(15)

Addendum to report on the Feasability of Constructing an Airfield on Cape Pembroke Peninsula.

Wainwright and Botham

Directorate of Civil Engineering
Development
Airfields Branch
M.P.B.W.
Lacon House
LONDON WC1

Ref: PP.7794/ 14th April 1970

FALKLANDS ISLANDS

Addendum to the Report on the Feasibility of Constructing an Airfield on the Cape Pembroke Peninsula prepared by:-

R J Wainwright BOT

and

F J Botham MPBW

Addendum covers:-

Materials Testing Reports and Recommendations:

FALKLANDS ISLANDS

Proposed Airfield at Cape Pembroke Peninsula

Materials Testing Reports addenda - Contents:-

1 Cardington Soils Section Report Reference SF/CEL/717/10002/3 dated 27 August 1969, on the local construction materials, sand, aggregate, clay and Uruguayan cement.

2 Cardington Soils Section Supplementary Report Reference SF/CEL/717/10002/3 dated 19 December 1969, an soil-cement stabilisation using 15% OPC.

3 Cardington Concrete and General Materials Section Report Reference CEL/517/Falklands Isles dated 18 August 1969, on the testing and suitability of the Falklands Island "all-in" aggregates and sand samples for concrete works.

4 Cardington Bitumen Section Report Reference B90002/10 on the suitability of the Falklands Islands Quartzite aggregate for surface dressing.

5 Grading Curve for a suitable filter material for use on the proposed runway base drains.

6 Recommendations.

Ref: SF/CEL/717/10002/3

Mr F J Botham
DCS (CE6)
Room 549
Lacon House

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY - RESULTS OF LABORATORY TESTS ON SOIL SAMPLES

With reference to your letter PP.7794/1853 dated 16 June 1969 and subsequent conversations with Mr Pickton and the writer, the samples received at this Laboratory on 9 June 1969 have now been tested and the results are contained herein.

The samples comprised sand taken from three positions on the airfield, two samples of clay, "all-in"crushed aggregate and a quantity of Uruguayan cement. The test results are given and discussed under the various type headings.

1. Sand Apart from a variable organic content (the bulk of which was in the form of fairly coarse root fibres, etc), the three samples were similar and consisted of grey uniformly graded fine and medium sand. Before testing started, the samples were sieved through a 3/16" mesh to remove the larger fibres; this accounted for approximately 1%, 4% and 25% organic matter for the samples from the Centre, East End and West End of the airfield respectively. Individual grading tests showed the three sands to be similar and they were therefore mixed to form one combined sample on which the remaining tests were performed; a grading envelope for the three samples is illustrated at Appendix B Sheet 1.

Three series of compaction tests were performed, both with and without cement, and the resulting plots are illustrated at Appendix B Sheet 1. As was expected with such a uniformly graded material, the compaction curves were rather "flat" and the maximum densities and optimum moisture contents ill-defined. An additional single compaction test with 10% Portland cement using the heavier standard of compaction (Test No 12 of BS 1377:67) was also performed to determine criteria for cement stabilization tests.

As regards the sand occurring as the natural foundation (ie formation), since values of the in-situ dry density are not available it is not possible to assess whether any benefit would accrue from compaction of the natural soil; also, because of the presence of variable amounts of organic matter in the sand consideration should be given to the use of a method specification for the compaction of this material (with or without cement) rather than a specification of the end-result type. (It may be of interest to note that the specification, in respect of compaction, for general earthwork construction recently introduced by the Ministry of Transport is of the 'method' type).

California Bearing Ratio tests were performed on a sample of sand statically compacted to a density of 102 lbs/cu ft, being approximately equal to the maximum dry density obtained in the compaction tests using the heavier standard of compaction (Test No 12) and at a nominal moisture content of about 12%, ie roughly at the optimum moisture content; the value of C B R obtained was 11% and this is of the order to be expected for such a material and state.

The results of unconfined compressive strength tests on 4 in x 2 in dia cylinders of cement stabilized sand are listed in Table 1 at Appendix A. It will be seen that samples were prepared at densities of 106, 110 and 114 lbs/cu ft and cement contents ranging from 6% to 12%; the moisture content was kept constant at a nominal 12% and the curing period was 7 days. The two lower values of density chosen are approximately equal to the maximum dry densities obtained in Tests 11 and 12 respectively and the upper value represents an air content of

about 10%; these values are based on compaction tests using a nominal 10% of ordinary Portland cement. Prior to the cement stabilization tests, measurements of the pH of soil-cement pastes were made (Test No 18 of BS 1924:67) using the sand mixed with both British and Uruguayan cements. This method tests for the presence of organic matter able to interfere with the hydration of Portland cement and this is indicated if the resultant pH value is below 12.1; it should be noted that it is a rejection test for unsuitable soils and a higher value than 12.1 does not necessarily ensure satisfactory hardening of stabilised soil. In the present case the results, for the three individual samples of sand submitted, ranged from 12.43 to 12.60 using British cement and 12.40 to 12.50 for the Uruguayan cement. The compressive strength results (Table 1) are comparatively low and probably reflect the uniform nature of the sand (average uniformity coefficient = 1.5); the results are, however, reasonably consistent and, for those series covering a range of cement contents, show an almost linear increase in compressive strength with cement content. The maximum value, 170 lbs/sq in at 7 days, was obtained using 10% Portland cement at a dry density of 114 lbs/cu ft; it is considerablylower than the minimum 7 day crushing strength (400 lbs/sq in) specified by the Ministry of Transport for sub-bases and Roadbases. It is stressed that the strengths listed in Table No 1 were achieved with sand from which the coarser organic matter was removed and it is to be expected that lower values would have obtained had these fibres been included. The samples prepared with Uruguayan cement had virtually no strength after curing and crumbled during normal handling.

It is understood that in the present case it may be possible economically to justify the use of high proportions of cement for stabilisation and it is therefore proposed to prepare further samples for 7 day compressive strength tests using 15% Portland cement and compacted to an air content of about 10%; a rough estimate of the strength to be expected, based on extrapolation of the previous results, would be 250 to 300 lbs/sq in.

2. Aggregate This sample, described as "metal from quarry", was sieved (dry) on arrival and the grading curve is shown at Appendix B Sheet 2. It was then submitted to the concrete and bitumen sections for further tests.

The aggregate is a reasonably well-graded material comprising mainly angular particles; considered as a filter material for the sand reported on above, the R_{50} and R_{15} values of 76 and 24 respectively are outside the recommended limits ("Soil Mechanics in Engineering Practise", Terzaghi and Peek, 1967 p 57) for this type of material and it is therefore considered to be unsuitable as a filter medium in the absence of an intermediate material.

3. Clay Classification tests showed that the sample from a depth of 4 ft 0 ins is a sandy clay of intermediate plasticity (CI); the sample from 10 ft 0 ins in fact proved to be a silt, probably somewhat clayey, and was virtually non-plastic (ML). Grading curves and classification results are given at Appendix B Sheet 2.

Because of the number of variables involved and the consequent risk of misleading results, it was not considered practical to perform realistic laboratory tests to indicate the suitability of these two fine-grained soils for compaction with the natural sand. The main difficulty would be to reproduce in the laboratory the same efficiency of mixing that could be achieved in-situ, or vice versa; and it is considered that the efficiency with which the soils are mixed would greatly influence the end-result.

From the point of view of improving the cohesion of the sand, it can be stated that some benefit would certainly accrue from adding either of the two soils to the sand and that to achieve a particular "coherency", a significantly smaller proportion of the sandy clay (4'0") would be required than of the silt

(10'0").

On the question of proportioning to achieve a particular grading, reference is invited to Chapter 11 of "Soil Mechanics for Road Engineers" for further details.

In regard to the possible use of the silt soil as an additive, it should be noted that this material may possibly be frost-susceptible and it is not unlikely that, in certain proportions, it may also confer upon the sand some degree of susceptibility.

4. Uruguayan cement The sample arrived slightly damp and rather lumpy. The soil cement cylinders that were made with this material crumbled easily after curing and it is assumed that the cement had become partially hydrated in transit.

J A HARTUP
for Head of Soils Section

27 August 1969

Soils Section
Civil Engineering Laboratory
RAF Cardington
Bedford

Tel: Bedford 58651 Extn 103

FALKLAND ISLANDS

Laboratory Tests in connection with Airfield Feasibility Study

Table No 1 - Unconfined Compressive Strength of Cement-Stabilized Sand (7 day curing)

Soil used: Combined sample of sand from East end, West end and Centre of airfield.

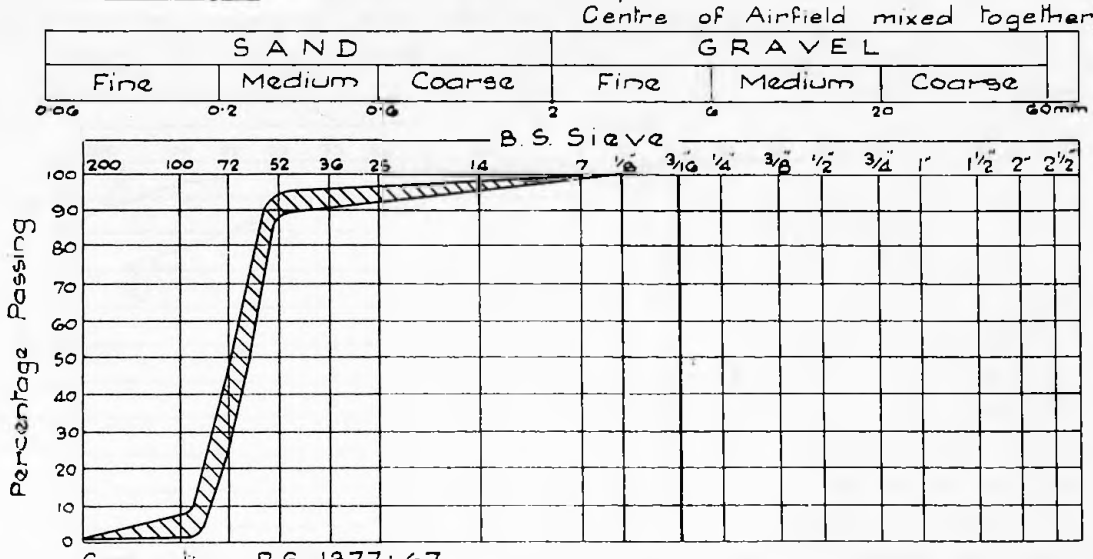
Method: BS 1924:67 Test No 10 (using 4" x 2" dia cylinders).

Moisture Content: Constant at 12% (nominal)

Dry Density (lbs/cu ft)	Cement Content	Unconf. Comp. Strength at 7 days (lbs/sq in)	
		Individual	Mean
106	8% O.P.C.	85 84 73	81
106	10% O.P.C.	120 120 108	116
106	10% Uruguayan	Samples crumbled during handling after curing	-
106	12% O.P.C.	136 176 179	164
110	6% O.P.C.	66 68 70	68
110	8% O.P.C.	108 117 92	106
110	10% O.P.C.	145 129 146	140
114	10% O.P.C.	172 174 157	168

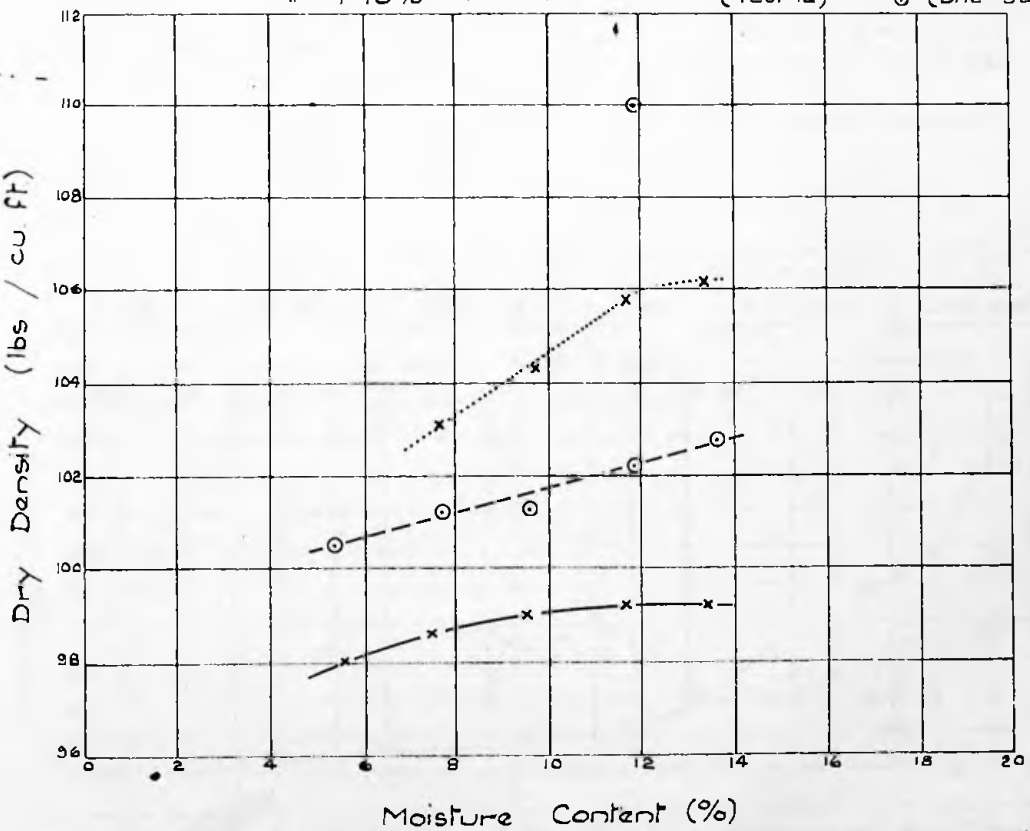
Ministry of Public Building and Works	SOIL	Appendix B
Soils Section, C.E.L. Cardington.	COMPACTION	Sheet 1

Sieve Analysis NATURAL SAND (Samples from East end, West end and Centre of Airfield mixed together)



Compaction B.S. 1377:67

Sand alone – Test 11 (5·5 lb. hammer) —x———x—
" " – Test 12 (10 lb. ") —⊙- - - - -⊙—
Sand + 10% Ord. Portland Cement (Test 11) ··x·····x··
" + 10% " " " (Test 12) ⊙ (one sample only)



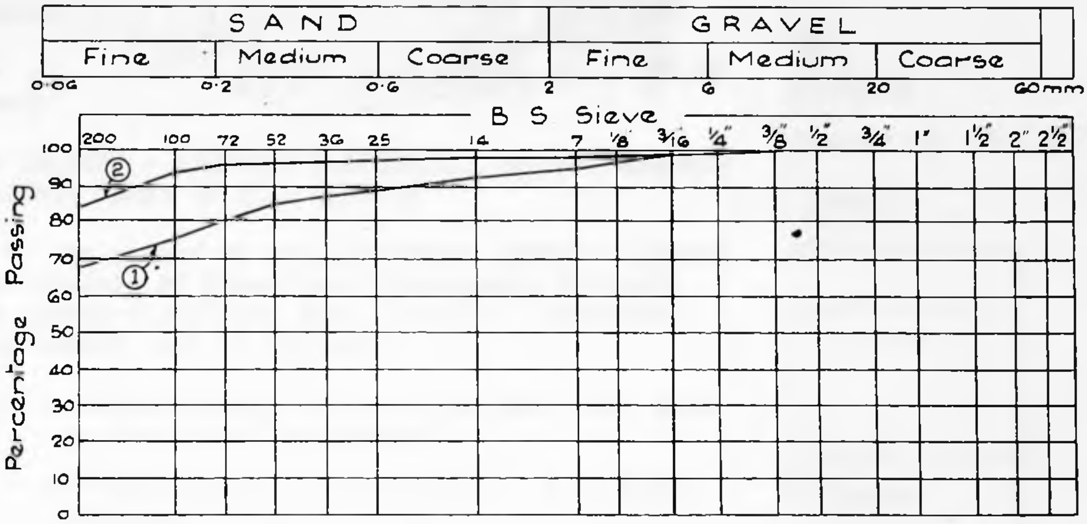
Description of Soil:

Grey uniform fine-medium SAND with much organic matter (roots, fibres, etc.) Classn. SU
(Note that the sand was sieved on a 3/16" mesh to remove coarser fibres before testing started)

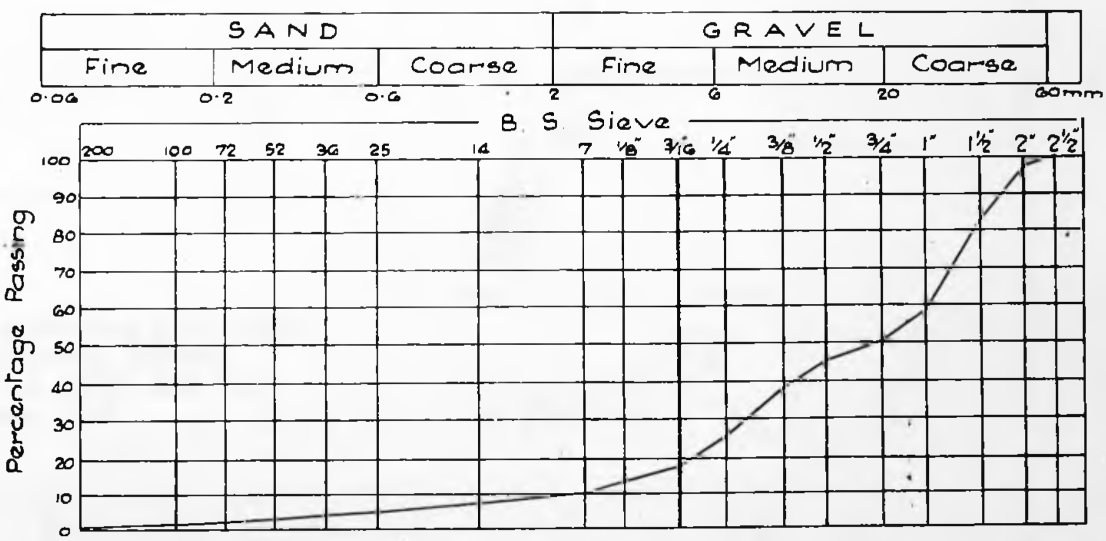
Task	Location
Laboratory tests in connection with Airfield Feasibility Study	FALKLAND ISLANDS

D JAH T RVM C JAH	J.H. Clifton for GA Pickton 26-6-69	Soil Classification Table 3 of CP2001	Drawing No. CEL/Soils/581/1/69	Task No. S/10002/3

Ministry of Public Building and Works	SOIL CLASSIFICATION	Appendix B
Soils Section C.E.L. Cardington		Sheet 2



Location and Symbol		LL	PL	PI	U	Description and Classification
① Bottom of Bay - 4' 0" deep		38	17	21		Orange/brown mottled sandy CLAY (Classn CI)
② Bottom of Bay - 10' 0" deep		29	25	4		Whitish-grey clayey SILT (Classn. ML)



Location and Symbol		LL	PL	PI	U	Description and Classification
"All-in" Aggregate (sample described as "metal from Quarry") (dry sieved)		Non-plastic				

Task	Location
Laboratory tests in connection with Airfield Feasibility study	FALKLAND ISLANDS

D J.A.H. T R.V.M. C [signature]	[signature] for G.B. PICKTON 20-8-69	Soil Classification Table 3 of CP2001	Drawing No. CEL/Soils/581/2/69	Task No. S/10002/3

8115

(35)

25 DEC 1969

Reference SF/CEL/717/10002/3

Mr A McLaren
DCSD 6
Room 550
Lacon House

Registry

PE 7794

B/F SC

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY - RESULTS OF LABORATORY TESTS ON SOIL SAMPLES

Further to our minute of even reference dated 27 August 1969, the results of Unconfined Compressive Strength tests on cement-stabilized sand, using an increased amount of cement, are as follows:-

Soil used: Combined sample of sand from East end, West end and Centre of Airfield

Method: BS 1924:67 Test No 10 (using 4" x 2" dia cylinders)

Moisture Content: Constant at 12% (nominal)

Cement Content: 15% O P C

Dry Density: 114 lbs/cu ft

Curing period	Unconfined Compress. Strength (lbs/sq in)	
	Individual	Mean
7 days	338 360 352	350
28 days	625 619 637	625

M.J. Hubbard
for J A HARTUP
for Head of Soils Section

Civil Engineering Laboratory
RAF Cardington, Bedford
Tel: Bedford 58651 Ext 103
19 December 1969

Dd. 45128

Re. Mr McLaren on file.

Reference SF/CEL/717/10002/3

Mr A McLaren
DCED 6
Room 550
Lacon House

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY - RESULTS OF LABORATORY TESTS ON SOIL SAMPLES

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for J A HARTUP
for Head of Soils Section

Civil Engineering Laboratory
RAF Cardington, Bedford
Tel: Bedford 58651 Ext 103
19 December 1969

Dd. 45128

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY
TESTING OF AGGREGATES FOR XXXXXXXXXXXXXXXX CONCRETE

Samples Submitted by: F J Botham, DCS Airfields (PP.7794/1853 received CEL 17.6.69)

Form W.1728 dated: -

DETAILS OF SAMPLES RECEIVED			
Laboratory Sample No. Date & weight received. *	Sender's Description	Laboratory Description	Source
3210 19.6.69 150 lbs in two bags	"all-in" crushed quarry quartzite (Bag label - 2½" down metal from quarry)	Quarzite - crushed rock angular and flaky - granular texture	Not known
3218 23.6.69 44 lbs	Sand	Very fine "soft" sand which originally contained a considerable quantity of vegetable matter mainly in the form of large roots (coarser pieces of root, retained 3/16", removed by Soils Laboratory).	Not known
* by Concrete Section			

Distribution:-

Mr Botham (2) - how many more cores do you want?

Internal: Supt
CE(B)
CA(R) for Minor Task reports folder - Task complete.
File
Circ

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY
TESTING OF AGGREGATE FOR CONCRETE

1. COARSE AGGREGATE Submitted by: F J Botham DCS (Airfields)

Source: not stated

(Source: -) Map ref: - 1" O.S. Sh.No: -

Description: See sheet 1

Date received: 19.6.69. ø

1.1 SIEVE ANALYSIS (GRADING) B.S. 812:1967, Clause 11							
Sample No.	3210			Specified Limits			
Aggregate Test No.	4004			B.S.882.1965 Table 1 MOD B.S.1963 Clause 5.1.4			
Weight received	150 lbs	lbs	lbs				
Nom. Size *	2½" all-in						
B.S. Sieve	% by weight passing						
3"/2½"							
1½"							
¾"							
½"							
⅜"							
3/16"							
No. 7							
Compliance							

Sample No.	3210			Specified Limits B.S.882:1965 Clause 4.6	
1.2 Size Tested	⅜" - ¼"				
Standard?	No			Wearing Surfaces	Other concrete
AGGREGATE CRUSHING VALUE (B.S. 812:1967 Cl.) %	27.6			@	@
TEN PER CENT FINES VALUE (B.S. 812:1967 Cl.35) ton				Not less than 10	Not less than 5
Compliance (as on right)	1 & 2			1	2
1.3 FLAKINESS VALUE % (B.S. 812:1967, Clause 35)	32.0			No limits in B.S.882 CEL recommended maximum 30%	
Complies with recommendation?	No				

@ No limits in B.S.882. Specified maximum in MOD B.S.201:65 (Clause 605a) are 35% for pavement quality concrete and 40% for other concrete.

* as = single-sized ø at Concrete Section

(Continued on sheet 4)

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY
TESTING OF AGGREGATES FOR CONCRETE

2. FINE AGGREGATE Submitted by: F J Botham DCS (Airfields)

Source: not stated

(Mineral: -) Map ref: - O.S. Sh. No. -

Nominal Description: See sheet 1

Date received at Concrete Section: 23.6.69.

2.1 SIEVE ANALYSIS (GRADING) B.S. 812:1967 Clause 11

Sample No.	3210	3218	Specified Limits			
Agg. Test No.	4004	4005	M.P.W.A. S.S.1969 Clause 5.1 & B.S.882:1965 Table 1 (± 5% total tolerance on limits not underlined)			
Weight Read.	lbs	44 lbs				
Type @		NS	Zone 1	Zone 2	Zone 3	Zone 4
B.S. Sieve			% by weight passing			
3/8" - 0	↑	(100)	100	100	100	100
3/16"		(100)	90 - 100	90 - 100	90 - 100	95 - 100
No. 7		(100)	60 - 95	75 - 100	85 - 100	95 - 100
No. 14		100	30 - 70	55 - 90	75 - 100	90 - 100
No. 25		99	15 - 34	35 - 59	60 - 79	80 - 100
No. 52		93	5 - 20	8 - 30	12 - 40	15 - 50
No. 100		3	0 - 10+	0 - 10+	0 - 10+	0 - 15+
No. 200		0				
Fineness Modulus		1.06				
Compliance ‡	↓	NIL				

See sheet

+ 20% for Crushed Stone *within 5% tolerance
‡ Zone 4 not permitted
@ NS = Natural Sand CS/GS = Crushed Stone/Gravel

Ø fine fraction

Sample No.		3210 Ø	3218	Specified Limits
2.2 ORGANIC IMPURITIES	pH of Cavani Reagent at 20°C (B.S.812:1967 Cl.32)	12.45 ≠	12.45 ≠ 12.65	Not less than 12.4 (not more than 0.2 increase ≠) ≠ - after heating as 32(g)(iii)
	Complies?		Yes but see below	
	Colour test (B.S.812:1967 para 28)		Darker than standard colour	Not darker than standard colour
	Complies?		No	

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY

TESTING OF AGGREGATE FOR CONCRETE

3. SPECIFIC GRAVITY & ABSORPTION (B.S. 812:1967, Clause 21)					
Sample No.	3210	3210	3210	3210	3218
Description/Size (Fraction for 3210)	$1\frac{1}{2}$"-$\frac{3}{4}$"	$\frac{3}{4}$" - $\frac{3}{8}$"	$\frac{3}{8}$" -3/16"	Pass 3/16"	Sand
Specific Gravity on an oven-dried basis	2.60	2.58	2.58	2.62	2.62
Specific Gravity on a Saturated Surface-dried (S.S.D.) basis	2.62	2.61	2.61	2.63	2.63
Apparent Specific Gravity	2.64	2.65	2.65	2.65	2.65
Water Absorption (24 hr. Drying) (% of dry weight)	0.62	0.94	1.02	0.44	0.39
Water Absorption (dried to constant weight) (% of S.S.D. weight)*	0.65	0.98	1.16	0.68	0.53

* additional to B.S. ① NS = Natural Sand CS/CG = Crushed Gravel/Stone

Sample No.	3210	3210	3210	3218	Specified Limits
Description/Size/Fraction	All-in	Coarse	Fine	Sand	
Type ①	CS			NS	
4. SILT CONTENT % (B.S. 812:1967 Clause 13)	1			0.4	Not exceeding:- Coarse & NS/CG & S CS & S (B.S.882:1965 clause 5a)
Specified Maximum	3.7			3	
Complies ?	Yes			Yes.	
5. AGGREGATE SOUNDNESS (% breakdown) ($MgSO_4$) (MPBW GS 201:65 Appx.A, ASTM C88-63)		9.1	20.4	Too fine for meaningful result	No limits except for PQC. CEL recommended maximum 18%
Complies ?		Yes	No	-	

6. CHEMICAL CONTENT

Chlorides as NaCl% 0.02

Sulphates as SO_3% ..... Trace

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY
TESTING OF AGGREGATE FOR CONCRETE

7. SIEVE ANALYSIS (GRADING) (BS 812:1967 Clause 11)

(All-in aggregate)

Sample No	3210					Specified Limits (BS882:1965)		
Fraction	As received	As received less ret. 1½"	Coarse (ret. 3/16")	Coarse less ret. 1½"	Fine (Passing 3/16")	1½" nom max size "All-in"	1½" nom max size graded coarse	Fine Zone 1
BS Sieve Size	Percentage by weight passing							
3"	100	-	100	-		100	100	-
1½"	82	100	78	100		95 - 100	95 - 100	-
¾"	54	65	43	55		45 - 75	30 - 70	-
½"	48	58	36	46		-	-	-
⅜"	41	49	27	35		-	10 - 35	100
¼"	27	33	10	13		-	-	-
3/16"	19	23	0	0	100	25 - 45	0 - 5	90 - 100
⅛"	14	17			74	-	-	-
No 7	12	14			62	-	-	60 - 95
No 10	9	11			49	-	-	-
No 14	8	10			43	-	-	30 - 70
No 25	6	7			31	8 - 30	-	15 - 34
No 52	4	5			20	-	-	5 - 20
No 100	2	2			9	0 - 6	-	0 - 20
No 200	1	1			4	-	-	-
Fineness Modulus	-	-	-	-	3.34*			
Compliance	Nil	Nil	Nil	1½" graded	Zone 1			

* excluding ⅛" & No 10 sieves.

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY

TESTING OF AGGREGATES FOR CONCRETE

8. Comparison of mortar cube strengths
(Cubes made and tested as Appx. C to BS 12:1968)

Age at test (days)	3		7		28		7 & 28 day strengths as % of 3 day	
Type of fine aggregate	Individual lbf/in²	Mean lbf/in²	Individual lbf/in²	Mean lbf/in²	Individual lbf/in²	Mean lbf/in²	7 day	28 day
1. Sample 3218 (Falkland Island Sand)	2400 1950 1500	1950	2300 2000 2150	2150	3050 2850 2900	2950	110	151
2. Leighton Buzzard Sand as BS 12 para C3d but of same grading as 1	2350 2250 2100	2250	3100 2750 3100	3000	4000 3600 3350	3650	133	163
3. Sample 3218 50% Fine fraction of Sample 3210 50%	3900 3950 4450	4100	*	*	*	*	-	-
4. As 2 but same grading as 3	4800 4800 4650	4750	-	-	-	-	-	-

Note: With the Falkland Islands sand difficulty was encountered in getting the water to mix with the dry materials. * insufficient sample.

9. Conclusions and recommendations

9.1 The Natural sand (sample 3218) is not ~~a~~ suitable for use as a fine aggregate for concrete, in view of its fineness and poor grading (virtually single-sized) its organic content and its retardation of the hydration of cement.

9.2 Apart from a slight excess flakiness (re which see para 9.5) the crushed rock is suitable for use in concrete but contains insufficient fines to use alone, and also contains too much material over 1½". The latter could of course be rectified by screening, which would also raise the proportion of fines to 23% which may be sufficient to obtain a satisfactory mix.

FALKLAND ISLANDS - AIRFIELD FEASIBILITY STUDY
TESTING OF AGGREGATE FOR CONCRETE

9.3 It may be possible to re-crush some of the oversize material to increase the proportion of fines. If not, one of the following alternatives will have to be adopted:-

a. a gap-graded mix designed (this will however require all compaction to be by mechanical vibration which may not be possible or desirable).

b. A mixture of natural sand and crushed rock fines used as fine aggregate. The resistance of the natural sand to wetting may make however mixing difficult.

9.4 For proper control the fine fraction of the crushed rock should of course be screened out and batched separately.

9.5 Regarding the slight excessive flakiness of the crushed rock this may be due to bad crushing technique (too great a reduction in size in one stage) or worn crusher jaws, rather than to an inherent flakiness in the rock itself, and attention to these points may well reduce the flainess below the recommended maximum.

P WRIGHT
Head of Concrete and
General Materials Section
18 August 1969

CEL Cardington
Tel Bedford 58651 Extn 348

TASK NO B90002/10

FALKLAND ISLANDS

CEL SPL NO 3210. Received in lab 7.8.69.

Stripping tests on Quartzite aggregate for surface dressing sieved in lab to the following fractions:-

Nom	Fraction
$\frac{1}{2}$"	$\frac{1}{2}$" - $\frac{3}{8}$"
$\frac{1}{4}$"	$\frac{1}{4}$" - $\frac{1}{8}$"
$\frac{1}{8}$"	$\frac{1}{8}$" - No 10

Tests using Coating Binder

Aggregates and 200 Pen Bitumen heated to 160°C, it was found necessary to raise binder contents above the $\frac{3}{4}$% - 1$\frac{1}{2}$% specified, mixed for two minutes, cured for 1 hour then immerised in distilled water.

Nom	Min % Bit for coating	Coating	Estimated % of No of stones showing stripping after immersion	
			24 Hrs (GS 204)	48 Hrs (GS 1900)
$\frac{1}{2}$"	2.0%	100%	10%	20%
$\frac{1}{4}$"	2.5%	100%	75%	85%
x $\frac{1}{8}$"	3.0%	100%	> 75%	> 80%

x aggregate too fine for accurate assessment.

Tests using Spraying Binder

"Shellphalte .K."
~~Straight run bitumen~~ (50 secs @ 40°C) + 1$\frac{1}{2}$% Duomeen T.
Binder and aggs heated to 155°C. Binder contents as above.

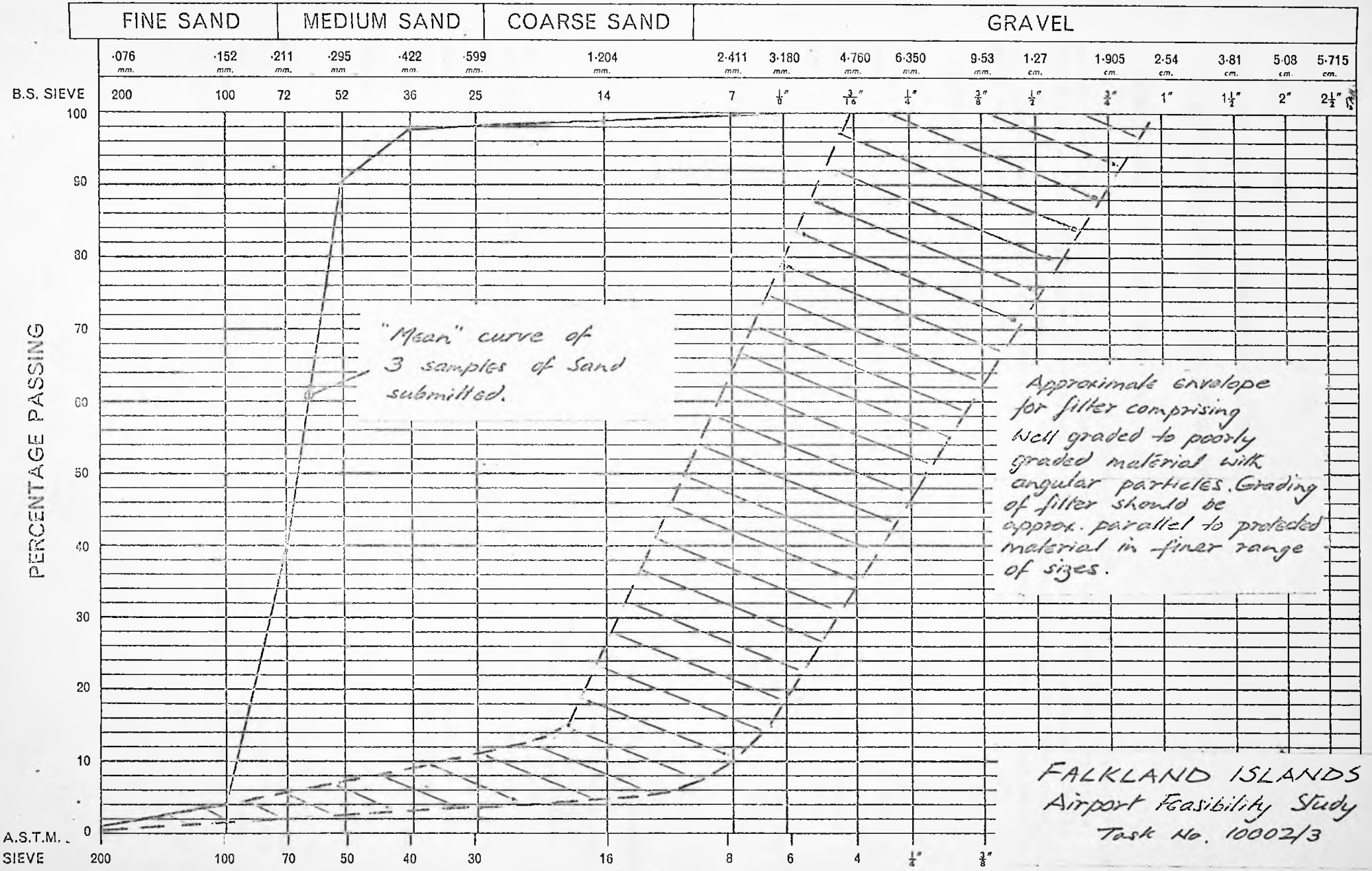
Nom	Coating	% stones showing stripping After 24 Hr	After 48 Hr
$\frac{1}{2}$"	100%	NIL	NIL
$\frac{1}{4}$"	100%	NIL	NIL
$\frac{1}{8}$"	100%	NIL	NIL

A few unsound pieces in the $\frac{1}{8}$" Nom.broke up during the test.

A J TILLEY
for Head of Bitumen Section

Tests using Coating Binder (Contd):-
On 4/9/69 further tests were carried out using Coating Binder with 1$\frac{1}{2}$% Wetting Agent added. These tests showed that with 2% mixture the coating and stripping were still unsatisfactory. However, with 2.5% mixture of 200 Pen.Bitumen and Wetting Agent a 100% coating and non-stripping condition was achieved.

GRADING CURVE



FALKLAND ISLANDS
Airport Feasibility Study
Task No. 10002/3

FALKLANDS ISLANDS

Proposed Airfield at Cape Pembroke Peninsula

Materials Testing Addenda - Recommendations:

Recommendation No 1 - Quartzite Rock:

Para 7.5.2 of the original Feasibility Report refers. This material as reference to the Cardington reports shows, is capable of being used for either concrete works or surface dressing works subject to the appropriate laboratory controls on grading, etc. In the case of its use as a surface dressing material, then it is recommended that it be washed and that a wetting agent be used in conjunction with the binder.

Recommendation No 2 - Fine Sand:

Para 7.5.3 of the original Feasibility Report refers. This material is not suitable for use as a fine aggregate for concrete due to its fineness, poor grading, its organic content and its retardation of the hydration of the cement. However, subject to the removal of the coarser organic matter, the results show that with the addition of not less than 15% of O.P.C, it could become suitable for a cement stabilised base (for minimum recommended mixing proportions and conditions see Cardington Soils Section Supplementary Report reference SF/CEL/717/10002/3 dated 19 December 1969. It is understood that due to the non-availability of other materials the use of a high percentage of O.P.C in the Falklands Islands is a viable economic proposition.

Recommendation No 3 - Runway Pavement - Triple Surface Dressing:

Paras 7.7.1 and 7.7.2 of the original Feasibility Report refer. The Cardington Bitumen Section Report B90002/10 clearly indicates that crushed Falklands Islands quartzite can be satisfactorily used for the proposed surface dressing works. However, it should be noted that the binder should be mixed with a wetting agent and that with this particular aggregate, a greater percentage of Coating Binder than normal is required ie. approx 2½% in lieu of the ¾ - 1½% usually specified. With particular reference to para 7.7.2 of the original report, it is again emphasised that it is necessary in each case to carry out a "trial area test" to establish rates of spread. The lightest application consistent with complete coverage of the surface is the most successful and strict attention has to be given to the grading of the chippings and the application temperatures of both binder and chippings. All loose chippings must be swept up by hand brooms. Mechanical brooms have proved to be not effective in removing all loose chippings.

Surface dressing requires continuous supervision during application to ensure compliance with the specification, if the final result is to be satisfactory.

It is important that the application of the ¾" size chippings be applied first as with bituminous emulsions only relatively small chippings can, in general, be held firmly. Also, experience indicates that it is not possible to pre-determine the rates of spread of binders and chippings due to the variations in the surfaces to be treated and the stone available. Hence, the recommendation to carry out trial area tests on site.

Recommendation No 4 - Proposed Mixing of Clay with On-site Sand:

With particular reference to para 7.5.4 of the original report, it will be seen that Pages 2 and 3 of Cardington Soils Section Report Reference SF/CEL/717/10002/3 dated 27 August 1969, adequately covers the investigations into these Falklands Island clays. Only the sandy-clay from the 4'-0" deep measures should be used if the stiffening of the natural sand surface proves necessary during the spot turfing and seeding operations on the airstrip non-paved areas.

Recommendation No 5 - Filter Media for Runway Base Drains:

It is recommended that a filter media complying with the Grading Envelope shown on the attached graph be used in conjunction with the proposed Runway Base Drains.
Note: Attention is drawn to Section a-a on Drawing No CE6 78/69 issued as part of the original Falklands Islands Report where the undermentioned corrections are required:-

i For "Impermeable Material" read "Permeable Material" and
ii For "Compacted Pervious Material" read "Compacted Impervious Material"