of unit.	Test No. I was made on material taken from a 60-ft. channel sample. It was crushed at the laboratory to pass the 2-in. sieve. Abrasion and soundness losses are high; unit weight and specific gravity are low; absorption is quite high. Although material is not suitable as aggregate for Class A portland-cement concrete, it has excellent structural stability for base course, embankment, and fill.	Fair 1/	Good to fair 2/	Good to fair 2/	---	---	Fair 3/	Very good 4/	Very good 5/	---	---	1/ Requires considerable processing; waste is high in proportion to amount of recovery of durable aggregate for portland-cement concrete. 2/ The cemented layers and surface rock supply better aggregate for asphalt work. 3/ Supply is limited to surface layers and cemented zones; specific gravity and resistance to scour are low for river and harbor work. 4/ Probably the second-best subgrade and base-course material on Okinawa. Some quarries have supplied material superior to Unit 5, but because of cemented layers requiring blasting, the low percent of binder, and greater difficulty in compaction, it is a poorer material for this purpose than Unit 5. 5/ May require binder for maximum stability.
**** ⊗	Well-cemented limestone	Representative of most of unit.	Test No. J indicates material will make satisfactory aggregate for concrete and asphalt when properly crushed, washed, and graded. This rock is poorer in quality than crystalline limestone (unit 9), and requires more washing to remove clay impurities.	Very good 1/	Very good 1/	Wery good	Very good 2/	Good to fair 3/	Very good 2/	---	---	---	---	1/ Requires crushing, washing, and screening. Screenings will require the addition of blending sand to make well-graded fine aggregate. 2/ Not resistant to attack by acidulated waters; low resistance to scour. 3/ Poorly developed bedding and jointing make trimming and shaping difficult.
7	Silty sand	Representative of most of unit.	Test No. L was made on an undisturbed sample. Test No. K was made on a channel sample from the same location. The samples tested are nonplastic and noncohesive; the undisturbed sample has a high void ratio and low field density. Bearing capacity of undisturbed sand is very poor; for disturbed, compacted sand it is fair. Many of the empirical engineering properties characteristic of SM and ML soils apply to 75% of this unit. The remainder contains clayey facies, some of which have properties of a CH soil, similar to Unit 8.	Poor 1/	2/	---	---	---	---	Good to poor 3/	Poor 3/	---	Blending sand for fine aggregate. Possible source of grog for brick and tile manufacture, but suitability is not known.	1/ Suitable as blending sand for fine aggregate, only after thorough washing. 2/ Possibly suitable for bituminous mixtures after washing, but requires testing. 3/ Variations in clay content and grading make sampling and testing necessary at specific deposits to determine engineering suitability and compaction properties.
8	Compact gray clay	Representative of silty clay layers in unit which includes silty sand layers.	Test No. N was made on an undisturbed sample. Test No. M was made on a disturbed channel sample from a different location. Material is plastic and cohesive. The C.B.R. tests indicate a very good bearing capacity for the undisturbed material, compared with a very poor bearing ratio for the disturbed, compacted material. This loss of bearing capacity after manipulation is characteristic of materials in this soil classification. Undisturbed clay is very impermeable.	---	---	---	---	---	---	Poor 1/2/	---	Good	Good for cement manufacture.	1/ The undisturbed material is fair to good subgrade provided it is protected by a nonexpansive blanket course. Otherwise exposure to moisture causes serious loss of bearing capacity, and large volume changes accompany fluctuations in moisture content. 2/ Fills constructed on this unit may slide if saturated.
9	Crystalline limestone	Representative of most of unit.	Test No. O was made on broken pieces of ledge rock sampled from a road cut and crushed at the laboratory to pass the 2-in. sieve. Abrasion and soundness losses are low. This rock will make an excellent aggregate for concrete and asphalt when crushed and graded.	Very good 1/	Very good 1/	Very good 1/	Very good 1/	Very good 1/	Very good 1/	Good	---	---	Good for cement manufacture. 1/	1/ Many good quarry sites could be developed.
10	Greenstone	Less weathered and fractured than most surficial rock of unit.	Test No. P was made on broken pieces of ledge rock taken from a road cut and crushed at the laboratory to pass the 2-in. sieve. Abrasion and soundness losses are low and indicate material will make excellent aggregate for concrete and asphalt pavement when crushed and graded. Unit weight and specific gravity are somewhat higher than that of average rock.	Very good to poor 1/2/	Good to poor 1/	Very good to poor 1/	Poor 3/	Good to poor 3/	Good to fair 4/	Good 5/	Good to fair 5/	---	---	1/ Most greenstone deposits contain friable and decomposed rock not satisfactory for aggregate. 2/ Greenstone may be deleterious to portland-cement concrete, because it contains pyrite, locally in relatively large amounts. 3/ Not obtainable in large blocks because rock is severely fractured and platy. 4/ Limited quantity available, because most rock of this unit is fractured. 5/ May require some clay binder.
11	Platy foliated rocks	Typical of weathered surface rock of unit.	Test No. Q was made on a channel sample of weathered, unconsolidated rock. Specific gravity and unit weight are low. Absorption is high. Proctor test indicates that material compacts to a fairly high density. Bearing capacity is fair. Material was not tested for abrasion or soundness, because it is too friable and decomposed for aggregate; no crushing was necessary at laboratory.	Poor 1/	Poor 1/	Poor 1/	---	Good to poor 2/	---	Good to fair 2/	Good to poor 2/	---	---	1/ Most of the rock in this unit is too decomposed, platy, and friable for use. 2/ This unit contains rock in various stages of weathering, from fairly fresh to severely decomposed. Fresh, platy rock requires binder for stability, whereas the decomposed rock may not require it. Testing is essential at all sites to determine the degree of suitability. Rock breaks along platy cleavages, giving platy fragments; not good for base.
12	Sandstone	Typical of very highly weathered zone only.	Test No. S was made on a channel sample and Test No. T on an undisturbed sample. This material is granular with a fairly high field density, low void ratio, and good bearing capacity. Weathered, unconsolidated rock predominates throughout the unit, although all gradations from unweathered to severely weathered rock are found.	---	---	---	---	---	---	Very good to poor 1/	Very good to poor 1/	---	---	1/ Variations within this unit make generalization difficult. Design should be based on test results from each deposit.
		Typical of fresh sandstone of unit.	Test No. R was made on broken pieces of ledge rock sampled from a road cut, crushed at the laboratory to pass the 2-in. sieve; this sample represents the limited amount of firm, tough, relatively unweathered rock in this unit. Abrasion and soundness losses are low. Fresh rock like this sample will make excellent aggregate for concrete and asphalt when crushed and graded.	Very good 1/	Very good	Very good	Very good to good 2/	Very good 2/	Very good 2/	Good	---	---	---	1/ Some of this rock may be deleterious to portland-cement concrete, because it contains pyrite. 2/ Blocks of sufficient size for use may not be obtainable everywhere, owing to fracture zones, beds with closely spaced jointing, and other unfavorable conditions.
13	Porphyry dike rock	Slightly less weathered, but representative of most of the unit.	Test No. U was made on pieces of broken rock from a quarry, crushed at the laboratory to pass the 2-in. sieve. The somewhat low specific gravity and unit weight, and the high absorption, abrasion, and soundness losses are due to weathering. The rock is not a durable aggregate for Class A portland-cement concrete. Some of it was used with success for seawalls, masonry, and monuments. Less-weathered rock, of better quality than the sample tested, is extremely rare in this unit.	Poor 1/	Fair to poor 1/	Fair to poor 1/	Good to poor 1/	Good to poor 1/	Good to poor 1/	Good to fair 2/	Good to fair 2/	---	---	1/ Applicable only to the limited amount of partly weathered rock; most of the rock in the unit is severely weathered, friable, or unconsolidated. 2/ Applicable to the predominant weathered, unconsolidated material.

* Variations are due chiefly to differences in the amount of weathering but also include cementation, fracturing, and deposition.

** For complete test data see Table 2.

*** Values are for guidance only and apply to the dominant material in the unit, except where otherwise indicated. Variations within each unit may necessitate more complete testing and appraisal of material from specific sites before use. Suitability is designated on the relative scale of: Very good, Good, Fair, Poor, (-) Not applicable.

**** Well-cemented limestone is found as isolated outcrops in Units 5 and 6, and although not large enough to map separately, significant differences warrant separate evaluation for engineering uses.