CHAPTER 4 RAW MATERIALS DEPOSITS

Raw materials deposits which supply raw materials to Kyangin Cement Plant are listed below:

(1) Htone Daung Limestone Deposit
(2) Clay deposit near the plant
(3) Silica sand deposit on River Irrawaddy
(4) Laterite deposit on Than Thang laterite hill
(5) Gypsum deposit in Hsipaw township

Of the above listed deposits, Htone Daung Deposit requires thorough reexamination on the existing condition of the deposit from both the quality and quantity point of view, on the occasion of expansion of the plant.

Needless to say the limestone is one of the main raw materials of cement, and correct knowledge on the existing condition of the limestone deposit is always required as one of the fundamental conditions for the cement plant location. However, in the case of Htone Daung limestone deposit, the examination is required not only on the quality and the quantity, but also on the physical properties as related to the handling. In other words, the greatest cause that is interfering the improvement in the production of the existing plant is considered to originate in the stickiness of the limestone.

This is one of the factors which should be taken into the most careful consideration on the occasion of the expansion of the plant. Because of this, it is necessary to make an effort to accurately grasp the conditions of the deposite including factors causing this stickiness of the limestone.

The raw materials deposits other than the limestone deposit show no particular problem in the operation of the existing plant, and there is no fear of any serious problem both in quality and quantity on the occasion of expansion of the plant.

Under the above mentioned situation, the emphasis of the raw materials survey was placed on Htone Daung limestone deposit.

The existing results of investigation (particulary the boring data) was reexamined while veryfying them with the conditions of quarry faces and outcrops.

Reconnaissance survey was conducted on the limestone deposit at Natmes Daung and another one located north-west of Kyangin cement Hill, in addition to Htone Daung Deposit, and sampling at outcrops was also conducted. As for the other raw materials deposits, geological and topographical observation was conducted on the area aroung the quarry faces and sampling site of the silica sand and

laterite. Typical samples were taken, but the detailed survey such as the geological mapping was not conducted. As for the gypsum, only sampling of representative samples was made from the transport vessel for gypsum which was being unloaded at the foreshore, and no field survey was conducted.

4-1 Htone Daung Limestone Deposit

4-1-1 Location and Communication

Htone Daung limestone deposit is located approximately 8-9km south-south-west of Kyangin Cement Mill. Access to the deposit is available by the exclusive railway from Kyangin Cement mill to the ore bin at the east edge of the deposit (distance of approx. 8.4km). The nearest railway station to this deposit on the public railway (Burma National Railway) is Tegyigon on Bassein - Kyangin line. The deposit is located 13 ~ 14km north-west-west of this station. Road network is not sufficiently arranged yet, and no direct route between the mill and the deposit accessible by car is available.

4-1-2 Outline of the Past Surveys

The first geological survey of Htone Daung limestone deposit was conducted in 1911 by Stuart, H (R.G.S.I. Vol 61) of Rangoon Geological Survey institute. Following this initial survey, a survey team was despatched from Japan by Onoda Cement Co., Ltd. in 1955, and by Kawasaki Heavy Industry Co., Ltd. in 1955. Survey for the possibility of establishing a cement mill was conducted by these survey teams respectively under the cooperation of Burmese public offices concerned. However, fullscale geological survey which included boring were conducted only twice by Mineral Development Corporation of Burma (M.D.C.) as listed below:

(1) 1964 - 1965 6 diamond core boring ... total 1,249.5 ft
(Chief investigator: Geologist U Khi)

(2) 1969 - 1971 Surface geological survey, topolographycal survey and 26 diamond core boring, total 8,883 ft.
(Chief investigator: Geologist U Ye Nyit, succeeded by Geologist U Khi, succeeded by U Maung Than who completed the report)

A report written in Burmese is available for the survey listed in item (1), but as the geological map, the geological cross-sections or the

boring column diagram etc, are not attached to this report, the detail of the results of boring is not clear. For the survey listed in item (2), a report written in English has been prepared, which is attached with a set of a geological map, geological cross section etc., and detailed core logging records are available. (Though the geological cross sections are not in a completed form).

Reports and its related data on the survey (2) was seriously studied in the present survey, and the re-examination of the existing conditions of the deposit was conducted mainly by verifying these data with the actual conditions of quarry faces and outcrops.

Table 4-1-1 shows the outline of the boring conducted in the survey listed in item (2) above.

Table 4-1-1 Outline of the Results of Diamond Core Boring in Htone Daung Limestone Deposit

B.H. No.	ELEV. (feet)	DEPTH (feet)	BORING ANGLE	BORING DIRECT	C.R. Lst.	C.R. Sh.	Total	C.L.	C.R.
A1	394.28	227'	90°	(Vert.)	32'5"	35'9"	68'20"	157'10"	30.1
B1	332.00	108'	90°	(")	-	53'	53'	55'	49.6
C1	444.00	420'	90°	(")	123'3"	9'6"	123'9"	287'3"	31.6
D1	390.00	302'	90°	(")	86'10"	5'80"	92'6"	209'6"	30.1
E1	256.00	200'6"	90°	(")	3'8"	145'	148'8"	51'10"	74.1
D2	427.00	400'	45°	S65°W	166'6"	48'10"	215'4"	184'8"	53.0
B3	411.00	102'	90°	(Vert.)	8'6"	34'3"	42'9"	59'3"	41.9
C3	596.00	640'	90°	(")	234'11"	51'2"	286'1"	353'11"	44.
D3	438.90	460'	90°	(")	194'3"	20'11"	215'2"	244'10"	46.
D3/4	428.54	325'	45°	S65°	135'11"	59'4"	195'3"	129'9"	60.0
C4	659.00	404'	90°	(Vert.)	142'10"	110'8"	235'6"	150'6"	62.
D4	511.14	267'	90°	(")	57'4"	74'4"	131'6"	31'6"	80.6
B5	511.14	267'	90°	(")	58'11"	35'	93'11"	173'11"	34.2
C5	676.00	531'	90°	(")	179'4"	63'	242'4"	288'8"	45.6
D5	460.00	274'	90°	(")	81'1"	10'8"	91'9"	182'3"	33.4
E5	316.00	201'	90°	(")	-	187°	187'	14'	94.0
B7	497.97	424'	45°E	N65°E	132'3"	50'5"	183'2"	241'4"	43.0
BC7	547.00	400'	90°	(Vert.)	76'	137'	213'	187'	53.2
C7	614.00	513'	90°	(")	77'5"	86'4"	163'9"	349'3"	31.9
CD7	556.45	430'	90°	(")	151'4"	129'11"	281'3"	148'9"	64.3
D7	445.87	405'	90°	(")	141'11"	66'6"	208'5"	196'7"	53.7
D8	494.70	302'	45°W	S65°W	128'3"	21'	149'3"	152'9"	49.4
C9	599.85	550'	90°	(Vert.)	212'6"	135'	347'6"	202'6"	63.1
D9	417.36	319'	90°	(")	5'10"	264'	269'10"	49'2"	84.5
E9	280.99	128'	90°	(")	-	119'8"	119'8"	8'4"	93.5
D11	418.00	388'	45°	S65°W	97'2"	78'6"	175'8"	212'4"	45.2

(Note) B.H.No. = Bore Hole Number, ELEV. = Elevation (above mean sea level)
DIRECT = Direction, C.R. = Core Recovered
C.L. = Core Lost, Lst. = Limestone, Sh. = Shale (Actually includ- soil, marl etc.)

4-1-3 Problems in the Past Surveys and the Feature of the Present Survey

As shown in Table 4-1-1, core recovery of the boring conducted at Htone Daung limestone deposit in the past is generally low. The recovery rate is slightly over 30% in extremely low case. Study on the recovery rate classified by the type of rock, shows that the recovery in the limestone zone tends to be generally low, and higher in the shale zone. For example, the boreholes E5 and E9 which show the highest core recovery rate are the ones drilled entirely in the shale zone, and no limestone was encountered. D-9 and E1 boreholes showing the high recovery rate next to the above two were also drilled mostly in the shale zone, and a slight amount of limestone encountered there was an accidental ones. Consequently, it is obvious that the core recovery rate in the limestone zone alone, or the core recovery of only the limited portions where the limestone zone was drilled in each boreholes would be much less than the figures given in Table 4-1-1 as the general core recovery rate. This factore should be seriously considered.

4-1-4 Existing Conditions of the Deposit

Htone Daung limestone deposit forms a series of hills extending from north-north-west to south-south-east. Outcrop zone of the limestone covers the upper half of the hill with the width of approximately 400m (S65°W - N75°E direction), and the total length of approximately 2500m. Altitude of the highest point used to be 696 ft, but, it has been excavated down to the present level of approximately 620 ft.

The general strike of the deposit is north-north-west to south-south east, and it often dips approximately 30 - 60° to the east. Deposit is observed to be greatly disturbed by the numerous faults and folds, and its geological structure is considered to be highly complicated. Generally its strike and dips are not stable, and west-ward dips are partially observed.

On the east edge of No.2 face, the part which looked to be overturned fold was observed, though it was unclear. General trend of this deposit is that the dip on the hill side on the west is gentle dip to the east of approximately 30° or less, and on the east side the dip is between 50 - 60° or more to the east. The dip of the formation measured in the borehole tends to be steeper in the deeper part than the shallow part (example: boreholes C4, D7, D1, etc.). This proves that the formation generally curves downward toward the east. However, this is

only the general trend, and in the case of bore hole C1, the dip therein is a sharp one of 60 - 80° from the surface to the medium depth, but becomes gentle at less than 10° in the deepest section. This suggests that the geological structure of this deposit is not simple.

The ore forming the deposit, change in this rock facies, geological structure and the quantity available for mining, and the quality of the ore are as described in the following.

(1) Component rocks and the change in the lithofacis

Roughly speaking, Htone Daung limestone deposit is composed of the three types of rock; limesone, shale and their alternation (the above two types form regular alternated beds) or mixture of the above two (above two are mixed irregularly). However, detailed observation, as described later, shows that the limestone includes wide variety of lithofacis such as almost pure limestone, argillaceous or arenaceous limestone, marly limestone, and slightly magnesian limestone etc. Also those classified as shale for convenience include those which are considerably calcareous and almost close to marl, or those which should be classified as siltstone or fine-grained sandstone due to its coarse grains.

U Maung Than, geologist at M.D.C. mentioned in section 4-1-2 classified the component rocks from upper to lower horizons as follows.

(A) Shale (Younger)

(B) Dark grey, porous, weathered limestone (cliff-forming) with thinly bedded shale

(C) Light grey, highly fossiliferous limestone (ridge-forming)

(D) Thick bedded shale with thinly bedded hard, compact argillaceous limestone

(E) Shale (Older)

The intention of the above classification was to briefly indicate the straitigraphic composition of the deposit. Typical lithofacies of each horizon was extracted and classified as the stratigraphic cllassification. Although this classification has its own usage, it seems to be too simplified to be a guideline for the practical mining operation. Actually, the rocks composing the deposit show extremely complicated and delicate change in the lithofacies. And as this is directly connected to the change in the quality, a more detailed lithological classification is much more important in the practical use than the stratigraphic classification.

For this reason, the present survey report has tried to add the lithological classification which is more detailed than the stratigraphic classification of U Maung Than described above. In making the lithological classification, stress was laid upon the frequency of the shale intercalated in the limestone or the ratio of shale intercalation against the limestone, as the most significant problem in the operation of Htone Daung quarry is the stickiness of the limestone, which is considered to originate mainly from the weathered shale (clay) intercalated in the limestone.

Component rocks are classified in this report as below, which is shown in attached drawing G-3.

(A) Shale (Younger), grey to dark grey, massive, very rarely and only eventually including thin beds or lenses (less than 1' thick) of limestone

(B) Alternation of Shale and Limestone (Shale is more dominant)

(C) Alternation of Limestone and Shale (Limestone is more dominant)

(D) Porous Limestone, dark grey, often weathered with thin interbeds of grey

(E) Fossiliferous Limistone, light grey, locally with Shale partings

(F) Alternation of hard compact Limestone and soft loose marly Limestone

(G) Shale (older), dark grey, fairly compact and often calcareous with interbeds of Limestone

In the above classification, (A) and (G) form the hanging wall and the foot wall of the deposit respectively. However (B) - (F) are not the stratigraphic classification but the lithological classification, and they do not appear in the above order, but are actually mixed irregularly.

(2) Geological structure and the quantity of minable reserves

The geological structure is as shown in the attached drawings G-3, and G-4. The detailed explanation is omitted here, but the distinct features of the structure are as described below:

(i) It is considered that the same bed is repeatedly encountered as the faults are developed in the direction of strike.

(ii) A case where a bed appears to extend thickly and widely in conformity with the slope of the land due to the folds is considered to exist.

(iii) As the lithological classifications described in the preceeding item (1)

are all subject to gradual change and not necessarily able to be clearly defined, it makes the analysis of the geological structure all the more difficult. The geological structure was duely analized through the present investigation and the quantity of minable reserves was estimated in accordance with this analysis. Attached drawings show the results of estimation which amounts to a total 300 - 360 million tons (difference depending on the setting of the lowest level of the mining) as minable reserves. However, in order to actually aquire this quantity, long-term quarry planning and detailed quality control over the quarry face in the daily work will be required.

(3) Ore quality

Table 4-1-2 shows the results of CaO, MgO analysis of the typical samples collected during the surface geological survery, which indicates that the quality is generally good. In addition, MgO contents were checked by dropping the so-called "FC-Test" solution at many outcrops in the field. Those which are recognizable as dolomite or dolomitic limestone were not found in the above test, but slightly magnesian limestone was recognized locally at the lower part of the deposit (Example: Sample B-1-A)

Many boring core samples were analyzed in the past boring investigation, but no sample with such a high MgO content equivalent to dolomite or dolomitic limestone has been reported. The past reports indicate only the existance of slightly magnesian limestone containing usually less than 5% of MgO. From the above, MgO content is not considered to be a cause of serious problems concerning the quality of limestone.

However, it must be noted that these magnesian limestones tend to be maldistributed (Example: Bore hole C-5, D-5), and continuous quarrying from such a portion only may cause a problem in the quality control. They should be adequately mixed together with the good quality limestone. The same applies to the low-grade limestone with low CaO contents. If such a limestone only is delivered continuously, there might be a difficulty in raw material proportioning. Therefore, the mixed delivery with the good-quality limestone is necessary. The quality control at the quarry face as described above should be conducted based on careful checking of the quality in the daily work in accordance with a long-term quarry planning.

Table 4-1-2 Analysis of Htone Daung Limestone

Sample No.	Cao	MgO	Calculated $CaCO_3$
B-1-A	48.16	2.59	86.00
B-1-B	51.99	0.48	92.84
B-1-C	47.25	0.48	84.37
C-9-4	52.40	0.16	93.57
C-9-B	53.00	0.33	94.64
C-9-C	53.32	0.81	93.43
C-5	51.64	0.81	92.21
CD-7-4	21.64	0.60	
CD-7-B	35.51	0.45	
CD-7-C	48.12	0.30	
CD-7-D	46.44	0.45	
C-4-A	14.29	1.21	
C-4-B	33.20	0.45	
C-4-C	23.95	0.60	
C-4-D	28.16	0.60	
D-8-A	47.70	0.30	
D-8-D	49.38	0.91	
D-11-A	51.48	0.45	
D-11-B	47.49	0.76	
D-11-C	53.65	0.32	

(Note): 1. B-1, C-9, CD-7 etc. in Sample No. correspond to the borehole no. and indicate that the samples were collected from the outcrop near the corresponding borehole.

2. Analysis was undertaken by the laboratory at Kyangin cement Mill

4-2 Natmee Daung Limestone Deposit

Natmee Daung limestone deposit is located approximately 4.5km south-south-east of Htone Daung Quarry. The deposit forms a narrow hill extending over approximately 1.5km from north-north-west to south-south-east, with altitude at its highest point being 536 feet. Natural gas wells out at the point half way up on the south side of the highest point (approx. 300ft level), and is accompanied by the slight oil property (exudation of the curde oil). This point is reached on foot

in approximately 1.5 hour from the south end of Htone Daung (driveway is not available all the way.)

The present survey covered the route from the above-mentioned natural gas spring to near the peak, taking only six representative samples. Although the details of the geological structure etc. are unknown, the samples collected are all high-grade limestones as shown in Table 4-2-1. These limestones of high quality are formed with each bed having the thickness of 30 - 50cm, and are continuously exposed. The strike and dip near the natural gas spring is (N-S, 45°W); westward dip is observed in the strike North-South (though it is not clear). However, the strike deflects to the west gradually towards north; (N15°W, 45°E), (N20°W, 65°E), (N25°W, 70°E). The eastward dip tends to be steeper, too.

In the outcrops of the limestone bed showing steep dip on the ridge, there exist deeply eroded spaces (concavities) of 10 - 20cm between the strata of the limestone, where quite often the limestone strata fall down. These spaces (concavities) are most likely to have been caused by the differential erosion of the argillaceous rocks (ex. shale) which originally existed therein. In any case, as this limestone deposit is considered to be composed of high-grade limestone, detailed geological survey including boring or trenching should be conducted before the remaining quantity of minable reserves at Htone Daung quarry becomes little, because the limestone supply from Htone Daung Quarry alone will not be sufficient to meet the demand when the quarry faces become narrow as the quarrying reaches lower levels.

Table 4-2-1 Analysis of Natmee Daung Limestone

Sample No.	CaO	MgO	Calculated $CaCO_3$	Location
MND-1A	54.24	0.32	96.86	Near the natural gas spring, 95m level
MND-1B	53.79	0.16	98.45	"
MND-2	54.46	0.48	97.25	South of the highest point, 125m level
MND-3	54.24	0.16	96.86	Sough of the highest point, 148m level
MND-4A	54.91	0.32	98.05	Near the highest point, 152m level
MND-4B	55.13	0.16	98.45	Near the highest point, 155m level

4-3 Limestone Deposit North of Kyangin Cement Mill

According to the geological map of Kyangin Area, limestone is distributed in the hills 2 - 3km north-west of the cement mill. Survey was conducted for a short period to confirm this. Three samples were collected. As shown in Table 4-3-1, the results of analysis show that these are all low-grade limestones. The area where the limestone is distributed extends from north-north-west to south-south-east. Outcrops in this zone are rare and the surface soil appears to be thick in general. The above described samples were collected from the outcrops slightly exposed on the road surface. The condition of this area does not allow the measurement of the strikes and dips. Consequently, the existing conditions of the deposit is unknown at present, but, juding from the rareness of the outcrops and the results of the analysis, this deposit can not be expected to be a promising deposit as Natmee Daung limestone deposit.

However, because of its close location to the cement mill, if considerable amount of the limestone can be quarried concentratedly, an advantage in the transport cost is evident. For this reason, it is desirable to conduct trenching at this deposit when conducting a detailed geological survey of Natmee Daung deposit and compare the two deposits.

Table 4-3-1 Analysis of the Limestone Existing in North-West of Kyangin Cement Mill

Sample No.	CaO	MgO	Calculated $CaCO_3$
KYG-1	49.51	0.65	88.41
KYG-2	48.84	0.81	87.21
KYG-3	46.14	0.81	82.39

(Note) 1. All the samples are argillaceous or marly limestones, dark brownish grey, hard and compact.

2. Analysis was undertaken by the laboratory at Kyangin Cement Mill.

4-4 Clay Deposit Near Kyangin Cement Mill

Clay is extracted from the hilly zone located 0.5 - 1.0km from the Mill.

A. No.1 Quarry, generally referred to as GUEST HOUSE QUARRY

B. No.2 Quarry, generally refered to as LABOUR QUARRY

C. No.3 " " A.C.E. QUARRY

In all the above quarry faces, two types of clay called "high-silica clay" and "high-alumina clay" exist. The former is preferably used at the Mill, and the latter is being avoided due to difficulty in raw material proportioning.

So-called "High-silica clay" is the weathered part of thick-bedded siltstone or fine-grained sandstone, and so-called "high-almina clay" is the weathered part of tuffaceous shale. These two form alternate strata with thickness of 5 - 10m each, and exist extensively in the long stretch of this hill zone. Consequently, the amount of the clay available could be regarded as practically limitless, so that no worry exist as far as the quantity is concerned.

Analysis results of the clay received at the Mill are as shown in Table 4-4-1.

Table 4-4-1 Analysis of clay received at the Mill

Sample No.	SiO_2	Al_3O_3	Fe_2O_3	CaO	MgO	L.O.I.
A	68.13	14.99	5.89	2.02	3.23	5.22
B	60.08	20.42	5.74	3.40	2.58	7.50

Note: Both of the samples A and B are considered to consist mainly of "high-silica clay", but the sample B appears to contain a limited portion of "high-alumina clay".

4-5 The Other Raw Materials Deposit

As for the other raw materials, silica sand from Irrawaddi River, laterite from Than Thaung Laterite Hill and gypsum from Ksipaw Tawnship, etc. are currently used.

4-5-1 Silica sand from Irrawaddi River

River sand is excavated from the bank or the sand bar of Irrawaddi River approximately 10Km from the Mill, and is utilized as the siliceous material. The sand is fine- to medium-grained silica sand with silica content above 85%, and is judged to be favourable as a siliceous material.

However, addition of the sand is either needless or, even if required, in a very small quantity in case the "high-silica clay" is used as clay.

Such kind of sand, on the other hand, occurs vastly along Irrawaddi River. Accordingly, there is no need to worry about supply of siliceous material, both in quality and in quantity.

In view of burnability of raw materials, this silica sand is considered to be inferior in burnability than clayer material, because the former consists mostly of quartz while the latter cotains a considerable amount of clay minerals.

Therefore, it would be advantageous, in respect to burning, to try to minimize addition of this silica sand by using mainly the "high-silica clay" as has been done in principle in the actual operation so far.

4-5-2 Laterite deposit at Than Thaung Laterite Hill

As for ferrous material, laterite is being used, which is obtained from Than Thaung Laterite Hill located approx. 21Km from the Mill and approx. 11Km from Htone Daung limestone quarry.

At the said locality, laterite occurs widely covering the vast surface of the hill with thickness of 5-6m at least.

Its surface portion forms a hard crust as result of consolidation of laterite grains, and such a portion is often peeled off from the surface and produces scattered boulders. Collection of laterite is done in a simple method, namely, by picking up such boulders by hand and loading them onto a truck.

The road between the Laterite Hill and Htone Daung is a rugged unpaved road, which does not allow to transport in the rainy seasons. Therefore, laterite is transported in the dry seasons only, and stored at the open stock yard in Htone Daung limestone quarry. Transport to the Mill is done, whenever required, through the same processes as those for limestone.

Analysis results of the laterite received at the Mill are as shown in Table 4-5-1.

Table 4-5-1 Analysis of laterite received at the Mill

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	L.O.I.
A	48.78	12.48	28.50	1.46	0.48	7.46
B	39.96	14.80	36.32	0.86	0.32	7.26

Note: The samples A and B are high-grade and low-grade laterite respectively, which represent the highest and the lowest quality of the laterite received at the Mill. In any case, there is no problem in relation to the quality as for cement raw material.

4-5-3 Gypsum deposit in Hsipaw Township

Gypsum is currently purchased from a gypsum quarry in Hsipaw Township. Transportation is made by railway for approx. 211Km from Hsipaw Township to Mandalay Shwe Kyetyet, then by boat for approx. 624Km from Mandalay to the Fore-Shore in Kyanging, and then by truck for approx. 10Km from the Fore-Shore to the Mill.

Any survey at site could not be conducted on this gypsum deposit this time. According to the explanation given by the Burmese side, the available reserves are abundant, and a quantity sufficient for requirement of the present project can be secured. Analysis results of the gypsum received at the Mill are as shown in Table 4-5-2.

Table 4-5-2 Analysis of gypsum received at the Mill

Sample No.	SO_3	L.O.I.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
A	38.73	20.80	3.87	1.64	0.12	35.22	0.34
B	32.48	18.32	4.20	1.99	0.17	31.46	0.82

Note: The samples A and B are high-grade and low-grade gypsum respectively, which represent the highest and the lowest quality of the gupsum received at the Mill. In any case, there is no problem relating the quality as for cement raw material.

CHAPTER 5 RAW MATERIAL SUPPLY

5-1 Present Situation of the Material Supply to the Existing Mill

5-1-1 Limestone

Supplied from Htone Daung Quarry located 5.4km from the mill, limestone is transported to the Mill by the diesel locomotive.

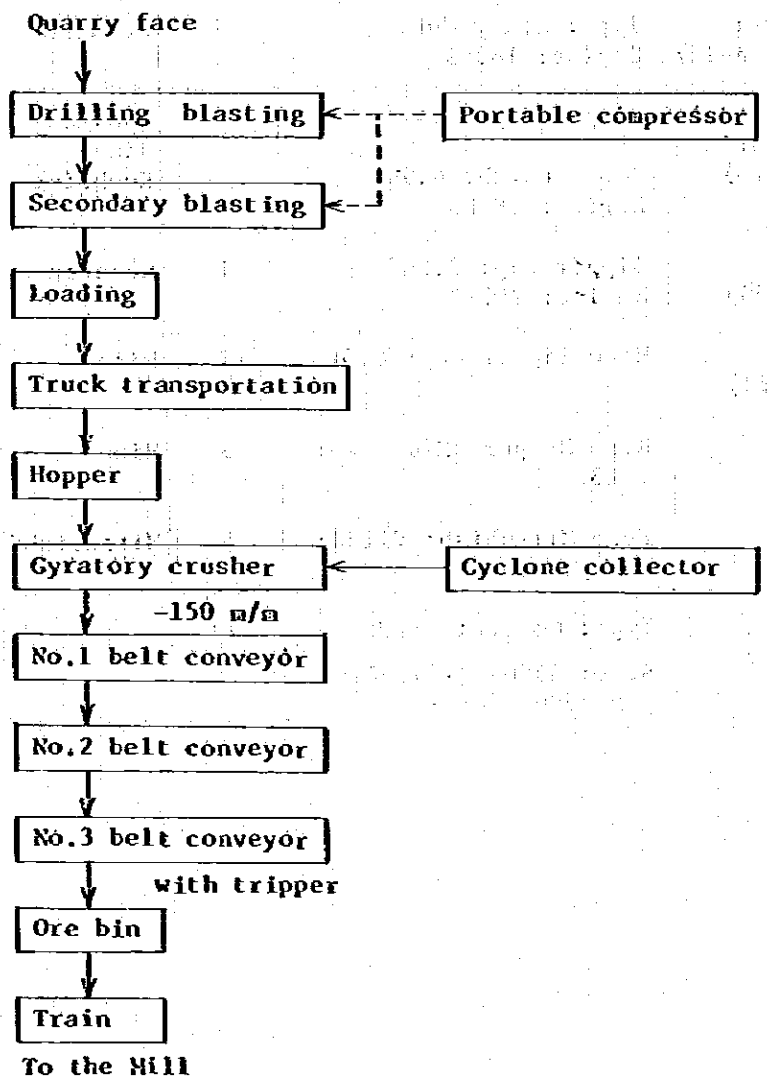
Htone Daung Quarry is situated in Kyangin Township in latitude 18°14' North and longitude 95°10' East. It is a narrow woody hill extending for approximately 1km from East to West, and 2.5km from South to North.

The present situation of Htone Daung Quarry is described in the following.

5-1-2 Flow Sheet of Htone Daung Quarry

Fig. 5-1-1 shows the Flow Sheet of Htone Daung Quarry.

Fig. 5-1-1



5-1-3 Present Facilities

Table 5-1-2 shows the present facilities.

Table 5-1-2

Description	Specification/ Capacity	No. of unit	Maker	Date of instal-lation	Remarks
Crawler Drill (CD-3)	Type: Air Blow Air consumption : 9m³/min	2	Tokyo Pneumatic machine	1973	Serviceable
Hand Drill (217D)	Air consumption: 2.6m³/min	9	Furukawa	"	"
Portable compressors (AMR600)	Type: Rotary vane type 1800rpm 7kg/cm², 17m³/min	3	Hokuetsu Kogyo	"	"
Electric Blasting Equipment	Type: Transistor & condenser	2	Nihon Kayaku	"	"
Bulldozer (D-85A-12)	Type: Heavy duty Engine: 180PS	2	Komatsu	"	1 unserviceable
Power shovel (Koehring 605-2B)	Dipper cap: 1.4m³ Boom length: 6.9m Engine: 180PS	2	Ishikawajima Koehring	"	1 unserviceable
Loader (D-75S)	Dipper cap: 2.2m³ Engine: 200PS	1	Komatsu	1978 OCT	Serviceable
Trucks (TE-11)	Hino Tipper cap: 6.5t	17	Hino	1974	9 Unserviceable
Dumpers	Hino Dumper ZH201 cap: 13t	3	Hino	1977 NOV	Serviceable
	Fuso Mitsubishi V112J: cap: 15t	5	Mitsubishi	1978 OCT	"
Limestone Unloading Hopper	Type: Concrete made Size: 4500mm x 4500mm x 3500mm depth	1		1971	"

(To be continued)

Description	Specification/ Capacity	No. of unit	Maker	Date of instal-lation	Remarks
Gyratory Crusher	Type: Superior primary non ckoking heavy duty type Rated capacity: 300 t/h Feed opening 1070mm x 2750mm Mantle diameter: 1650mm Eccentric throw: 32mm Discharge setting: 150mm Mainshaft speed: 150 gyrations/min Pinion shaft speed: 497rpm Capacity of motor: 260kw	1	Kobe-seiko	1971	Serviceable
Cyclone Collector	Type: Cyclone Capcity: 300m^3/min at 40°C	1	Kawasaki heavy industry	"	"
Belt Conveyor (No.1)	Trough type Capacity: 350 t/h 1500mm width 10000mm length Speed: 35 m/min	1		"	"
Belt Conveyor (No.2)	Trough type Capacity: 350 t/h 750mm width 281.7m length -39.7m height Speed: 116m/min Motor: 45kw	1	Fukuchi Giken	"	"
Belt Conveyor (No.3)	Trough type Capacity: 350 t/h 750mm width 180m length +13m height Speed: 116m/min Motor: 30kw	1	Fukuichi Giken	1971	"
Ore bin	Type: Concrete made Capcity: 1800t of limestone	1		"	"
	Gate: Steel plate con-struction	12		"	"
	Electric Hoist for Gate 3 tons: 4 numbers 1 ton : 8 numbers	12		"	"
Storehouse of explosive	Capacity: 18t	1		"	Mill site

5-1-4 Present No. of Personnel and Working Hours

(1) Personnel

Table 5-1-3

Place	Kind of Labour	No. of Labour
Face	Drillers	15
	Blastor	6
		21
Equipment	Heavy equipment Operator (Bulldozer and Excavator etc.)	15
	Dumper Operator	23
	Maintenance Crew	46
	Road Maintenance	7
	Office Staff	5
	General Labourers	11
		107
Crushing plant	Operator	54
	Maintenance crew	17
	Office	6
		77
Total		*205

* Among the 205 quarry personnel, approximately 70 persons live in Kyangin and other villages(commute by locomotives), and the rest near the quarry.

(2) Working hours

(i) Actual working hours: 6 hours/shif

(ii) Number of shifts: 3 shifts/day

2 shifts on Saturdays and Sundays, as a principle.

1 shift for drilling and blasting work as a principle, but overtime or 2-shift/day may be applied depending on the situation.

(iii) Shift Schedule

1st shift ... 7:00∿15:00

2nd shift ...15:00∿23:00

3rd shift ...23:00∿ 7:00

5-1-5 Production Results

Table 5-1-4 and 5-1-5 show the production results in 1977 and 1978.

Table 5-1-4

	1977	1978
January	21,460t	28,044t
February	22,075	24,286
March	26,120	32,295
April	28,285	21,460
May	16,935	16,967.5
June	11,204	19,388
July	6,508	6,250
August	6,844	11,112
September	10,352	11,892
October	14,748	18,360
November	18,904	34,293
December	28,511	-
Total	211,946	224,347.5
Average	17,662	20,395.2
Remarks	The quantity is calculated based on the number of trucks.	

Table 5-1-5

Monthly Average Production in Rainy Season and Dry season (t/month)

Dry season		Rainy season	
1977/Jan. ∿ Apr.	24,485t/m	1977/May ∿ Oct.	11,095t/m
1977/Nov.∿ 1978/Apr.	25,584	1978/May ∿ Oct.	13,995
Average	25,145	Average	12,547

5-1-6 Mining Method and Quarry Face

(1) Mining method

By Bench cut method

(2) Quarry face

No.1, No.2 and No.3 face are opened in the quarry.

(i) No.1 face

Located at 620 feet level approximately 1(one) mile to the primary crusher (300 feet level), the face presently quarried produce low-grade limestones with high content of clay($CaCO_3$ 60 ∿ 70%).

For this reason, they can not be used without mixing with better limestones, and they are stored in the form of blasted rocks. The rocks are shipped in small quantity during dry season, but cannot be consumed in a short period. Consequently the face can not progress, and is practically suspended from operation.

(ii) No.2 face

Situated at 370 ∿ 380 feet level, at the point approximately 0.5 mile from the primary crusher, this is the main face. The length of the face is approximately 100m, and the height of the bench is approximately 10m ∿ 20m.

Bench is planned to be made in 2-level, but, it is delayed due to the frequent troubles with bulldozer.

The limestones with high clay contents which could not be transported during the rainy season are stored in the face, and are adequately transported during the dry season.

(iii) No.3 face

Situated at 580 feet level at a point approximately 1 mile from the primary crusher. Length of the face is approximately 15m, and the bench height is approximately 12m. The face is planned to be expanded along the road.

All the No.1, No.2 and No.3 face have alternation of limestone and thin shale.

5-1-7 Present Situation of the Various Works

(1) Overburden removing

As all the present faces have hardly any top soil, and the policy is to utilize the low-grade portions as much as possible, practically no work for removing overburden is required.

All that is done presently is to collect the roots of the trees and bamboos on the surface of No.2 face by bulldozer to burn them.

(2) Drilling and blasting

(i) Drilling

Drilling is performed with crawler drills (2 units) and hand hammers (for secondary blasting).

a) Drilling results

Table 5-1-6

	Total number of holes drilled (hole/month)			Total length drilled (ft/month)		
	No.1 crawler drill	No.2 crawler drill	Total	No.1 crawlwer drill	No.2 crawler drill	Total
1978						
JAN	83	94	177	2045	1540	3575
FEB	83	41	124	2119	575	2694
MAR	87	70	157	2240	1400	3640
APR	77	89	166	2104	1143	3247
MAY	30	41	71	990	832	1822
JUN	19	66	85	232	1144	1376
JUL	61	14	75	794	390	1184
AUG	35	20	55	455	430	885
SEP	104	138	242	1099	1019	2118
OCT	95	57	152	2063	491	2554
NOV	127	189	316	3188	2319	5507
DEC	-	-	-	-	-	-
Total	801	819	1620	17329	11273	28602
Average	72.8	74.5	147.3	1575.4	1024.8	2600.2

b) Drilling results by rainy season and dry season

Table 5-1-7

		Total number of holes drilled			Total length drilled		
		No.1 cralwer drill	No.2 crawler drill	Total	No.1 crawler drill	No.2 crawler drill	Total
Rainy season 1978 May ∿ Apr.	Total	hole 344	hole 336	hole 680	feet 5633	feet 4306	feet 9939
	Avé-rage	57.3	56	111.3	938.8	717.7	1656.5
Dry season 1978 Jun ∿ Apr.	Total	457	483	940	11696	6967	18663
	Ave-rage	91.4	16.6	188	2239.2	1393.4	3772.6

The efficiency of drilling is greatly reduced in the rainy season due to collapsing of the hole while it is being drilled (especially in downward drilling).

c) Toal length of drilling classified by the length of drilling per hole (actual results in the dry season only).

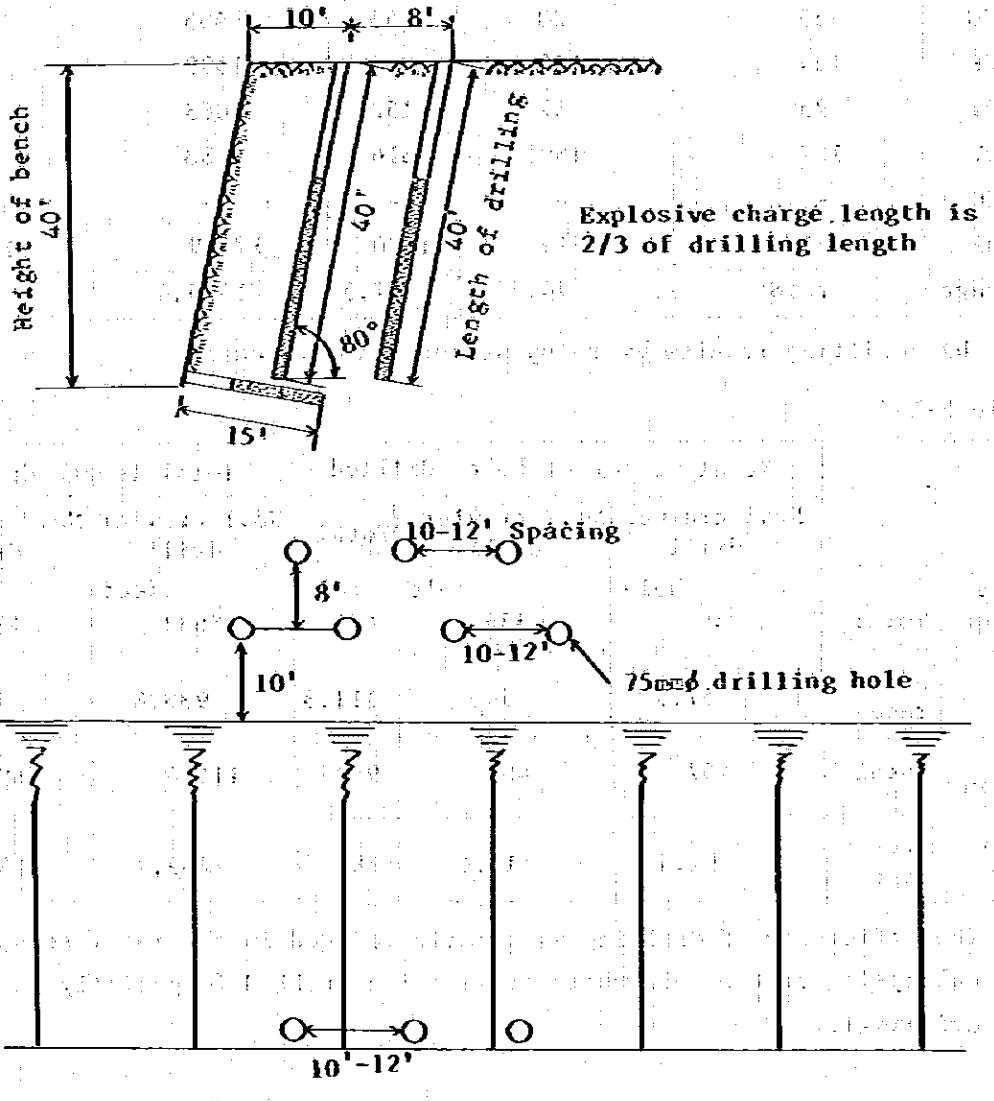
Table 5-1-8

Drilling length per hole	Total length of drilling
10' length	300'
20' "	250'
30' "	200'

(ii) Blasting

a) Blasting pattern

Fig. 5-1-9

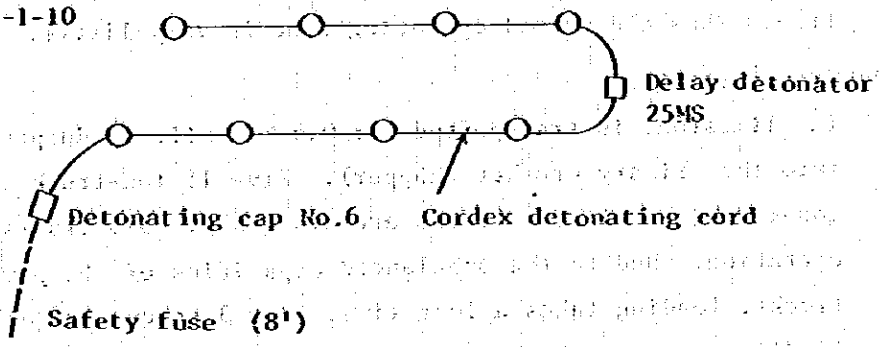


b) Blasting method

° Blasting: As a principle, ANFO explosive is used with gelatine as the primer for both downward drill holes and toe-holes in dry season, and blasting is done by the detonanting cord and safety fuse.

In the rainy season, ANFO can not be used, so only gelatine is used. Electric blasting is not employed. (See the drawing below).

Fig. 5-1-10



° Secondary blasting: Large lumps are collected at one place, and drilled with hand hammers, then blasted with ANFO explosive and detonating cord and the fuse. Gelatine is used in place of ANFO in the rainy season. Secondary blasting is done approximately once in 7 ∿ 8 days.

c) Type of explosive and the unit consumptions

° Gelatine: 70% NG 2 1/2"ϕ x 2 1/2 lb
" " 1 1/4"ϕ x 4" length } 50% } 13.78t/kg explosive.

°*Ammonium Nitrate. Prilled fuel oil 50% treated AN/FO

° Detonating cap No.6 : 1200t/piece

° Delay Detonator 25MS : -

° Safety fuse (Velocity of detonation 2 feet/min) : 300t/foot

° Cordex detonating cord : 1/2'/t

° AN + FO mixing is done using the concrete mixer at the quarry site.

(3) Loading/transport

(i) Loading

Two power shovels (1.4m^3) and one dozer shovel (2.2m^3) are available as the loading machines. However, one of the power shovels is now utilized as the parts supplying source after its breakdown. Therefore, actual machines available for the operation is 1 power shovel and 1 dozer shovel.

As this old power shovel is used in 3-shift operation, the trouble occurs frequently and supplying of fuel etc. requires a considerable time. Thus the actual operating time is very little.

(ii) Transportation

The limestone is transported for 0.5 ∿ 1 mile by dumptruck, and fed into the primary crusher (hopper). Five 15-ton-truck and three 13-ton-truck, total of 8 trucks are available. 3-5 trucks/shift are in operation. Due to the unbalanced capacities of the power shovel and trucks, loading takes a long time. 2 ∿ 3 trucks are alloted to one loading machine. If 3 trucks are alloted, the waiting time is considerably long. The transportation capacity is reduced to about a half in rainy season due to the adhesion of the sticky limestone to the vessel.

Table 5-1-11 Truck Transport Results

Vehicle distribution (number of trucks)	2	3	4	5
Frequency of transportation/shift	41.3	40.8	47.4	56.4
Frequency of transportation per vehicle/shift	20.7	13.6	11.8	11.3

(4) Primary crushing and transportation

Whole amount on the truck is directly fed into the primary crusher (hopper). When the limestone has high clay content, the limestone is fed into the hopper little by little to prevent jamming. Jamming does occur from time to time despite of this.

Both the primary crusher and the beltconveyors have considerable idle operation time due to the trouble in the preceding/succeding processes (ex. troubles of loading machines, waiting for the train). Flushing may occur at the No.1 BC directly below the pirmary crusher in the rainy season.

(5) Ore bin

Total capacity is 1800t (150t x 12) with 12 loading chutes. Loading is done from one chute. Loading from the multiple chutes is not employed. Initially, simultaneous loading from 4 chutes were possible, but, the facility has been remodeled for loading from single chute for the following reasons:

(1) There is a gap between the centers of chutes and those of wagons.

(2) Limestones stocked in the ore bin would stick in the rainy season, so the uniform loading can not be accomplished. In the dry season too, the chute can not be shut when the limestone once stocked is being loaded.

Consequently, the present method is actually a direct loading with practically no running stock. The loading time is a bottle-neck in the production, requiring approximately 1.5hr/train in the dry season and 2 ∿ 3 hr/train in the rainy season.

(6) Materail transportation

All the explosives, fuels, oil/grease, etc., are transported from the mill site to the quarry site by locomotives.

For a certain period in the dry season, a temporary road is sometimes constructed along the railway for truck transportation. Heavy duty machines (self-driving included) are transported via this road.

5-1-8 Problems in the Present Situation and their Countermeasures.

(1) Quarry Face

(i) Being busy to meet the production demands, the development is being delayed.

: Due to the insufficient number of heavy machines and the low working ratios

Countermeasure: Improvement of the working ratios of the heavy equipment. Replacement of the old equipment and procurement of new equipment is necessary.

(ii) Insufficient face area and length

: One of the causes is that the face can not be advanced as the low-grade limestones with high clay content which could not be carried to the outside during the rainy season are stored in the face and used little by little in the dry season.

Countermeasure: It is necessary to remove a certain amount of the low-grade limestones. For this purpose, the required heavy machines and the waste disposal site are required.

(iii) Excessive bench height

: Rock base is liable to collapse and is dangerous. Also the crawler drill capacity is deteriorated. All caused by the delay in the preparation due to the lack of enough machines.

Countermeasure: As (i).

(iv) Low working ratios of heavy machines

: a) Old and have frequent breakdown (maintenance problem)

b) Too much time taken for supplying fuel.

c) Suspended from operation due to the trouble in the succeeding process.

d) Takes time in transfer at the shift relief.

Countermeasure: Maintenance has quite a big problem as all the machines are imported items. Improvement of the operators' skill and the ability of the repair crew is essential. However, it is also necessary to establish a proper system where the spare machine is not to be utilized as the parts supplying source.

The fuel supplying system, too, should be improved by the procurement of second-hand tank lorry, etc.

(v) Handling of the sticky limestone in the rainy season.

(See the following item (4) a) where the countermeasures against the rainy season is discussed.)

(2) Primary crushing and transport

(i) Liable to cause crusher clogging

: As the whole amount loaded on the truck is fed into the crusher directly, crusher clogging is caused not only in the rainy season but in the dry season as well, if the clay content is high.

Countermeasure: Since the drastic improvement such as the installation of grizzly in front of the crusher is impossible, chains shall be provided at the inlet to the crusher so that the limestones are fed gradually.

(ii) Flushing (overflowing) of fine material occurs from time to time in the dry season from the BC directly below the crusher.

: Due to lack of the carrier rollers.

Countermeasure: Additional carrier rollers shall be installed.

(iii) Insufficient actual operation time

: Stopping due to its own cause (ex. clogged crusher) and the idle running due to the preceding/suceeding processes (ex. waiting for trucks/wagons).

Countermeasure: Reduce the idle running caused by the preceding/succeding process for this purpose.

a) Sufficient number of heavy machines shall be secured to eliminate waiting time for the truck.

b) The ore bin shall be remodelled to change the direct transfer currently employed to the condition where the storage of the ore is possible.

(3) Ore bin

(i) Can not store the ore.

(ii) Takes excessive time for loading.

See item 5-1-7 (5) Ore bin.

Countermeasure: Currently, the ore bin is designed to extract the ore from one side.

This should be remodeled to extract the ore from the center, and in addition it shall be provided with the water-spray facility to each chute by the piping from the tank for the primary crusher cooling water to prevent the sticking in the rainy season, which will improve the sticking in the rainy season. It shall be improved into the facilities to allow simultaneous loading to multiple number of wagons. The gate shall be remodelled to hydraulic type.

(4) General

° Handling of the sticky limestone in the rainy season

: The handling of the sticky limestone in the rainy season is the biggest problem at present. Limestone of Htone Daung Quarry contains 40 ∿ 50% of shale and limestone dust. Due to this, they become extremely sticky in the rainy season and cause serious troubles in their handling through almost all the processes from the working face to the unloading hopper at the mill site (excavator, dumpers, crushers, ore bin gates, railway wagons, etc.). The production in the rainy season is reduced to about a half of the production in the dry season simply because of this fact.

Following countermeasures have been taken in the past, but none of them has brought drastic improvement:

(i) The roof of the primary crusher house was extended.

(ii) The manually quarried limestone lumps (stored during the dry season) were used.

(iii) The cover to the loading gate was provided to prevent the rain water from entering.

(iv) Canvas sheets covering the ore wagons transporting limestone from the ore bin to the unloading hopper were provided.

The following drastic countermeasures may be applied:

a) Storage method

Sufficient quantity of ores to compensate for the reduction in the rainy season is to be stored during the dry season, and is to be used in the rainy season. The stockyards are to be installed both at the quarry site and the mill site.

b) Washing method

Washing facilities shall be installed at the quarry site and the limestones are to be transported after being washed in the rainy season.

c) Drying method

Drying facility shall be installed at the quarry site, and the limestones are to be transported after being dried in the rainy season.

d) Develop the reserved deposit (Natmee Daung) and open a face exclusively for the rainy season.

Of the above assumable countermeasures, (a) Storage method is considered to be the best. It is idealistic, if a face containing hardly any clay could be provided at the present quarry exclusively for the rainy season. However, it is judged to be extremely difficult in view of the existing condition of the deposit.

5-1-9 Other Materials

(1) Clay

Clay is quarried in the following locations near the Mill.

- No.1 Quarry, Guest House clay quarry
- No.2 Quarry, Labour quarry
- No.3 Quarry, A.C.E. clay quarry

(i) Quarrying method: Bench cut quarrying

° Clay is excavated by the buildozer (D-85A with ripper), and loaded onto the truck (6.5t) by a wheel loader.

° Only the surface portion is quarried.(Deeper portion is not being used as its high alumina content makes raw material proportioning impossible.)

(ii) Production results (1977/Jan ∿ 1987)

Table 5-1-12

	1977	1978
January	2970 t	0 t
February	2169	0
March	90	0
April	270	48
May	900	0
June	270	245
July	135	889
August	171	1473.5
September	200	595
October	305	1050
November	1700	542.5
December	1125	-
Total	10125	4843.0
Average	843.8	440.3

(2) Siliceous Material

Collected from River Irrawaddy approx. 10km from the mill.

(3) Ferrous Material

Collected at Than Taung Laterite Hill situated approximately 21km from the mill and approximately 11km from the quarry, respectively.

(i) Collection and transportation methods

Lumps are collected by hand and loaded onto the truck (6.5t load). Transported only in the dry season (transportation in the rainy season not possible due to the bad road conditions), and stored at the quarry site. Transported to the mill in the same process as that of limestone when required (Hopper - primary crusher - B.C. - Ore bin - Railway - Mill).

(ii) Reserves: Limitless

(4) Gypsum

Transported from Hsipaw township

° Transportation method

Railway transportation for approximately 211km from Hsipaw township to mandalay shwe kyetyet. Transported by boat for the distance of approximately 624km from Mandalay Shwe Kyetyet to Kyangin (Fore shore), and then transported by truck for the distance of approximately 10km from the fore shore to the mill.

5-2 Material Supply to the Expanded Mill

5-2-1 Limestone

(1) Production capacity of clinker

Assuming that the operating days are 25d/m, 300d/y.

400t.cl/d x 4 sets = 1,600 t.cl/d

1,600t.cl/d x 25 d/m = 400,000 t.cl/m

1,600t.cl/d x 300 d/y= 480,000 t.cl/y

(2) Required amount of limestone

(i) Unit consumption of limestone: 1.33t/t.cl

(ii) Water content: dry season ... 2%, rainy season ... 16%.

a) Dry season:

$$1{,}600\text{t.cl/d} \times 1.33 \times \frac{1}{1 - 0.02} \fallingdotseq 2{,}170\ \text{t/d}$$

2,200 t/d x 25 d/m = 55,000 t/m

b) Rainy season:

$$1{,}600\text{t.cl/d} \times 1.33 \times \frac{1}{1 - 0.16} \fallingdotseq 2{,}530\ \text{t/d}$$

2,530 t/d x 25 d/m = 63,250 t/m

(3) Required capacity of the limestone quarrying

As the working ratio in the rainy season goes down to 40%, the deficit of 60% shall be produced and stored during the dry season. Consequently, the required quarrying capacity in the dry season is as follows:

2,170 t/d + 2,170 t/d x 0.6 ≒ 3,500 t/d

3,500 t/d x 25 d/m = 87,500 t/m ≒ 90,000 t/m

The above calculation shows that quarry output of 90,000 tons per month is required.

(4) Limestone grade required

Average grade received at the Mill ... CaO 46.45 (min. 44.13%)

(5) Working hours

(i) Drilling/blasting work ... 8hr/day, 1 shift

(ii) Loading/transportation: 16hr/day, 2 shift

(iii) Crushing and transportation: Same as (ii)

5-2-2 Construction Work Required for the Expansion

For the increased limestone production required with the expansion of Kyangin Cement Mill, the following construction works will be required.

(1) Construction of the waste dump area.

(2) Construction of the waste transportation road to the dump area.

(3) Deforestation and the construction of the working face.

(4) Construction of the transportation road between the face and the newly constructed crushing plant.

(5) Construction of new crushing plant and the ore bin (includes the extension of railway).

(6) Construction of the limestone stockyard at the quarry site.

(7) Procurement and installation of equipment.

(8) Construction of the office, workers' rest house and parts' warehouse.

(9) Installation of the communication facility for announcing blasting and construction of the shelter from blasting.

The outline of the plan for the main items among the above works shall be described in the following.

(1) Construction of the waste dump area

The waste dump area for the overburden to be removed (including the removal of low-grade limestones) in the future is required.

(i) Estimated quantity of the overburden to be removed.

The quantity expected in the presently planned area for quarrying is approximately 1.2 ∿ 1.5 million m^3. The detailed survey in the future is required.

(ii) Proposed waste dump areas

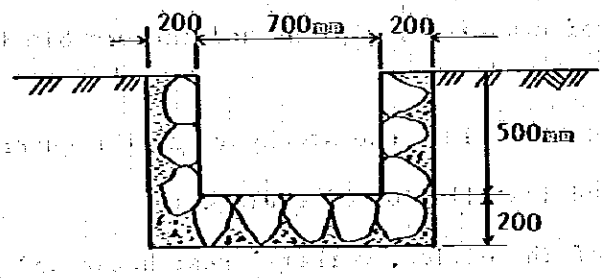
Three valleys adequate for waste dumping are found in the vicinity of the planned quarrying area, but only one, waste dump area shall be constructed initially, and shall be increased as required in the future. (Refer to drawing Q-4)

(iii) Facilities

a) Rock-fill dam: Width of the top of bank: 5m
Width of the base of the bank: approx. 60m
Length of the bank: approx. 42m
Height of the bank: approx. 18m
Material: Limestones approx. 16,500m^3 (Refer to the ANNEX Q-1)

b) Water channel on the mountain side: To prevent the off-site water from entering.

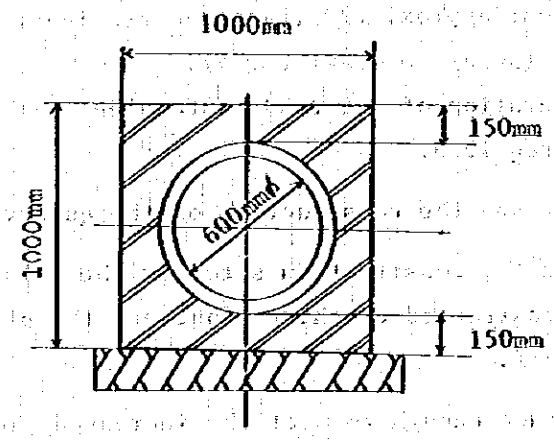
Drawing 5-2-1 Standard Sectional Diagram



Scale: 1/30

c) Covered conduit: Installed inside the quarry for draining the valley water and the plant water.
Reinforced concrete pipe (600m/m dia.)
Concrete around the whole cross-sectional surface.
Length: Approx. 140m

Drawing 5-2-2 Standard Sectional Diagram



Scale: 1/30

Filter (to be closed with a punctured steel plate or a wire net and cobble, gravel and sand are to be layed each in thickness of 1(one)m in front of the filter) will be provided at the top edge (inlet) of the covered conduit.

d) Settling basin: Shall be made directly under the waste dump area to prevent the outflow of the dirty/muddy water.
Digging: Volume ... 6,000m^3

e) Special road for bulldozer: To compact the dumped wastes (overburden) by the bulldozer.
Width 5m, length 370m, average gradient: 20%.

(iv) Dimensions and capacity of the waste dump area:
Dimension: approx. 45,000m^2
Capacity: approx.350,000m^3

(2) Construction of the waste transportation road to the waste dump area.
Road to transport the waste (overburden) to the waste dump area shall be constructed branching off from the existing road used for the transportation of limestones.

(i) Between 550ft level ∿ 450ft level: width 7 ∿ 20m (including the roadside ditch without cementing and the space for dumping operation)
Extension: approx. 450m, average gradient: approx. 7%, Cuttings: approx. 7000m^3)

(ii) Between 600ft level ∿ 450ft level: width 7m (including the roadside ditch without cementing)
Extension: approx. 790m, average gradient: 6%, cuttings: approx. 14000m^3 (Refer to drawing Q-4).
The alteration of the road route along with the progress of quarrying is required.

(3) Deforesting and the construction of the quarry face

(i) Trees in the construction site for the related facilities of the newly constructed crushing plant and the planned quarrying site must be cut off.

(ii) Quarry face enough to meet the increased production after the expansion is required.

a) Required length of face
Assuming quarry output: 3,500t/day (dry season)
Burden: 2.5m + 2m = 4.5m
Bench height: 10m
$4.5m \times 10 \times X \times 2.7t/m^3 \fallingdotseq 3,500t$
$X \fallingdotseq 30m$
Required length of face with the grade-control taken into consideration is: 30m x 3 x 3 = 270m

b) Face width
Sufficient width for loading to the dump truck by loading shovel shall be required. Min. 15m.

(4) Construction of the transportation road between the face and the newly constructed crusher plant

(i) The road for the transportation of the limestone to the newly constructed crushing plant shall be constructed branching off from the existing limestone transporting road.
Between 450ft level ∿ 280ft level: width 7m (including the roadside ditch without cementing) Average gradient: approx. 5%
Between 420ft level ∿ 390ft level, banking is to be done, and the rest shall be cuttings.
Banking: approx. 10,500m^3, cuttings: approx. 13,000m^3, extention: approx. 1,030m

(ii) Construction of the connecting road between the existing crushing plant and the newly constructed crushing plant.
Between 310ft level ∿ 280ft level: width 7m (including the roadside ditch without cementing)
Extension: approx. 330m, average gradient: approx. 3%, cuttings: approx. 3,500m³ (Refer to drawing Q-4).

(5) Construction of the new crushing plant and the ore bin (including the extension of railway) (See sections 6-11-1, 7-2-1, and 7-2-2).

(6) Construction of the outdoor stockyard at the quarry site.
(See sections 6-11-1, 7-2-1)

(7) Procurement and installation of the equipment
See the specification for the main facilities given in Section 5-2-4.

(8) Installation of the communication facilities for announcing blasting and construction of shelters from blasting.
See Section 5-2-7, 'Safety measures and preventive measures against environmental pollution'.

5-2-3 Construction Cost in Relation to Face

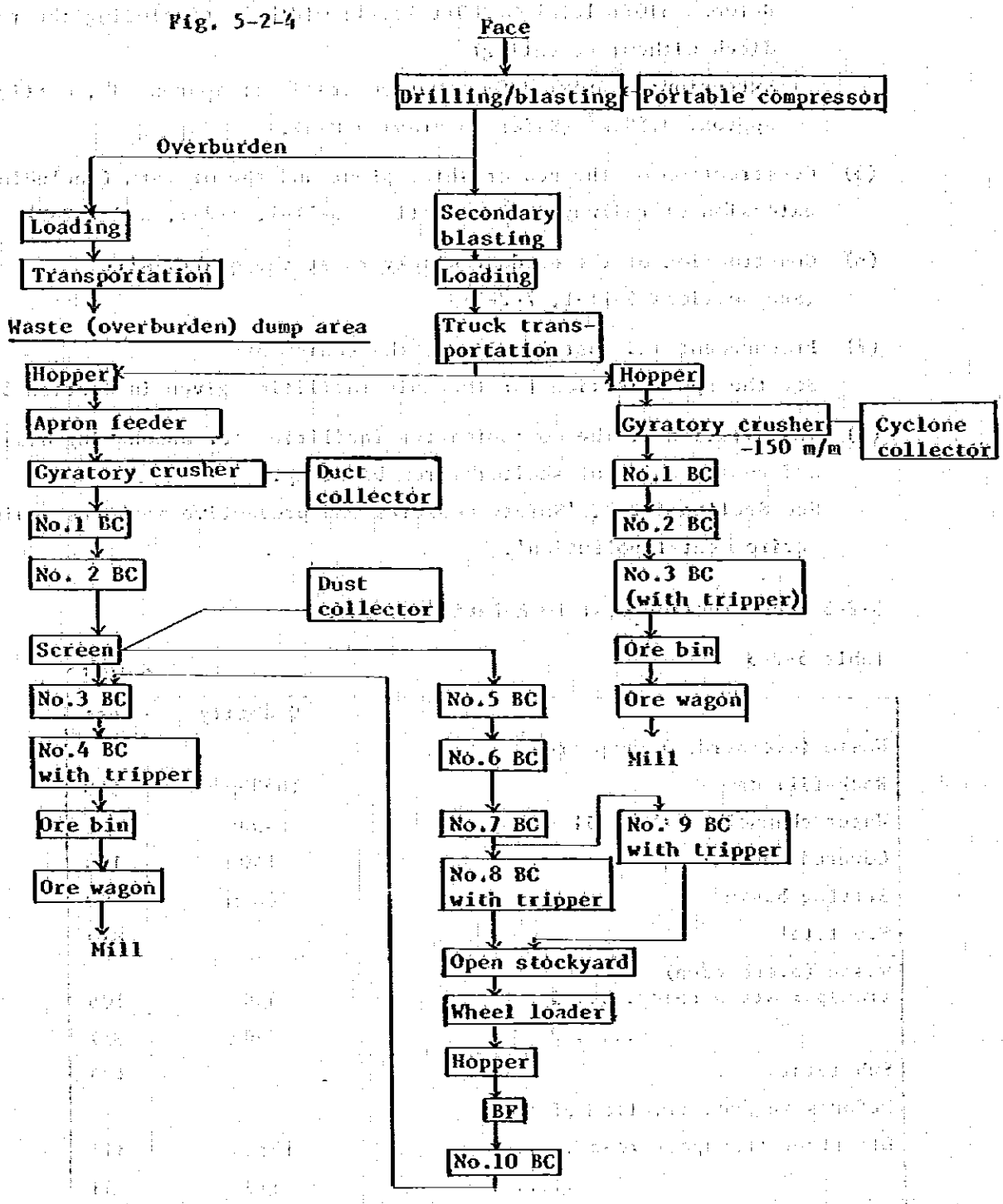
Table 5-2-3 × 10^3KS

	Quantity	Cost
Waste (overburden) dump area		
Rock-fill dam	16500m³	550
Water channel on the hill side	450m	70
Covered conduit	140m	100
Setting basin	6000m³	90
Sub total		810
Waste (overburden) transportation road 1	450m	106
" 2	790m	317
Sub total		423
Deforesting/construction of face	-	-
Limestone transport road 1	1030m	347
" 2	330	53
Sub total		400
Miscellaneous works		67
Grand total		1700

5-2-4 Facilities at Htone Daung Quarry

(1) Flow-sheet

Fig. 5-2-4



(2) Specifications for the principal facilities

Table 5-2-5

	Description	Specification/ capacity	Quantity	Remarks
FOR LIMESTONE QUARRYING	Crawler drill	Air blow type Air consumption :15m^3/min approx. at 5kg/cm^2 pressure Tokyo Ryuki Seizo K.K. CD 6A or equivalent	5	1 unit for spare Also used for overburden removing
	Portable compressor	Capacity: 7kg/cm^2 pressure, 17m^3/min in compressed air delivery Hokuetsu Kogyo K.K. PDR-600 or equivalent	6	2 units for spare
	Breaker	Base machine (track) : Hydraulic type construction machine 15 ∿ 20t 20HT manufactured by Komatsu Seisakusho or equivalent Breaker: Hydraulic type Manufactured by Furukawa rockdrill K.K. HB-600 or Nihon Pneumatic Kogyo K.K.: New Ehmite H-9X or equivalent	2	1 unit for spare
	Bulldozer	Type: Heavy duty Engine: rated output 220 PS Komatsu seisakusho D-85A or equivalent	5	3 units with ripper 1 unit for spare
	Loading shovel	Hydraulic type: 2 engine, 4 pump 2 valves Engine: Isuzu-E 120 x 2 Rated output: 300 (150PS/1, 700rpm x 2) Dipper capacity: 2.6m^3 bottom dump type	5	1 unit for spare

(To be continued)

	Description	Specification/ capacity	Quantity	Remarks
FOR LIMESTONE QUARRYING	Loading shovel	Hitachi Kenki K.K. Hitachi UH-20 or equivalent		
	Dozer shovel	Type: Heavy duty Bucket capacity: 3.2m³ Komatsu Seisakusho D-95S or equivalent	3	1 unit for spare
	Dump trucks	Type: Scoop-end rear dump truck, rock bottom body type Max. carrying capacity: 15 tons Hino Automobile ZG150D or equivalent	25	
FOR REMOVING OVERBURDEN	Dozer shovel	Type: Heavy duty Bucket capacity: 3.2m³ Engine: rated output 200 PS Komatsu Seisakusho D-95S or equivalent	2	1 unit for spare
	Bulldozer	Type: Heavy duty Engine: rated output 220 PS Komatsu Seisakusho D-85A or equivalent	1	With ripper
	Dump trucks	Type: Scoop-end rear dump truck, rock bottom body type Max. carrying capacity: 15 tons Hino Automobile or equivalent	3	
OTHERS	AN/FO mixer and loader	Capacity: 75kg	2	
	Oil supply car	Capacity: 2000ℓ∿4000ℓ	1	
	Patrol car	For 7 persons	2	

5-2-5 Quarrying Plan

(1) Quarrying method

The current bench cut quarrying, machine loading and truck transportation (to the primary crusher) shall be succeeded.

(2) Operation

(i) Stripping (overburden removing)

Due to the thin top soil, little stripping work is carried out at present. However, after the completion of the expansion, full-scale stripping work including the removal of the low-grade limestones will become necessary, judging from the existing conditions of the deposit, for assuring the required output and the quality.

a) Expected volume of overburden to be removed

5,000 ∿ 10,000m^3/month

b) Heavy equipment for removing overburden

Bulldozer x 1, Dozer shovel x 2 (one for spare)

Dump-truck x 3. Crawler drill shall be used for the limestone quarrying as well. See section 3-2) Specifications for the principal facilities for details.

c) Accumulation method

The range of accumulation shall have the area of approximately 45,000m^2 between the rock-fill dam and 450ft level as the object. The method is to dump the waste (overburden) of the limestone and the low-grade limestone off the dump truck from the location at 450ft level into the waste dump area, and then compact them by the bulldozer.

d) Forming the slope of the waste dump area

For the distance of approximately 15m from the rock-fill dam, the waste is to be accumulated horizontally to about 1m lower than the top of the bank. Then, 25m horizontal stages shall be built at 3-levels with the gradient of 16° for every 15m in height (horizontal distance of 50m). At the back (upper) of the above, the waste shall be accumulated at the gradient of 17° ∿ 11°, up to approx. 175m (450ft) level.

Refer to the ANNEX Q-2 and Q-3.

(ii) Drilling/blasting

a) Blasting pattern

Shall be separated as below for each season

Dry season

Mainly by the downward drilling. Toe hole shall be abolished as a principle, but shall be applied only in the case of the base correction. (See Fig. 5-2-6.)

° Drilling angle: The angle of 80° currently employed is too steep. 65° ∿ 75° is considered to be better. Not only the fragmentation effect and the blasting effect at the foot of the face are increased, but the danger of collapsing is reduced. Also advangateous in view of preventing the back-break.

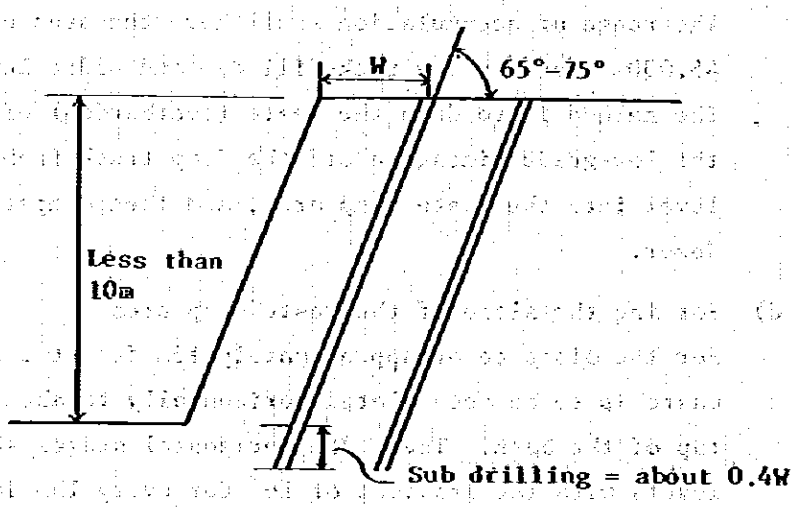
° Bench height: Should be max. 10m considering the following points.

: Maximum scooping height of the loading shovel is approximately 9.5m.

: Efficiency of the crawler drill becomes deteriorated if the drill length becomes longer.

: High bench is not desirable as the rock has a property of being liable to collapse easily.

Fig. 5-2-6

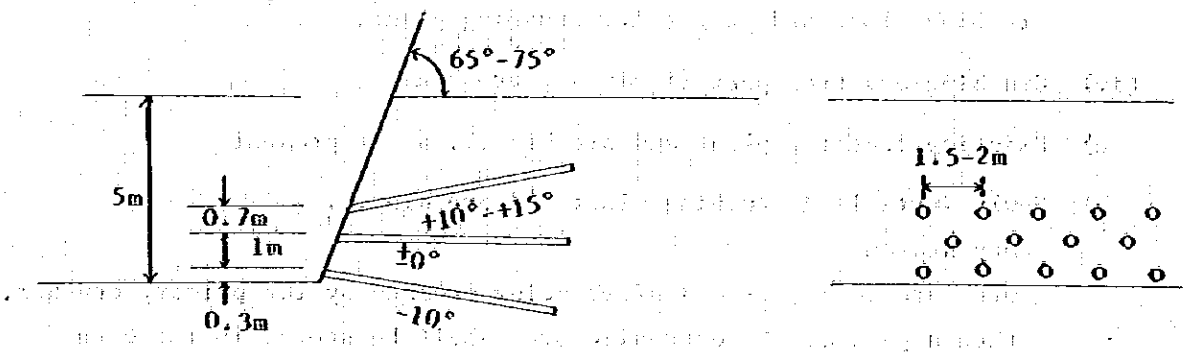


° Burden, Spacing and length of explosives charge etc.: As at present

Rainy season

In downward drilling, the efficiency is radically deteriorated due to frequent collapsing of holes. For this reason, the horizontal drilling face shall be partially constructed. (See Fig. 5-2-7)

Fig. 5-2-7



° Drilling angle: -10° ∿ +15°

° Bench height: approx. 5m

° Space between the holes: 1.5 ∿ 2.0m

° Length of the explosive charge: approx. 1/2 of the drilling length

b) Blasting method

° Blasting

The current blasting method with the detonating cord and the fuse shall be continued for the time being, but the electric blasting should be employed in the future. Sufficient consideration should be given to prevent the accidental firing caused by static electricity in this case.

° Secondary blasting

Along with the increase in the production, large lumps will increase. In order to prevent the reduction in the actual operating time due to the secondary blasting, and to prevent the large lumps from being fed into the primary crusher, large lumps must be thoroughly broken. For this purpose, rock breaker should be introduced on completion of the expansion project, and the secondary blasting shall be cancelled thereafter.

c) Explosives

The explosives currently employed shall be used for the time being.

(iii) Loading/transportation

See item(2), Table 5-2-5, "Specifications for the principal facilities" for the type and number of equipment. The number of the loading machines as compared with that of the trucks should be reasonable, judging from the transporting distance to the existing crushing plant and to the new crushing plant.

(iv) Crushing and transport (including ore bin)

a) Existing crushing plant and ore bin ... as at present

b) Newly installaed crushing plant and ore bin ...

° Dry season

Ores are to be screend after being crushed by the primary crusher, then a part of the over-size ores shall be stored in the open stockyard at the quarry site, and the rest are to be transported to the Mill by railway via the newly installed ore bin.

° Rainy season

Whole quantity of ores fed into the hopper from the truck plus ores extracted from the open stock yard will be transported to the Mill by the existing railway via newly installed ore bin.

The above is a plan as a principle, and there may be a case where the method for the rainy season is temporarily applied in the dry season, or vice versa.

(v) Others

a) Fuel supply: Fuel consumption of the heavy equipment will be increased to two or three times as much as the present rate after expansion. Even at present, too much time is being taken for supplying fuel which is one of the causes of the deterioration in the working rate of the heavy equipment. Therefore, it is essential to install a vehicle for fuel supply (2kℓ ∿ 4kℓ) capacity after the expansion to shorten the time required for supplying fuel to the heavy equipment. Also the capacity of the fuel tank at the quarry site should be increased.

b) Transportation of the explosives: Explosive consumption will increase to two or three times as much as the present consumption rate after the expansion. There is no problem as to the capacity of the existing explosives warehouse at the mill site (capacity: 18t). However, it is desirable to move the warehouse to the quarry site, in view of time and labour taken in the transportation.

c) Water: The water consumption including the cooling water for the equipment will increase. Piping between the water supply source and the tank shall be rearranged so that the cooling water pump for the primary crusher in front of the ore bin can be used during the dry season as well as in the rainy season.

(3) Quarrying plan

(i) Range of Quarrying

See the attached drawing Q-4.

(ii) Quarrying plan

For the time being, No.1 face shall be advanced.

Unusuable low-grade limestones are to be eliminated. Utilizing the sharp slope between Boring points D5 and D7, blasted rocks are pushed in by the bulldozer (the distance of the pushing shall be within the range of 60m), and loaded onto the truck by means of the dozer shovel in the open space at 450ft level, provided the simultaneous operation at both levels (implies the loading operation at 450ft level while the pushing operation is conducted by bulldozer) are strictly forbidden. At the same time, adequate measure should be taken to prevent the limestones, which have been pushed, from reaching the transportation road. As for the area located at a distance over 60m, the limestones shall be loaded onto the truck at 620ft level as is done at present. Cutting down is to be made between boring points, C4 and C5 at the time when No.1 face is advanced for a certain degree, to construct a new face at 580 ∿ 590ft level. The face will be extended to the both directions toward C4 and C5. As for the face opened toward C5 direction, quarrying will be divided into the bulldozer pushing down to 420ft level and the loading onto the truck at the face level depending on the distance to the falling

point of the steep slope, same as in the case of No.1 face. The level-down should be attempted in the same method as described above. No.3 face will be advanced, without expanding its width, toward D3 where the good quality limestones are considered to exist. And when the face reaches the vicinity of C3, the width of the face is to be expanded and shall be advanced toward C4 (situates back to back with the face described above which also is expanded toward C4). At the point when the next level-down is to be accomplished (by this time, the face in C4 direction of the new face (550 ∿ 560ft level) which was opened by the second cutting down between C4 and C5 is advanced for a certain extent), cutting will be done toward C3 and C4 to extend the face toward east and west. Level-down is to be accomplished hereafter in the same method.

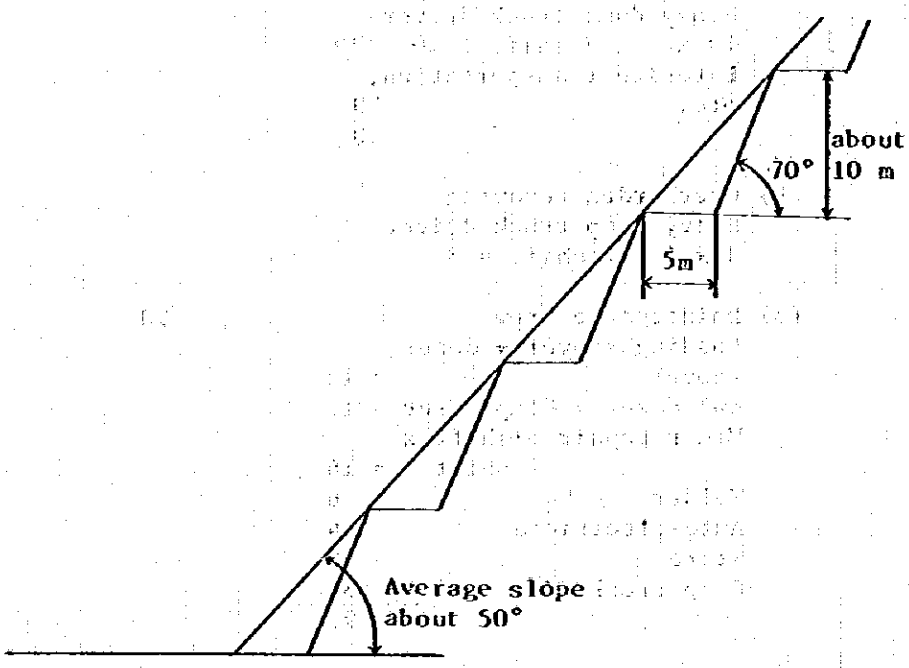
As for No.2 face, after installing 2-level bench, the face is to be extended upwards for 3,4,5 ... levels (fittable from the existing transportation road on the west side). When the face cores to a level where it meets No.3 face which is being benched-down, No.2 face is to be benched down from this point.

During the course of the progress of the quarrying, the existing transportation road must be rerouted. (Refer to drawing Q-4).

In long-range view, with the final wall left on the south side, east side and west side (average gradient of apprcx. 50°, bench incline of 70°, height 10m, berm with the width of 5m shall be left for each 10m level), level-down should be continuously done. The final quarry level, judged from the existing conditions of the deposit, will be 200ft, 300ft, 300ft and 300ft at C1, C3, C4 and C5 respectively. (See the geological profiles in Dwg. No.G4-A, B and C).

Final remnant wall

Fig. 5-2-8



5-2-6 Personnel (Inclusive of 205 workers for the existing facilities)

Table 5-2-9

Place	Kind of Labour	No. of Labours
Face	(1) Drillers 4 crawler x 4	16
	(2) Blastors	12
	(3) Maintenance, others	14
	Sub total	42
Equipment	(1) Heavy equipment Operator	63
	a) Limestone quarrying Bulldozer 4 x 2 x 2 shift = 16 Loading shovel 4 x 3 x 2 = 24 Dozer shovel 2 x 2 x 2 = 8 Breaker 1 x 2 x 1 = 2 50 + 8	
	b) Overburden removing Bulldozer 1 x 2 x 1 shift = 2 Dozer shovel 1 x 2 x 1 = 2 4 + 1	

(To be continued)

Place	Kind of Labour	No. of Labours
Equipment	(2) Dump truck driver a) Limestone quarrying Heavy dump truck driver 10 x 1 x 2 shift + 10 = 30 Laterite transportation, etc. 10 40 b) Overburden removing Heavy dump truck driver 3 x 1 x 1 shift = 3	43
	(3) Maintenance Crew Loading shovel + dozer shovel = 12 Bulldozer + Compressor = 12 Minor repair 8/shift x 2 shift = 16 Welder = 6 Auto-electrician = 4 Store = 8 Dump truck = 32 90	90
	(4) Road maintenance	20
	(5) General Labour	20
	(6) Office staff	10
	Sub total	246
Crushing Plant	(1) Operator a) Existing primary Cr, Ore bin (15/shift +12/shift) x 2 b) New Cr. Plant, Ore bin (15/shift +12/shift) x 2	108
	(2) Maintenance crew	19
	(3) Office staff	10
	Sub total	137
Grand total		425

5-2-7 Safety Measures and the Preventive Measures against the Environmental Pollution

(1) Safety measures

The following safety measures are required after the expansion.

(i) Both the blasting frequency and the blasting locations will increase. As well as installing the communication facilities to inform of blasting over the whole area at the quarry (installation of sirens and speakers at the several points), shelters from blasting (built with concrete) should be constructed.

(ii) The original standard of the quarry itself should be prepared for the equipment to be newly installed, in accordance with the operational standard and security standard of the manufacturers. The training should be continued until the operators aquire thorough knowledge of these standards.

(iii) Necessary safety training must be given to the new employees (large number of them are required), and sufficient field training should be given in addition, in order to make them throughly understand the operational standard before stationing them to actual operation.

(2) Preventive Measures for the Environmental Pollution

Htone Daung Quarry is located in mountain, where the houses are scarce.

(i) Dust
(ii) Noise
(iii) Vibration

} No problem is foreseen as to these items even after the expansion

(iv) Waste water: There may be a danger of the muddy/dirty water flowing out from the newly installed waste dump area. Therefore, the following measures should be taken to prevent the dirty/muddy water in rainy days:

a) The water channel around the yard should be completed, in order to minimize the water that flows into the waste (overburden) dump area.

b) Setting basin of sufficient capacity should be installed to let the dirty/muddy water to settle and segregate itself so that the upper clean water alone flows out.

5-2-8 Required Works in the Future

If this project is to progress toward actual execution, the following works will be required in order to improve the accuracy of the construction plan.

(1) Topographical survey of the planned site for the waste (overburden) dump area.

(2) Topographical survey of the planned route for the transportation road to the waste dump area.

(3) Topographical survey of the planned route for the transportation road between the face and the new crushing plant.

(4) Topographical survey of the sites for the new crushing plant and ore bin.

(5) Topographical survey of the planned site for the open stock yard at the Quarry.

(6) Investigation of the thickness of overburden in the planned area of quarrying.

5-2-9 Other Materials

(1) Clay

(i) Required amount of clay

a) Clay unit consumption: 0.25/t.cl

b) Water content: 2.5% ∿ 10%

c) Required amount of clay (at water content of 10%)

$$1600\text{t.cl/d} \times 0.2 \times \frac{1}{1 - 0.1} \fallingdotseq 360\text{t/d}$$

$$360\text{t/d} \times 25\text{d/m} = 9000\ \text{t/m}$$

The amount actually required is expected to be considerably less than the above figure, as the deterioration in the grade of the limestone is very well expected.

(ii) Quarry site

Present quarry No.1 ∿ No.3, and near the Mill.

(iii) Quarrying method

Present bench cut method shall be continued.

Excavated and loaded by the dozer shovel, and will be transported to the Mill by the dump-truck.

(iv) Facilities required

° Dozer shovel (Bucket capacity of 2.2m^3, Komatsu Seisakusho D75 or equivalent) x 1 ... new installation

° Dump truck (capacity 12 ∿ 15t) x 3 ... Those currently used at Htone Daung shall be utilized.

(v) Post-expansion problems

Nothing in particular.

(2) Silliceous material

Same as at present. No particular problems assumable after the expansion.

(3) Ferrous material

(i) Required amount of laterite

a) Laterite unit consumption: 0.03t/t.cl

b) Water content: 2.5%

c) Required amount of laterite:

$$1600\text{t.cl/d} \times 0.03 \times \frac{1}{1 - 0.025} \fallingdotseq 50\text{t/d}$$

50t/d x 25d/m = 1250t/m

(ii) Mining and transportation methods

Same as at present.

(iii) Post-expansion problems

Improvement of the transportation road shall be required.

(4) Gypsum

As at present. No particular problems is assumable after the expansion.

CHAPTER 6 BASIC STUDY OF THE EXPANSION OF THE CEMENT MILL

6-1 Basic Conditions of the Plan

The production capacity of existing mill is 400t/d x 2 units = 800t/d (wet process). The new cement production lines with a capacity of 400t/d each, totalling 800t/d (wet process), are planed to be installed.

For this purpose, the field survey including study of the existing facilities and operation have carefully been carried out.

Clinker production capacity after the expansion is calculated as follows:

Existing production capacity ...	400t/d x 2 = 800t/d
New production capacity	400t/d x 2 = 800t/d
Total	1,600t/d

Limestone crushing facilities and the ore bins for loading at the quarry are to be installed at a location away from the existing facilities.

The new principal facilities at the mill are to be installed in accordance with the existing plant layout as much as possible for the purpose of accomplishing the actual plant construction smoothly.

6-2 Outline of the Existing Mill

The existing mill has various problem in view of both the facilities and operation control. The problems are;

(1) Sticky limestone properties interfering the smooth transportation,

(2) High fuel consumption due to the excessive water content in the slurry, and

(3) Difficulty in smooth cement shipping.

The above problems are restricting the cement production, resulting in the poor productivity of the plant.

The causes are analyzed in detail as follows.

6-2-1 Limestone Properties

(1) The raw material limestone is sticky even during the dry season (6 months), and it becomes extremely sticky in the rainy season (6 months). Transportation of the limestone during the rainy season is extremely difficult, resulting in the deteriorated cement production. This, we could say, is the most significant problem of this plant.

(2) At present, primary limestone crusher (300t/hr) is installed in the quarry. In the dry season the required amount of limestone can be crushed though the efficiency is unsatisfactory.
However, in the rainy season, the properties of the limestone change completely. Moisture content reaches up to 16%, and with the powder contents of 50%, it takes muddy form, and adhesion thereby calls for flushing work repeatedly. This causes operation per day to drop as low as 1 - 3 hours hence the production capacity is greatly deteriorated.

(3) Heavy machines, transport trucks, receiving hopper, ore bins for loading and unloading hopper require all the more manpower due to thereto. Presently loading/unloading operation is done by manpower but the available manpower is not sufficient to cope with the amount of work.

6-2-2 Slurry Water Content

(1) The water content in the slurry in the wet process is usually 35 - 38%. However, the water content in the slurry in the existing mill is 40 - 50% which is an excessive amount. This leads to the clinker production decrease and the increase of the fuel consumption (see Table 6-2-3).

(2) This problem originates in the insufficient capacity of the slurry pump. If the slurry content is set low, the pump can not feed the slurry due to the increased viscosity of the slurry.
At first, viscosity reducing media was mixed. However, the supply could not be secured for a long time. As a result, the water content had to be increased so as to reduce viscosity. (See Table 6-2-4.)

(3) For the above reason, the production capacity of the plant even in the dry season is approx. 300t/day, which is 75% of the design capacity of the kiln, 400t/day at the maximum. (See table 6-2-1 and 6-2-2.)

6-2-3 Shipping of Cement

(1) The design capacity of the existing packing and shipping facilities is 50t/h x 2 = 100t/h, by 50 kg-bags.
However, the actual capacity at present is only 25t/h x 2, or 50t/h, with the deteriorated workability due to the narrow working space in the wagons.

(2) Cement is currently transported from the plant to the foreshore on the bank of the Irrawady River by wagons for loading to the ships.
However, loading to the ships is not smoothly done at present because the capacity of the ships varies in five different levels ranging from 120t to 500t and their arrival is not on schedule.

Above are the serious problems for the facilities of the existing plant. There are, in addition, various other problems to be solved. The expansion of the plant must be planned taking into consideration the measures to solve those problems are much as possible.

Cement Mills (Kyangin)

Monthly Cement Production

Table 6-2-1

Month	Cement Production (tons)			
	1975-76	1976-77	1977-78	1978-79
April		9457.48	15543.00	12508.00
May		8067.00	9647.00	11213.00
June		10378.00	7775.00	10742.00
July		4307.00	7033.00	7821.00
August		2898.00	5353.00	8734.00
September		2848.00	5300.00	9333.00
October		2030.00	10277.00	11794.00
November		8049.00	14680.00	18224.00
December	1127.48	10064.00	15205.00	
January	8054.04	9263.00	14170.00	
February	8048.28	11004.00	15022.00	
March	2425.32	14615.00	17522.00	
Total	19655.12	92980.48	137527.00	90369.00

Cement Mills (Kyangin)

Monthly Clinker Production & Running/Stoppage Hours of Rotary Kilns

Table 6-2-2

Month	Running Hours	Clinker Production (tons)	Remarks
April	-	-	1975-76
May	-	-	
June	-	-	
July	-	-	
August	-	-	
September	-	-	
October	-	-	
November	-	-	
December	* 669.75	6514.60	* Kiln (2) un-test
January	* 698.33	8944.70	
February	618.75	9246.79	
March	562.75	8703.49	
Total	2549.58	33409.58	
April	592.92	8876.26	1976-77
May	-	-	
June	360.53	3397.00	
July	286.83	2790.00	
August	337.00	3060.00	
September	391.67	2929.00	
October	169.99	1755.00	
November	561.50	7835.00	
December	679.84	9664.00	
January	639.35	9872.00	
February	659.57	10310.00	
March	1168.82	15036.00	
Total	5848.02	75524.26	

Month	Running Hours	Clinker Production (tons)	Remarks
April	1167.75	15819.00	1977-78
May	965.75	9472.00	
June	664.50	5795.00	
July	484.00	3397.00	
August	525.00	4964.00	
September	546.75	4922.00	
October	781.43	9701.00	
November	1344.07	14040.00	
December	1359.33	14771.00	
January	1184.89	13442.00	
February	1293.84	14087.00	
March	1475.75	16685.00	
Total	11793.06	127355.00	
April	953.50	11282.00	1978-79
May	957.41	10654.00	
June	916.67	11024.00	
July	497.34	6252.00	
August	693.34	7951.00	
September	725.25	8704.00	
October	1165.09	10983.00	
November	1420.08	16989.00	
Total	7328.68	83839.00	

Fuel Gas Consumption

Table 6-2-3

Year / Month	1976-77		1977-78		1978-79	
	Cubic meter (m^3)	Kcal/kg-cl	Cubic meter (m^3)	Kcal/kg-cl	Cubic meter (m^3)	Kcal/kg-cl
April	2358770	2127.43	3507650	1775.44	2904360	2060.93
May	-	-	2656030	2182.65	2744090	2061.98
June	1173940	2766.62	1785080	2466.06	2797390	2031.48
July	651030	1868.08	1260950	2971.68	1532210	1961.99
August	1026970	2686.80	1492120	2406.42	1580150	1591.02
September	1093430	2988.62	1460690	2375.83	2086820	1919.40
October	530400	2419.50	2350380	1939.64	2562850	1868.11
November	2945720	3009.90	3550680	2026.06	3756020	1869.94
December	3334080	2761.97	3653060	1979.91		
January	3200000	2595.04	3447850	2053.45		
February	2376550	1845.39	3724500	2116.05		
March	3425080	1823.63	5919590	284030		

Table 6-2-4 Monthly Average Water Content of Slurry

Month	1976	1977	1978
January	51.0	45.0	46.0
February	47.0	44.5	45.0
March	46.0	43.0	45.0
April	46.0	44.0	46.0
May	52.0	46.0	46.0
June	53.0	49.0	47.0
July	56.0	53.0	50.0
August	54.0	52.0	50.0
September	54.0	51.0	50.0
October	51.0	50.0	48.0
November	50.0	46.0	45.0
December	49.0	46.0	-

6-3 Plans for the Limestone Crushing and Storage Facilities

6-3-1 Basic Conditions

(1) Operating days: 25 d/m x 12 m/y = 300 d/y

(2) Clinker production after expansion (clinker basis)

400t/d x 4 lines = 1600t/d (480,000 t/y)

(3) Limestone unit consumption: 1,330 t/t-cl

(4) Required amount of the limestone

For existing lines (400 t/d x 2) x 1.330 ≒ 1,065 t/d

For expansion lines (400 t/d x 2) x 1.330 ≒ 1,065 t/d

Total ≒ 2,130 t/day (dry basis)

Dry season; $\frac{2,130}{1 - 0.02}$ ≒ 2,170 t/d (wet basis 1)

Rainy season; $\frac{2,130}{1 - 0.16}$ ≒ 2,530 t/d (wet basis 2)

(5) Table of the required amount of limestone

Table 6-3-1

	Dry basis	Wet basis 1	Wet basis 2
(t/h)	89	90	105
(t/d)	2,130	2,170	2,530
(t/m)	53,200	54,300	63,250
(t/y)	638,400	325,800	379,500
		705,300	

(Note) Dry season: 6 months/year
Rainy season: 6 months/year

(6) Operating hours

Quarry site

Drilling/blasting	8 h/d, 1-shift/d
Primary crushing	16 h/d, 2-shift/d
Railway transportation	16 h/d, 2-shift/d
secondary crushing	16 h/d, 2-shift/d

6-3-2 Scale and Policy of Expansion

(1) Modification of the existing facilities for the expansion will need a long suspention from the operation. For this reason, limestone crushing and transport facilities including ore bins for loading are to be installed separately.

(2) Additional railway sidetrack shall be installed with these new installation.

(3) Since the operating rate during the rainy season falls down to 40% of the rate in the dry season, the amount of limestone equivalent to 60% of the consumption in the rainy season must be compensated by crushing and storing during the dry season.

(4) The amount of the limestone to be stored to compensate the consumption in the rainy season will total to 200,000 tons. 100,000 tons of limestone is to be stored at the open stockyard provided in the quarry, and the other 100,000 tons is to be stored in a roofed limestone stockyard in the mill.

(5) Limestone stockyard in the quarry is to be outdoor stockyard. Only the good quality limestones are to be stored.

(6) Inside the plant, a roofed limestone stockyard provided with reclaimer is to be installed to allow the continuous delivery of a constant quantity of limestone.

(7) The quantity of the limestone to be stored is estimated on the basis of the following:

- Dry season: 6 months
- Limestone unit consumption: 1.33
- Rainy season operation rate: 40%

(1,600 t/d x 1.33 x 25 d/m x 6 m/y) x (1 - 0.4) = 191520 t say: 200,000 t

(8) The number of locomotives and ore wagons are to be increased.

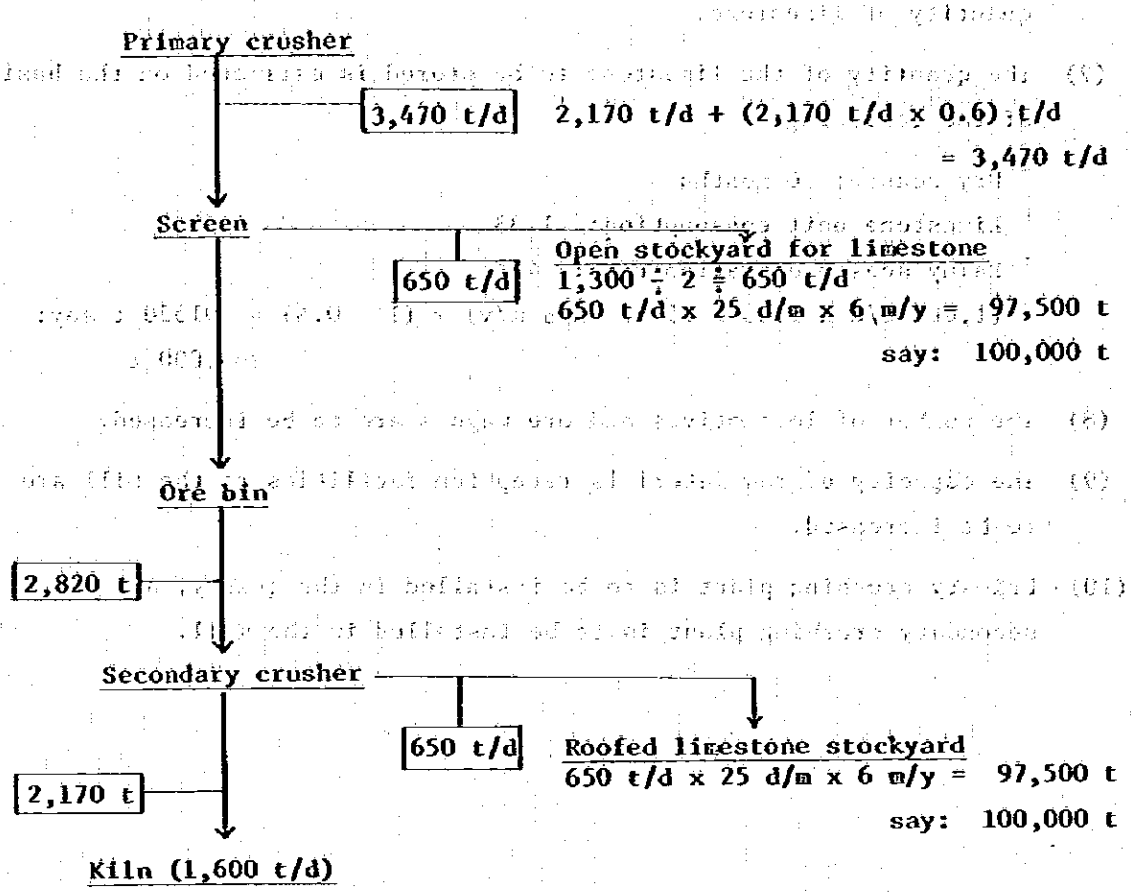
(9) The capacity of raw materials reception facilities at the mill are to be increased.

(10) Primary crushing plant is to be installed in the quarry, and the secondary crushing plant is to be installed in the mill.

6-3-3 Material Balance

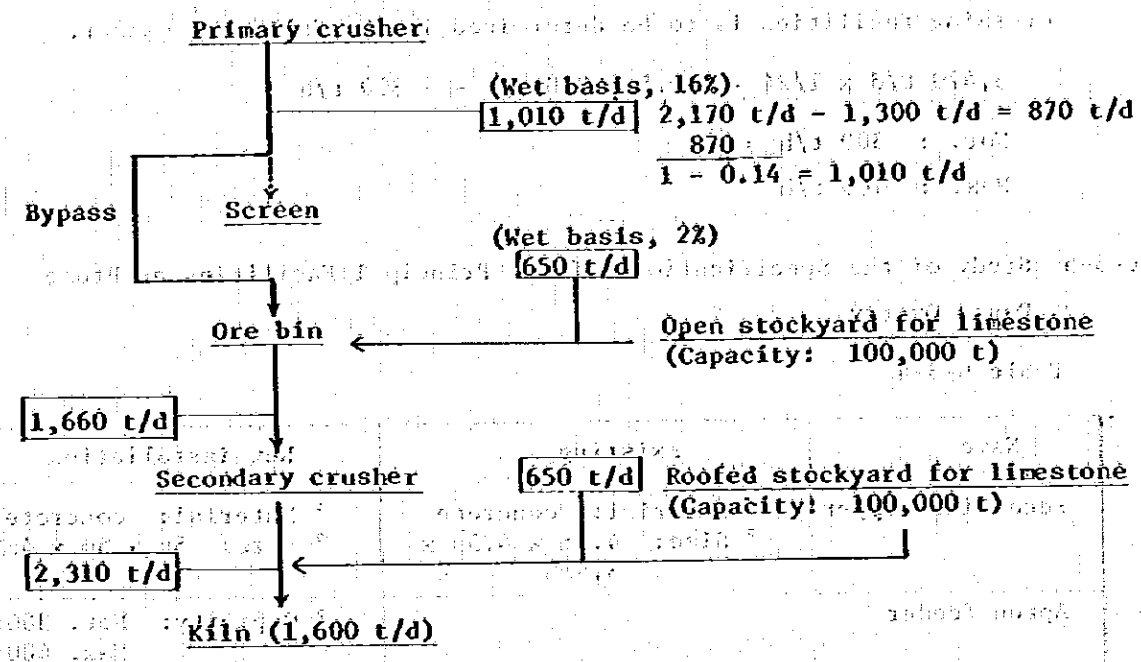
(1) Dry season (6 months) moisture content 2%

Fig. 6-3-2



(2) Rainy season (6 months) (maximum moisture content 16%)

Fig. 6-3-3



6-3-4 Determination of the Specification of the Additional Facilities

(1) Outline of the existing facilities

Although the installed capacity of the crushing plant is 300 t/h, the maximum actual operation rate in the past is calculated to be 50.5 t/h (34,000 t/m ÷ 28 d/m ÷ 24 h/d = 50.5 t/d).

The main reasons of the deterioration in the operating rate are listed below.

a) Mining method

b) Difficulty in handling of limestone due to their stickiness

c) Inadequate crushing plant facility and type of wagon for the limestone quality

d) Old heavy equipment at the Quarry and the transportation trucks.

Production capacity of the existing facilities cannot be expected to improve greatly for the above reasons.

(2) Specifications of the additional facilities

Sufficient study should be made at the detailed designing stage to eliminate the problems listed in Item (1) above. The capacity of the crushing facilities is to be determined in the following manner.

3,470 t/d x 1/24 x 1/0.5 ≒ 290 t/h --- 300 t/h

Nor. : 300 t/h

Max. : 400 t/h

6-3-5 Study of the Specifications of the Principal Facilities at Ktone Daung Quarry

Table 6-3-4

Name	Existing	New installation
Receiving hopper	° Material: concrete ° Size: 4.5m x 4.5m x 3.5mH	° Material: concrete ° Size: 5m x 5m x 4mH
Apron feeder	None	° Capacity: Nor. 300t/h Max. 400t/h ° Supply lumps: -1000mm ° Type: heavy duty type,
Primary crusher	° Capacity: 300t/H ° Type: Gyratory ° Supply lumps: -1000mm ° Outlet lumps: -150mm ° Horse power: 260 kW	° Capacity: 300t/h ° Type Gyratory ° Supply lumps: -1000mm ° Outlet lumps: -150mm 85% ° Horse power: 260 kW
Belt conveyor	° Capacity: Nor. 300t/h max. 400t/h ° Belt width: 750 ∿ 1050W	° Capacity: Nor. 300t/h Max. 400t/h ° Belt width: 750 ∿ 1050W
Primary screen	None	° Capacity: Nor. 300t/h Max. 400t/h ° Supply ore size: -200mm ° Type: Heavy duty, Single deck ° Dimensions: 5' x 12' ° Sieve: supposed at 100mm $A = \frac{400}{67 \times 1.5 \times 1 \times 1 \times 1 \times 1 \times 1 \times 0.7}$ ≒ 5.7m²
Ore bin	° Material: concrete ° Dimensions: 6m(W) x 60m(L) ° Quantity: 12	° Material: concrete ° Dimensions: 6m(W) x 60m(L) ° Quantity: 10

6-4 Plan for the Limestone Transportation Method

6-4-1 Limestone Transportation Conditions at Present

(1) Distance of transportation: 8.4 km between the quarry and the mill

(2) Locomotives: 215 HP diesel locomotive x 4 cars
(Four cars out of total seven cars of locomotive available are utilized for the transportation of the limestone.)

(3) Wagons: 60 cars with a capacity of 10 t D/W (8.5 t/car in practice)
(60 cars out of total 74 cars available are always in operation.)

(4) Train formation: 15 cars x 4 = 60 cars
(It is possible to tract a formation consist of maximum 20 cars.)

(5) Operating hours (per formation)

Loading	45 min.
Operation/shunting	75 min. (30 min. x 2 + 15 min.)
Unloading	45 min.
	2 hours 45 min.

where the load is 8.5 t/car x 15 $\frac{1}{2}$ 130 t

(6) Operating time and the quantity transported
12 times/d x 130 t = 1,560 t (dry season)
90 cars/8 h (max.)
50 - 60 cars/8 h (average)
Note: Data for the rainy season is not available.

(7) Problems
Dur to the pin structure of the coupler of the present wagon, speeding up is rather difficult. However, the time necessary for one way trip may possibly be shortened upto 20 minutes. The cars have started to become old and worn.

6-4-2 Limestone Transportation after the Expansion

(1) Quantity transported: 2,820 t/d or more

(2) Determination of the operating hours (per formation)

Loading	30 min.
Operation/shunting	60 min. (30 min. x 2)
Unloading	30 min.
	120 min. (2 hours)

(3) Locomotives and wagons

(i) Wagons of 15 tons load capacity shall be employed.

(ii) One formation shall consist of 10 wagons (15t x 10 = 150t).

(iii) 215 HP diesel locomotives, the same as the existing ones, shall be employed to secure the interchangeability.

(iv) The existing wagons shall be operated in the dry season only taking into account the remaining durable years and the low efficiency.

(4) Train formation and the transport quantity

Train formation shall be made in accordance with the required amount of limestone for the dry season and for the rainy season respectively as follows:

(i) Dry season ..... 3 formations

Newly added wagons 150t x 16/2 trip x 2 formation = 2,400 t/d

Existing wagons 130t x 16/2 trip x 1 formation ≒ 1,000 t/d

Total ≒ 3,400 t/d

(ii) Rainy season ..... 2 formations

Newly added wagons 150t x 16/2 trip x 2 formation = 2,400 t/d

As shown in the above calculation, more than the required amount of limestone can be transported both in the dry season and in the rainy season. In the rainy season, in addition, the required amount of limestone could be well secured, even if the operation rate of the trains should be lowered upto 70% (refer to Fig. 6-4-1).

(5) Required number of locomotives and wagons

Locomotives: 2 units (215 HP diesel locomotives)

Wagons : 15t x 24 units (including 4 units as stand-by)

(6) Others

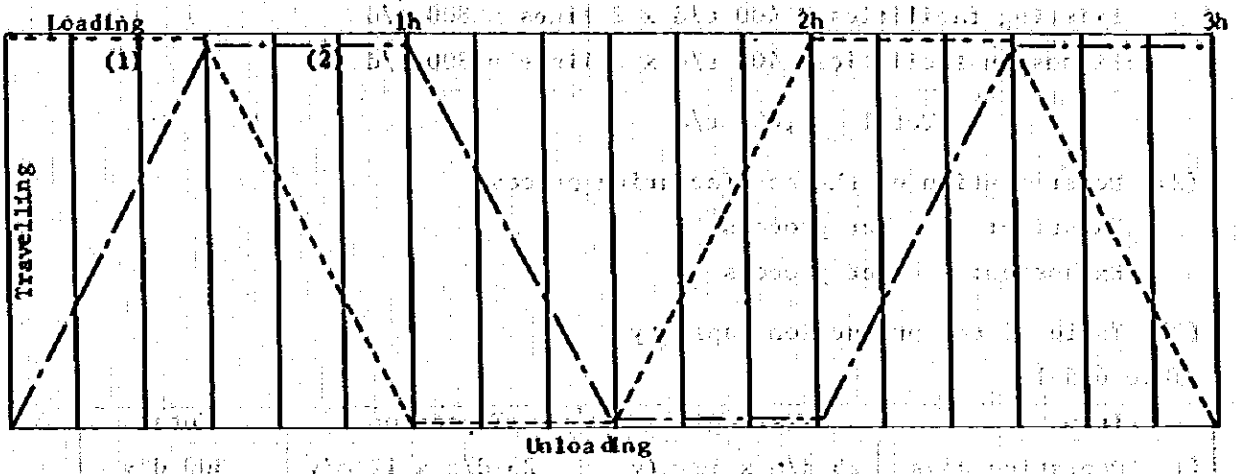
In a simple calculation, the existing locomotives and wagons are sufficient in number considering, however, their old ages and low efficiency in loading/unloading, it is recommended to purchase new locomotives and wagons and thereby reinforce or replace the existing units.

The unloading system of the new wagons shall be of the both sides bottom-open/close type.

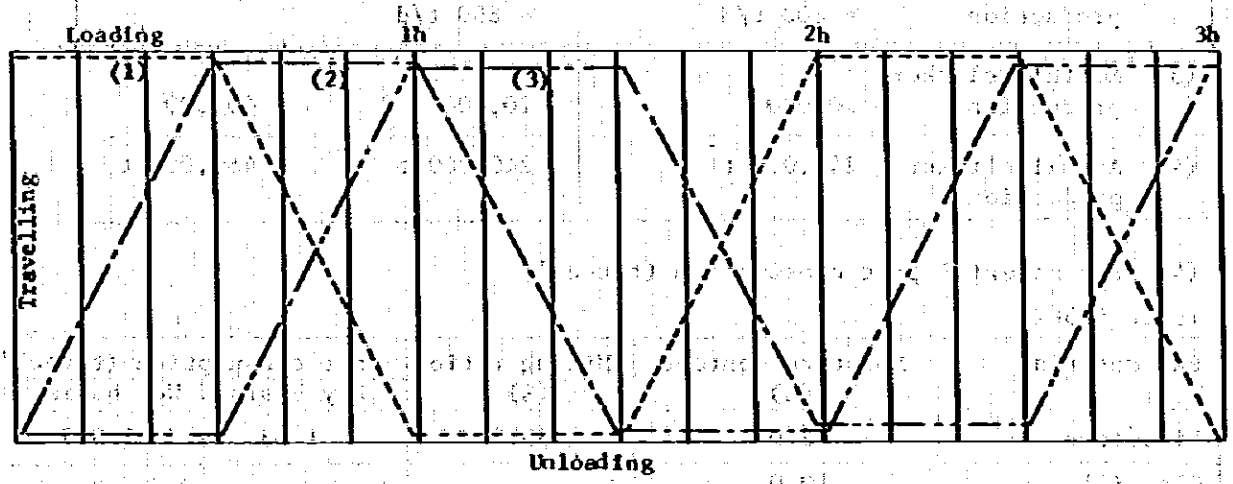
6-4-3 Train Operation Diagram

Fig. 6-4-1

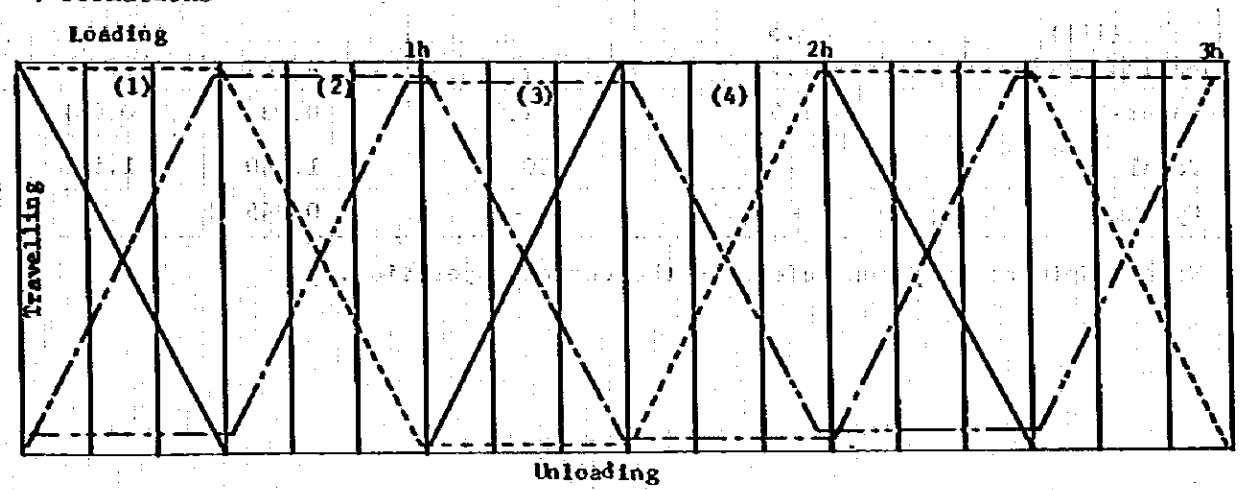
For rainy season
2 formations 150t x (16/2 times/d x 2) = 2,400 t/d



For dry season
3 formations 150t x (16/2 times/d x 2) = 2,400 t/d
130t x (16/2 times/d x 1) ≒ 1,000 t/d Total ≒ 3,400 t/d



For reference
4 formations



6-5 Plan for the Mill Facilities

6-5-1 Basic Conditions

(1) Determination of the production capacity

Existing facilities: 400 t/d x 2 lines = 800 t/d

Expansion facilities: 400 t/d x 2 lines = 800 t/d

Total 1,600 t/d

(2) Determination of the manufacturing process

Existing: Wet process

Expansion: Wet process

(3) Table of the production capacity

Table 6-5-1

Item	Existing	Expansion	Total
(1) Operating days	25 d/m x 12 m/y = 300 d/y	25 d/m x 12 m/y = 300 d/y	300 d/y
(2) Daily clinker production	400 x 2 = 800 t/d	400 x 2 = 800 t/d	1,600 t/d
(3) Monthly clinker production	20,000 t	20,000 t	40,000 t
(4) Annual clinker production	240,000 t	240,000 t	480,000 t

(4) Raw material unit consumption (t/t-cl')

Table 6-5-2

Raw material	Moisture content (%)	Mixing ratio (%)	Unit consumption (t/t-cl')	
			Dry basis	Wet basis
Limestone	2.0	85.2	1.33	1.357
Clay (I)	10.0	12.8	0.2	0.21
" (II)	2.5			
" (III)	2.5			
Silica sand	2.5	–	–	–
Laterite	2.5	2.0	0.03	0.031
Total	–	100	1.560	1.598
Gypsum	–	–	0.045	–

Note: Unit consumption refers to the current operation.

6-5-2 Type and Quality of Cement

(1) Type: Ordinary Portland Cement (One type only)

(2) Standard: In accordance with BSS 12/1958

(3) Comparison table of the standards and actual results:

Table 6-5-3

	Kyangin Cement Mill		BSS 12/1958	
	Min.	Max.	Min.	Max.
Specific Surface (cm^2/g)	2,800	3,200	2,250	
Lechatelier Expansion (mm)	0	4		10
Initial Setting Time (min.)	110		45	
Final Setting Time (h)		4 h		10 h
3 days Strength (psi)	3,500		2,200	
7 days Strength (psi)	4,900		3,400	
Lime Saturation Factor	0.85	0.92	0.66	1.02

(4) Quality of the cement (Results obtained at Kyangin Cement Mill)

HM : 2.02 - 2.09

SM : 2.24 - 2.85

IM : 1.6 - 2.0

(5) Example of the cement chemical composition

SiO_2	21.67	SO_3	1.76
Al_2O_3	5.87	K_2O	-
Fe_2O_3	3.45	Na_2O	-
CaO	63.83	Cl	-
MgO	1.53	LOI	1.26

6-5-3 Chemical Composition of Water, Fuel and Raw Material

(1) Water

Total Hardness as $CaCO_3$	48.0 ppm
Carbonate Hardness as $CaCO_3$	43.0 "
Non-Carbonate Hardness as $CaCO_3$	5.0 "
Chloride as Cl	4.2 "
Sulphate as SO_4	21.4 "
Calcium as Ca	11.4 "
Magnesium as MgO	57.9 "
Turbidity	1000.0 "
P.H.	7.0 "

(2) Fuel (natural gas)

Methane	96.48 to 98.80
Ethane	0.93 to traces
Propane	0.98 "
Iso-Butane	0.97 "
Normal Butane	0.54 "
Pentanes	0.10 "
Specific gravity	0.6105 to 0.5476
Heating Value (BTU/cft)	900

(3) Raw Material

Table 6-5-4

	Limestone		Clay		Siliceios	Laterite		Gypsum	
	Range	Mean value	Range	Mean value	Material	Range	Mean value	Range	Mean value
Loi	35.25-41.47	37.15	5.22- 9.16	8.37	3.92	7.46- 7.26	7.36	18.32-20.80	19.56
SiO_2	14.02- 6.02	7.62	68.18-57.72	59.82	86.45	48.78-39.96	44.37	4.20- 3.87	4.04
Al_2O_3	2.36- 0.54	0.90	14.99-20.21	19.17	2.77	12.48-14.80	13.64	1.99- 1.64	1.82
Fe_2O_3	1.74- 0.54	0.78	5.89- 6.03	6.00	1.45	28.50-36.32	32.41	0.17- 0.12	0.15
CaO	44.13-50.03	48.85	2.02- 4.22	3.78	Nil	1.46- 0.86	1.16	31.46-35.22	33.34
MgO	0.70- 0.60	0.62	3.25- 2.44	2.60	0.48	0.48- 0.32	0.4	0.82-0.34	0.58
SO_3	-	-	-	-	-	-	-	32.48-38.73	35.61
Na_2O	-	-	-	-	-	-	-	-	-
K_2O	-	-	-	-	-	-	-	-	-
Cl/P_2O_5	-	-	-	-	-	-	-	-	-

Note: Siliccous Material is very seldom used.

6-5-4 Principal Facilities to be Newly Installed

(1) Design policy for the principal facilities

(i) The design must be made taking into consideration the measure to eliminate the problems in the existing facilities as much as possible.

(ii) The specification employed must be as close as possible to the specifications of the existing facilities in view of the future maintenance and operation.

(iii) The facilities must be arranged in accordance with the initial plant layout unless any particular problems are foreseen.

(iv) Roofed stockyard for limestone (capacity: 100,000 t) is to be newly installed as a measure against the rainy season.

(2) Policy for the expansion of the principal facilities

Table 6-5-5

Name	Description
1) Raw material receiving hopper	The load of 10 cars is unloaded at the same time. Hoppers shall be made of steel plate.
2) Secondary crusher (inclusive of secondary screen)	Same type as of the existing one.
3) Clay washing mill	- ditto -
4) Raw material and clinker stockyard	To be installed as planned initially. Installation of the mill hopper shall start on completion of this installation.
5) Overhead travelling crane	1 unit of the same type shall be installed.
6) Roofed stockyard for the limestone and reclaimer	° Capacity: 100,000 t ° Dimensions: 5 m(W) x 220m(L) ° Structure: Steel frame structure ° Extracting method: Reclaimer installation
7) Wet process raw grinding mill	2 units of the same type as the existing mill shall be installed.
8) Slurry tank	6 units of the same type as the existing tanks shall be installed.
9) Slurry pump	Pump capacity increase must be examined. (Refer to 6-2-2.)
10) Slurry basin/slurry agitator	1 unit of the same type as the existing type shall be installed.

(to be continued)

Name	Description
11) Kiln	2 units of the same type as the existing kiln shall be installed.
12) Cooler	2 units of the same type as the existing cooler shall be installed.
13) Cement mill	2 units of the same type as the existing mill shall be installed.
14) Cement silo	6 units of the same type as the existing silo shall be installed.
15) Packer	2 units of the same type as the existing packer shall be installed.
16) Burning equipment	° Exclusive for natural gas burning. ° Fuel oil burning equipment or boiler is not to be installed.
17) Industrial water cooling device	1 unit for the same type as the existing cooler shall be installed.
18) Industrial water cooling pond	A pond of the same type as the existing pond shall be installed.
19) Gypsum crusher	1 unit shall be newly installed.
20) Compressor	The same type as the existing compressor shall be employed.
21) Water pump	- ditto -

6-5-5 Estimated Amount of the Raw Materials and Fuel Consumption after Expansion

Table 6-5-6

Description	Existing	Expansion	Total
Limestone (dry basis)	800t/d x 1,33≒1,056t/d 1065 ÷ 24 ≒44.5 1065 x 300 ≒ 319,200	Same as left.	2,130t/d 89t/h 638,400t/y
Clay (dry basis)	800 x 0,2 = 160 160 ÷ 24 = 6.66 160 x 300 = 48,000	- do. -	320t/d 13t/h 96,000t/y
Silica sand (dry basis)	-	-	Seldom used.
Laterite (dry basis)	800 x 0.03 = 24 24 ÷ 24 = 1 24 x 300 = 7,200	- do. -	48t/d 2t/h 14,400t/y
Gypsum (dry basis)	800 x 0.045 = 36 36 ÷ 24 = 1.5 36 x 300 = 10,800	- do. -	72t/d 3t/h 21,600t/y
Fuel (Natural gas)	1400 ∿ 1900kcal/kg-cl' 8000kcal/m³ = 0.175 ∿ 0.238m³/kg-cl' 800 x 10³ x (0.175 ∿ 0.238) = 140,000 ∿ 190,000m³/d (140 x 10³ ∿ 190 x 10³) / 24 ≒ 5,833 ∿ 7,916m³/h	1400 ∿ 1650kcal/kg-cl' 8000kcal/m³ = 0.175 ∿ 0.2m³/kg-cl' 800 x 10³ (0.175 ∿ 0.2) = 140,000 ∿ 160,000 m³/d (140 x 10³ ∿ 163 x 10³) / 24 = 5,833 6,875m³/h Fuel consumption should be guaranteed at 1,650 kcal/kg-cl'.	280 x 10³m³/d 350 x 10³m³/d

Note: The calculations are based on clinker production as 1,600 t/d and actual figures for unit consumptions.

6-5-6 Approximate Storage of the Materials and Products after Expansion

Table 6-5-7

Description	Existing	Expansion	Total
Open limestone stockyard in the quarry (for rainy season)	-	100,000t	100,000t
Limestone stockyard in the plant (for rainy season)	-	100,000t	100,000t
Limestone stockyard	9,000t (25W x 25L x 12H x 1.5t/m^3)	9,000t (Same as left)	18,000t
Clay stockyard	2,600t (25/2W x 12L x 12H x 1.4t/m^3)	-	2,600t
Laterite stockyard	3,400t (25/2W x 12L x 12H x 1.9t/m^3)	-	3,400t
Siliceous material stockyard	2,000t (25/2W 12L x 12H x 1.1t/m^3)		2,000t
Gypsum stockyard	2,400t (25/2W x 12L x 12H x 1.3t/m^3)	-	2,400t
Slurry tank	750m^3 x 4 = 3000m^3	750m^3 x 6 = 4500m^3	7,500m^3
Clinker stockyard	19,000t (19W x 48L x 12H x 1.3t/m^3, 25W x 12L x 12H x 1.3t/m^3)	18,000t (25W x 50L x 12H x 1.3t/m^3)	37,000t
Cement silo	3,000t x 6 = 18,000t	3,000t x 6 = 18,000t	36,000t
Packed cement warehouse	2,000t	3,000t	5,000t

6-5-7 Rough Examination of the Specifications for the Principal Facilities at the Mill

Table 6-5-8

Description	Existing	Expansion
Raw material receiving hopper	° Material: Concrete ° Dimensions: 4.8mW x 25.5mL x 2.5mH ° Quantity: 6 ° Others: With gate	° Material: Steel plate ° Dimensions: 6mW x 60mL x 5mH ° Quantity: 20 ° Others: With vibrating feeder. As the existing hopper has inadequate form, steel plate hopper with vibrating motor shall be employed so as to extract the raw material constantly.

(to be continued)

Description	Existing	Expansion
Secondary screen	° Size: 1,200mmW x 3.4mL ° Capacity: 200t/h ° Mesh: 25mm x 50mm ° Motor: 7.5kW ° No. of units: 2	° Model and capacity shall be the same as that of the existing facility. ° No. of units: 2
Secondary crusher	° Type: Impeller breaker ° Capacity: 150t/h ° Supply ore: -150mm ° Outlet ore: -25mm ° Motor: 190kW ° No. of units: 2	° Type: Impeller breaker ° Capacity: 150t/h ° Supply ore: -200mm ° Outlet ore: -20mm 80% ° Motor: 190kW ° No. of units: 2
Clay washing mill	° Type: Rotary rake type ° Capacity: 45t/h (dry basis) ° No. of unit: 1	° Same type mill having the same capacity as that of the existing shall be installed. ° No. of unit: 1
Raw material and clinker stockyard	° Dimensions: 25mW x 132 mL x 12mH ° Capacity: See 6-5-6.	° Dimensions: 25mW x 207mL x 12mH (75m extended) ° Capacity: See 6-5-6. ° Stockyard shall be installed beofre installing hopper.
Overhead travelling crane	° Type: Overhead travelling ° Capacity: 8t ° Span: 23.9m ° Lift: 15.5m ° No. of units: 2	° Capacity and the type of the crane shall be the same as the existing crane. ° No. of unit: 1
Limestone stockyard (with roof)	None	° Capacity: 100,000t ° Dimensions: 50mW x 220mL ° Structure: Steel frame structure ° Basis of estimation: (1,600t/d x 1.33 x 25d/m x 6m) x (1-0.4) = 191,520t say: 200,000t Half of the above shall be stored.
Limestone reclaimer	None	° Type: Gantry type ° Capacity: Min. 20t/h Nor. 27 - 50t/h Max. 91t/h ° Basis of estimation: 650t/d ÷ 24h/d = 27t/h ° No. of unit: 1

(to be continued)

Description	Existing	Expansion
Wet process raw grinding mill	° Type: Open circuit wet mill ° Capacity: 35t/h ° Inlet size: -25mm ° Outlet size: 170 mesh residue 7% ° Mill size: 2,500mm dia x 12.5mL ° Revolution: 19.8 r.p.m ° Motor: 800kW ° Ball charge: 80t ° No. of units: 2	° Type and the capacity of the mill shall be the same as that of the existing mill. ° Checking the capacity; 800t/d x 1.56 x 1/24 x 1/2 = 26t/h < 35t/h OK ° No. of units: 2
Slurry tank	° Capacity: $750m^3 \times 4 = 3,000m^3$ ° No. of units: 4 ° Calculation of storage days: $K = \frac{1 - 0.4}{\frac{1 - 0.4}{2.67} + 0.4} = 0.96$ $C = (1-0.35)\ 0.96 = 0.96$ $X = \frac{1.56}{0.96} = 1.625$ $3,000m^3 \times \frac{1}{1.625} \times \frac{1}{800} = 2.3d$ To store approx. for 2 days.	° Capacity: $750m^3 \times 6 = 4,500m^3$ ° No. of units: 6 ° Calculation of storage days K=0.96 (t/m^3) C=0.624 ($t\text{-}cl'/m^3$) X=1.625 (Raw material unit consumption) $4,500m^3 \times \frac{1}{1.625} \times \frac{1}{800}$ = 3.5d 3.5 > 2 ∿ 3d No problem as total capacity of tanks is for more than 3 days.
Slurry pump	° Capacity: $0.7m^3/min$. ° Lift: 40m ° Motor: 30kW Due to the insufficient capacity of the existing pump, slurry at the water content of 35 - 38% cannot be fed, so the present is water content is set to be 40 - 50%.	° Capacity: $0.7m^3/min$. ° Lift: 42m ° Motor: 37 - 45 kW The problem of existing pump can be solved by increasing the motor capacity, in estimation. Shall be improved to allow the feeding without viscosity reducing media.
Slurry basin and agitator	° Dimensions: 35m dia. x 8mH ° Capacity: $6,900m^3$ ° No. of unit: 1 ° No problem either in capacity or the performance.	° Type and capacity of the slurry basin and agitator shall be the same as that of the existing type. ° No. of unit: 1

(to be continued)

Description	Existing	Expansion
Kiln	° Production capacity: 400t/d ° Dimensions: 3.3m dia x 125mL ° Revolution: 1.2 ÷ 0.4 r.p.m. ° Motor: 120kW ° No. of units: 2 The operation is reduced at present to 300t/d due to the excessive water content of the slurry.	° Checking the kiln capacity; $\frac{400 \times 10^3 \times 1/24}{0.7854 \times 3.3^2 \times 125} =$ $\frac{16.7 \times 10^3}{1069}$ $= 15.6 kg/m^3h < 20 \sim 25 kg/m^3h$, OK ° Checking L/D; $\frac{125}{3.3} = 37.8 \fallingdotseq 35 \sim 40$, O.K. ° Kiln capacity is sufficient. 2 units of the same type and capacity as that of the existing kiln shall be installed. ° Roof for kilns shall be installed to prevent the deformation due to rain while at rest.
Cooler	° Cooling capacity: 400t/d ° Dimensions: Width: 1,680mm, Length: 12,000mm ° No. of units: 2 ° Amount of the cooling air: 1,100m³/min at 45°C 250mmAq No problem observed at present.	° Checking the cooler capacity; $1.86 \times 12 = 20.16 m^3$ 400 t/d x 1/24 x 1/20.16 $= 0.827$ t/m h $0.827 t/m^3h < 1.2 \sim 1.5 t/m^3h$ ° Checking the amount of cooling air; $\frac{24 \times 60 \times 944 Nm^3/min}{400 \times 10^3} \fallingdotseq$ $3.4 Nm^3/kg\text{-}cl'$ $3.4 Nm^3/kg\text{-}cl' > 2.5 \sim 3.0 Nm^3/kg\text{-}cl'$ ° Cooler cooling capacity is sufficient. ° Two units of the same capacity as that of the existing cooler shall be installed.

(to be continued)

Description	Existing	Expansion
Cement mill	° Type: Closed circuit side drive type ° Capacity: 22.5t/h ° Product size: 170 mesh 3% residue ° Mill size: 9'dia x 25'L (2,750mm dia x 8,219 mmL) ° Revolution: 19 r.p.m. ° Motor: 800kW ° Ball charge: 75t ° No. of units: 2 No particular problems	° Checking the capacity; 800t/d x 1.045 x 1/24 x 1/2 = 17.4t/h < 22.5t/h O.K. ° Type and the capacity of the mill shall be the same as that of the existing type. ° No. of units: 2
Cement silo	° Capacity: 3,000t x 6 = 18,000t ° No. of units: 6 ° Storage days: $\frac{18,000}{846} \fallingdotseq 21d$ ° Troubles tend to be at the silo feeding air slide. ° Fairly large amount of dead-stock remains in silos.	° Capacity of the silo shall be the same as that of the existing silo. ° No. of units: 6 ° Silo feeding transportation machine shall be trough chain conveyor. ° Extraction shall be also remodeled.
Packer	° Type: 4-tube type ° Capacity: 50t/h ° No. of units: 2 Packing capacity is 50t/h, however, the actual operation is done at about 25t/h due to the loading problems.	° 2 units of the type and capacity same as that of the existing type shall be installed. Also the loading facility shall be remodeled to attain full packer capacity.
Fuel burning equipment	° Type: Heavy oil/ gas burning ° Capacity: Oil (Max.) 3.2t/h Gas (Max.) 4,300Nm^3/h ° No. of units: 2 ° Heavy oil is not presently used. Gas burning only. Heavy oil facilities have been disassembled.	° Type: Gas burning ° Capacity: (max.) 4,300Nm^3/h ° No. of units: 2 ° Checking capacity; 4,300Nm^3/h > 2,900 ∿ 3,400m^3/h O.K. ° Only gas burning shall be employed.

(to be continued)

Description	Existing	Expansion
Industrial water cooling system	° Capacity: 180t/h ° Cooling temperature: 38°C → 30°C No particular problem.	° Type and the capacity of the system shall be the same as that of the existing system. ° No. of unit: 1
Cooling pond	° Dimensions 40mW x 50mL x 5mD ° Capacity: Approx. 8,000t No particular problem.	° Dimensions: 40mW x 40mW x 50mD Capacity : Approx. 6,000t Shall be installed adjacent to the existing pond.
Gypsum crusher	Crusher is not available at present so the gypsum is crushed by the hand hammer for use. Insufficiency of the operation requires improvement.	° Type: Jaw crusher ° Capacity: 20t/h ° Product size: -30mm 80% ° Motor: 55kW ° No. of unit: 1 Gypsum crushing facility shall be installed.
Compressor	No particular problem.	Required number of the compressors of the same type as the existing compressor shall be additionally installed.

6-6 Plan for the Packing and Shipping Facilities

6-6-1 Basic Conditions

(1) Operating days: 25d/m x 12 m/y = 300 d/y

(2) Shipment after expansion (cement basis)
400 t/d x 4 x 1.045 ≒ 1,670 t/d (501,000 t/y)

(3) Form of shipment:
All products will be shipped in bags (50 kg). Bulk shipment will not be employed.

(4) Working hours:

Packing and loading at mill	24 h/d, 3-shift/d
Shipment by railroad	24 h/d, 3-shift/d
Loading and unloading at waterfront	24 h/d, 3-shift/d

6-6-2 Policy of Expansion and Scale of Additional Facilities

(1) Packing and bag loading on to the freight cars in the plant, transportation by railway wagons and unloading and loading bags onto the ships at the foreshore must be smoothly carried out by adopting the most effective means in 3-shift/day operation after the plant expansion.

(2) Two units of packer (50 t/h) are to be installed. Simultaneous loading onto 2 wagons from one packer is to be considered. One unit will be reserved as a standby.

(3) Three (3) formations each consisting of 6 wagons (15t x 6 = 90 t) shall be organized.

(4) Four existing locomotives (215 HP, diesel locomotive) shall be utilized and one of them shall be reserved as a stand-by. Both existing locomotives and wagons shall be used for this project. (Wagons are rent from the Burmese National Railways.)

(5) Additional warehouses shall be constructed at the riverside of the Irrawaddy to temporarily store cargoes for the possible case where continuous loading of cargoes is not possible. Two (2) forklift trucks shall be provided to convey the cargoes inside the warehouse.

(6) One unit of hanging type ship loader is to be added at the foreshore.

(7) Three (3) flat-bottomed boats for tugging large ships to the berth shall be newly constructed. Existing two boats shall be returned to the owner as they are on loan.

(8) Sidertracks shall be additionally laid for controlling and operating freight cars at the riverside warehouse.

6-6-3 Preliminary Review of Specifications for Main Facilities at Foreshore

Table 6-6-1

Description	Existing	New Installation
Hanging conveyor for ship loading	° Hanging belt conveyor capacity: 100 t/h ° No. of unit: 1	° Conveyor of the same type and capacity as that of existing one will be added. ° No. of unit: 1 ° Loading chute is to be improved.
Warehouse	° Dimensions: 22mW x 120mL x 4.5mH ° Capacity: 2,000t	° Dimensions: 30mW x 120mL x 4.5mH ° Capacity: 3,000t ° The width of this warehouse will be widened in consideration of the movability of forklifts. ° Conveyors require improvement.
Forklift track	° None	° No. of units: 2 ° For carrying cargoes inside the warehouse. ° Required number of pallet will be provided.
Flat bottom boat (pontoon)	Existing two boats must be returned as they are on loan.	Three (3) pontoons of the same capacity as existing one will be required.

6-7 Plan for the Cement Transportation Method

6-7-1 Present Condition of Cement Transportation

(1) Distance of transportation:

10 km between mill and foreshore shipping facilities

(2) Locomotive:

215 HP diesel locomotive x 2 cars

(3) Wagon:

15t covered wagon x 12 cars

50 kg x 300 bags = 15t

(On loan by the Burmese National Railways)

(4) Train formation:

4 cars x 3 formations

(5) Traveling time: (per train)

Loading	60 min.
Traveling	30 min. x 2 = 60 min.
Unloading	60 min.
	180 min. (3 hours)

(6) Frequency of train operation and amount of transportation:

15t x 4 x 12/d = 720 t/d

(7) Ship loading capacity:

Design capacity		400 t/d x 2 unit = 800 t/d
Actual capacity	(Average)	500 t/d x 2 unit =1,000 t/d
	(Maximum)	700 t/d

(8) Consideration:

The average actual capacity of 500 t/d is based on a case that cargoes are loaded onto a ship of 500t capacity. However, in reality, continuous loading cannot be performed since cargoes must be loaded onto 5 different types of ships at present. There are problems in loading cargoes especially in rainy season or when ships are exchanged at the berth.

6-7-2 Cement Transportation after Expansion

(1) Amount to be transported:

Not less than 1,670 t/d

(2) Determination of train service: (per formation)

Loading	30 min./car x 2 =	60 min.
Traveling	30 min. x 2 =	60 min.
Unloading, ship loading	20 min./car x 2 =	40 min.
	Shunting	20 min.
		180 min. (3 hours)

(3) Locomotive and wagon:

(i) Locomotive: 215 HP diesel locomotive x 4 cars (existing)
One locomotive will be reserved as standby.

(ii) Wagon: 15t covered wagon x 18 cars
(Additional cars will be borrowed from the Burmese National Railways)

(4) Train formation:

6 cars x 3 formations

(5) Amount to be transported:

(15t x 6) x 24/3 x 3 formations = 2,160 t/d > 1,670 t/d

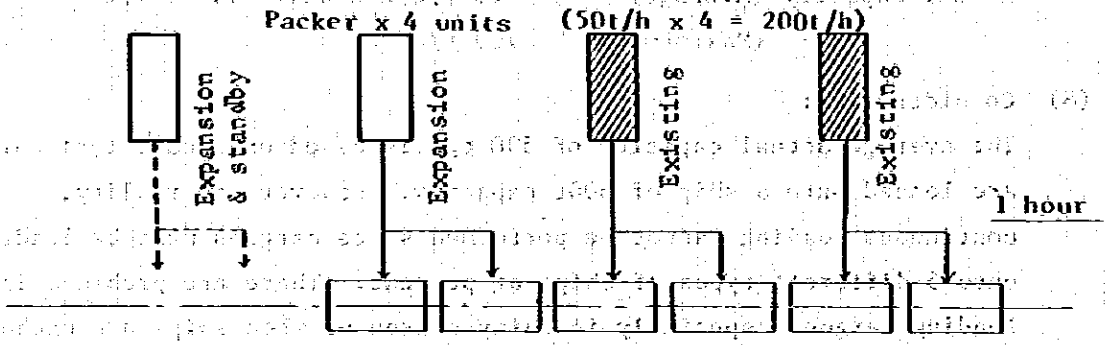
(6) Percentage of shipment:

It is planned that 20% of shipment will be transported by railroad and 80% by ship in future. The percentage of shipment by truck is assumed to be zero at present since roads have not been properly arranged yet.

6-7-3 Train Service Diagram (per train)

(1) Packing loading

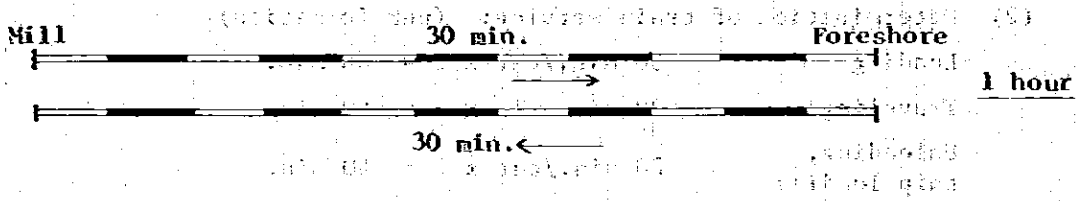
Fig. 6-7-1



15t/wagon x 6 = 90t/1 formation
Loading hour: 30min./wagon x 2 = 1 hour

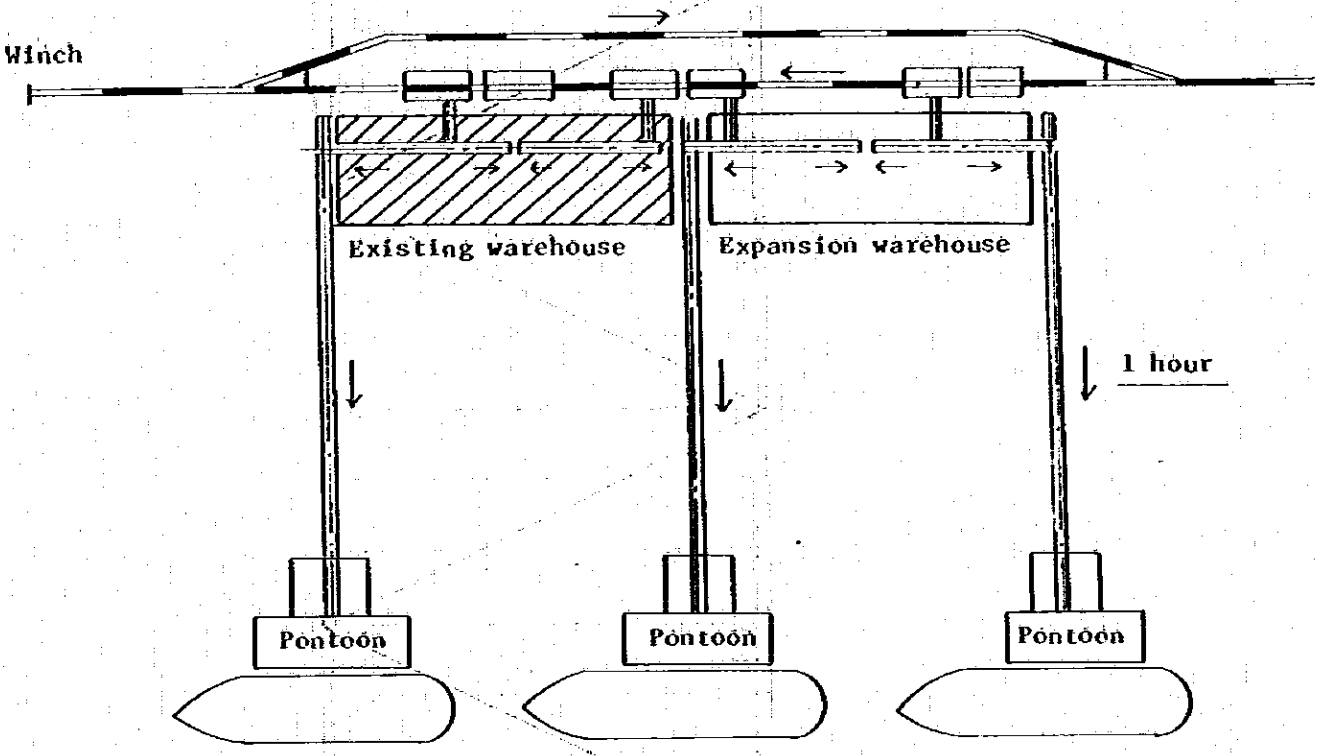
(2) Travelling (one way 10 km)

Fig. 6-7-2



(3) Unloading and ship loading

Fig. 6-7-3



Unloading hour: 20 min./wagon x 2 = 40 min.

Shunting hour : 20 min.

6-7-4 Train Operation Diagram

Fig. 6-7-4