V BASIC STUDY OF PLANT

V. BASIC STUDY OF PLANT

V-1 Study on the Demand and Supply Situation of the Cement in Malaysia and Peninsular Malaysia

V-1-1 Demand forecast

Four equations for forecasting the cement demand in Malaysia were formulated by mathematical methods based on (a) Correlation with GDP between 1970 and 1980, (b) Correlation with Fixed Capital Formation between 1970 and 1980, (c) Growth curve (Logistic curve) based on the per capita cement consumption (five year moving average) between 1967 and 1978, and (d) Elasticity of cement demand growth against Construction sector growth between 1970 and 1980.

The equations obtained are as follows:

(a) $\log e\, Y = 3.19853 + 1.47901 \log e\, X$

$(R^2 = 0.988882)$

Y: Cement demand

X: GDP

(b) $\log e\, Y = -0.924684 + 1.0775 \log e\, X$

$(R^2 = 0.957803)$

Y: Cement demand

X: Fixed capital formation

(c) $$y = \frac{1675.^{36}}{1 + 23.7675^{0.09141011}}$$

$(R^2 = 0.994135)$

$Y = y \cdot P$

Y: Cement demand

y: Per capita cement demand

P: Population

t: Number of year starting from 1967

(d) $Y = 3050 (1 + 0.095 \times 1.29)^t$

Y: Cement demand

t: Number of year from 1981

(① The elasticity of cement consumption growth against construction sector growth: 1.29.
② The annual construction sector growth rate for the present decade (planned): 9.5%)

The variables to be used in calculation of the cement demand for the present decade were taken from Fourth Malaysia Plan. (For GDP, Fixed Capital Formation, Construction Sector please refer to Tables III-1-3 and -4. Population in 1980, 1985 and 1990 are 14,261, 16,179.5 and 18,143 thousand respectively and the annual growth rates are 2.6% and 2.3% for the first half and second half respectively.)

The estimates of the cement demand obtained are shown in Table V-1-1 and Fig. V-1-1.

Table V-1-1 The Estimates of Cement Demand in Malaysia

(In '000 M/T)

Estimate / Year	A	B	C	D	E (Most likely)
1980	3,065	3,200	3,140	3,050	3,050 (214)
1981	3,418	3,381	3,484	3,424	3,401 (233)
1982	3,810	3,573	3,863	3,844	3,792 (253)
1983	4,248	3,775	4,278	4,315	4,228 (268)
1984	4,736	3,988	4,732	4,844	4,714 (299)
1985	5,280	4,214	5,228	5,438	5,256 (325)
1986	5,954	4,670	5,755	6,105	5,861 (354)
1987	6,714	5,175	6,326	6,853	6,535 (386)
1988	7,571	5,735	6,945	7,693	7,286 (420)
1989	8,537	6,355	7,611	8,636	8,124 (458)
1990	9,624	7,042	8,328	9,695	9.058 (499)
1981~1990 Average Annual Growth Rate (%)	12.1	8.2	9.6	12.3	11.5

Note: The figures in parentheses denote the per capita demand.

The estimates A and D show the average annual growth rates of 12.1% and 12.3% respectively, while the estimates C and B show the average annual growth rates of 9.6% and 8.2% respectively.

It is noted that the estimate B, which is calculated by the correlation with Fixed Capital Formation or, Investment has shown the lowest growth of cement demand, because the average annual growth rate of Fixed Capital Formation between 1981 and 1990 is estimated by FMP at 7.6% which is much lower (by 4.6%) than the actual annual growth rate (12.2%) of that during the last decade and also because its share of GDP in the present decade is declining as trend from 26.5%

Share of Investment in GDP

(In: %)

	1970	1975	1980	1985	1990
Private	12.1	14.1	17.7	18.0	19.3
	(68)	(62)	(67)	(76)	(76)
Public	5.7	8.5	8.8	5.7	6.1
	(32)	(38)	(33)	(24)	(24)
Total	17.8	22.6	26.5	23.7	25.4
	(100)	(100)	(100)	(100)	(100)

Note: Figures in parentheses denote percentages of Private and Public Investment against Total.

in 1980 to 23.7% in 1985 and 25.4% in 1990 making shallow U curve instead of the rising trend between 1971 and 1980. Besides, the ratio of the private investment against the total investment also changes quite much from 67% in 1980 to 76% both in 1985 and 1990 unlike the rather stable ratio during the past decade (62 ~ 68%). This means that there may be considerable change in the content of the fixed capital formation between the last decade and the present decade.

Moreover, the investment amount in each year showed considerable fluctuation during the last decade and will do same also for the present decade. However, the amount for this decade seems to be somewhat too small compared with the trend based on the actual performances during the last decade, and also to support the target GDP growth rate for 1980s*. So the ratio between the GDP growth rate and the share of the investment or fixed capital formation in GDP (the capital output ratio) was calculated based on the actual performances during 1970s and planned figures for 1980s (cf. FMP) as follows:

Period	Average of GDP Growth Rage [g](%)	Average Share of Fixed Capital Formation in GDP [s] (%)	The Capital Output Ratio $c = \frac{s}{g}$
1971~1975	7.19	22.07	3.07
1976~1980	8.57	23.26	2.71
1971~1980	7.88	22.67	2.89 (2.91)
1981~1985	7.60	24.80	3.26
1986~1990	8.50	24.73 [29.75]	2.91 [3.50]
1981~1990	8.00	24.76 [27.27]	3.10 [3.41]

Note 1: Figures in parentheses [ ] denote our estimates.

Based on the above it may be said that the capital output ratio, that is the ratio between the average share of fixed capital formation in GDP and the average GDP growth rate during the first half of 1970 is 3.1, and that for the second half is 2.7. From this we may understand that the average ratio for 1970s is some 2.9. Then the ratio of 3.3 for 1981 ~ 1985 is easily accepted. However, when it comes to the ratio of 2.9 for 1986 ~ 1990, there arises concern whether it is possible for the ratio to decline to 2.9 from 3.3 in the previous period, while aiming for the much higher GDP growth rate of 8.5% per annum for this period. It is generally believed from the actual statistics of many countries over the world that there is a tendency of this rate increasing moderately since there is more fixed capital formation or investment as time passes.

Therefore, it is estimated by us that the rate for 1986 ~ 1990 period will increase moderately to 3.5. If this is applicable, then the fixed capital formation in 1990 will be M$ 16,886 million (in 1970 prices) accounting for some 30% of GDP. Suppose the increment from the planned M$ 14,436 in 1990 is to be financed by the Government then the ratio between the private and public investment will be some 65% vs 35% which is more of less same with that in 1980, though the content within private and public investment are yet to be checked.

* Using the correlation equation between GDP and Fixed Capital Formation, which is formulated on the actual figures of both between 1970 and 1980, the Fixed Capital Formation, which are required to achieve the target GDP growth for 1980 specified in FMP, are calculated. The figures obtained are larger than those mentioned in FMP.

Thus the cement demand which is to be estimated by the equation based on the correlation with the adjusted fixed capital formation becomes 8339 thousand tons in 1990 and the average annual growth rate between 1981 and 1990 is 10.05%.
Then the four estimates (A,B,C and D) in Table V-1-1 can be grouped into two – the optimistic estimates of some 12% annual growth (Estimate A and D) and the pessimistic estimates of some 10% annual growth (Estimate B and C).

The most likely growth rate seems to be 11.5% [as shown in the column E (most likely)] which is a quarter on the higher side from the midline between 10 and 12%, considering the possibilities mentioned as follows:

(1) The actual cement consumption in Malaysia has been curbed so far due to shortage of the domestic product.

(2) There are very good possibility that the unit requirement of cement per unit expediture for every major field of the Fixed Capital Formation will increase considerably in the future,
  a) because the infrastructure to be constructed will have to endure heavy duty.
  b) because there will be more concrete house replacing the traditional brick house due to labor shortage,
  c) because there will be more production facilities of heavy industry to be constructed in the future.

Summarizing the estimate of the cement demand for 1980s it can be said that though MIDA has made the estimate of 15% annual growth rate (between 1981 and 1988), and the Cement Industry is saying 12 ~ 10% annual rate, our estimate is 11.5% as discussed above.

The demand in Peninsular Malaysia in 1,990 was estimated by the following equation, as being proportionate with GDP:

$$Y_P = Y_M \times \frac{GDP_P}{GDP_M}$$

Y_P = Cement demand in Peninsular Malaysia

Y_M = Cement demand in Malaysia

GDP_P = GDP in Peninsular Malaysia (M$48,344 million in 1990)

GDP_M = GDP in Malaysia (M$ 56,760 million in 1990)

The estimated demands as a result are shown in Table V-1-2 in the column of G(most likely).

The demand of Peninsular Malaysia was also estimated by the logistic curve based on the actual cement consumption between 1,969 and 1,978 by the equation:

$$Y = \frac{19,951.2}{1 + 28.0567\, e^{-0.129821t}}$$

$(R^2 = 0.961374)$

Y: Cement Demand

t : Number of year starting from 1969

The calculated demand is shown in Table V-1-2 in the column of F.

Table V-1-2 Demand Estimates in Peninsular Malaysia

(In '000 M/T)

Estimate / Year	F		G (Most likely)	
1980	2,888	(244)	2,608	(220)
1981	3,224	(266)	2,907	(240)
1982	3,590	(289)	3,240	(261)
1983	3,988	(313)	3,611	(284)
1984	4,419	(339)	4,025	(309)
1985	4,881	(365)	4,486	(336)
1986	5,376	(394)	5,000	(367)
1987	5,901	(424)	5,573	(400)
1988	6,454	(454)	6,212	(437)
1989	7,033	(485)	6,924	(477)
1990	7,635	(515)	7,715	(521)
			11.5% (average annual growth rate (1981 ~ 1990)	

Note: Figures in parentheses denote the per capita demand (kg).

The demand in each year in the Estimate G was determined based on the assumption that the demand will grow at the same annual rate, that is calculated to be 11.5%. It is seen that the demands in 1980s determined by Estimate F and Estimate G are very close to each other, which itself supports the Estimate G (obtained from the estimates for Malaysia) can be used as the estimate for the Peninsular Malaysia. The demands by Estimate F and G are shown in Fig. V-1-1.

V-1-2 Export and import possibility

(1) Import

Peninsular Malaysia imported some 321 thousands tons of cement in 1980 which is almost twice as much as that in 1979. This is mainly due to delay of the implementation of the approved projects on one side and the rapid increase of the demand there on the other side.
Now that APMC's expansion is completed, Peninsular Malaysia is virtually in a position of being self sufficient as long as APMC's expansion goes on stream as scheduled.

However, in the east Malaysia there were 122 thousand tons cement and 258 thousand tons of cement clinker imported in 1980. Therefore, we can say Malaysia as a whole is still short of cement supply.

(2) Export

The demand and supply situation of export market are shown in Tables V-1-3 to V-1-6.

Fig. V-1-1 Estimated Cement Demands in Malaysia and Peninsular Malaysia

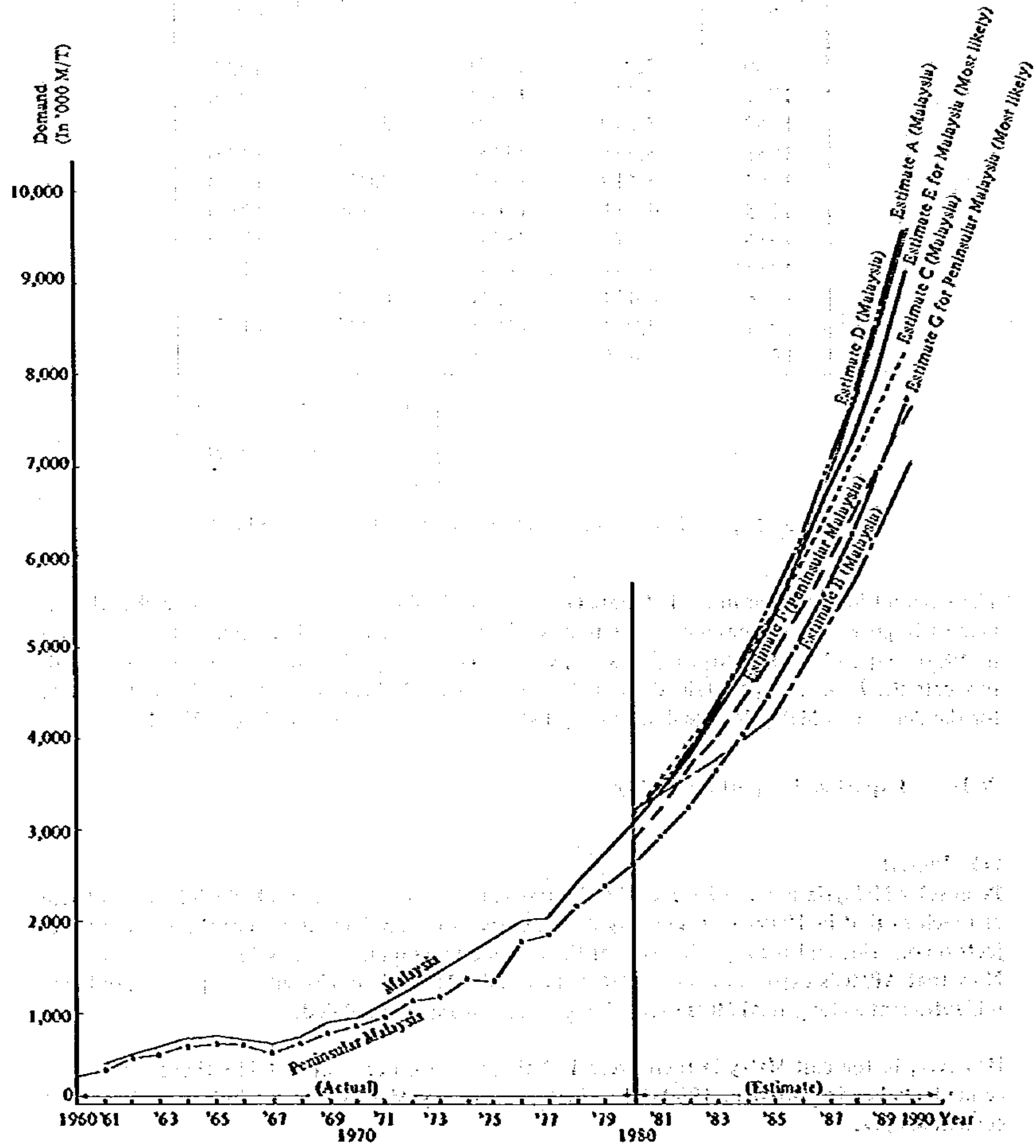


Table V-1-3 Demand and Supply Estimates in Cement Export Market

(In '000 M.Tons)

Region	Year	Import Demand (A)	Export Supply										Balance (B) - (A)
			Major Exporting Countries in East Side						Sub-total	Others in East side	West Side	Grand-total (B)	
			Japan	Korea	Taiwan	Philippine	Thailand	Indonesia					
Southeast Asia	1980	11,165	2,982	3,024	630	777		452	7,865	3,300	—	11,165	0
	1981	11,330	3,140	2,670	1,530	850	300	540	9,030	3,250	—	12,280	950
	1982	11,750	3,000	3,000	1,530	850	400	600	9,380	3,550	—	12,930	1,180
	1983	11,100	2,900	3,200	1,530	850	400	600	9,480	3,950	—	13,430	2,330
	1984	11,550	2,800	3,300	1,530	850	400	600	9,480	4,000	—	13,480	1,930
Middle East	1980	16,350	4,863	1,385	—	13	—	14	6,275	—	10,075	16,350	0
	1981	16,600	5,300	2,570	250	50	—	—	8,170	—	10,000	18,170	1,570
	1982	17,600	5,300	2,900	250	50	—	—	8,500	—	10,000	18,500	900
	1983	17,850	5,000	3,200	450	50	—	100	8,800	—	10,000	18,800	950
	1984	17,350	4,700	3,600	450	50	—	200	9,000	—	10,000	19,000	1,650
West Coast U.S.A.	1980	1,050	473	—	—	—	—	—	473	—	577	1,050	0
	1981	1,000	500	—	—	—	—	—	500	—	500	1,000	0
	1982	1,100	500	100	—	—	—	—	600	—	500	1,100	0
	1983	850	400	100	—	—	—	—	500	—	350	850	0
	1984	600	300	100	—	—	—	—	400	—	200	600	0
Others Australia Islands in Pacific Ocean Mouritius	1980	500	236	—	3	4	—	—	243	—	257	500	0
	1981	530	200	—	20	—	—	—	220	—	310	530	0
	1982	560	200	—	20	—	—	—	220	—	340	560	0
	1983	590	200	—	20	—	—	—	220	—	370	590	0
	1984	620	200	—	20	—	—	—	220	—	400	620	0
Total	1980	29,065	8,554	4,409	633	794		466	14,856	3,300	10,909	29,065	0
	1981	29,460	9,140	5,240	1,800	900	300	540	17,920	3,250	10,810	31,980	2,520
	1982	31,010	9,000	6,000	1,800	900	400	600	18,700	3,550	10,840	33,090	2,080
	1983	30,390	8,500	6,500	2,000	900	400	700	19,000	3,950	10,720	33,670	3,280
	1984	30,120	8,000	7,000	2,000	900	400	800	19,100	4,000	10,600	33,700	3,580

Note: Others in East Side: Singapore (re-export), China, North Korea, West Malaysia

West Side: West Europe, East Europe, Africa, Canada, Australia, U.A.E.

Table V-I-4 Demand and Supply Estimates in Southeast Asian Countries (Major Exporting Countries)

(In '000 M/T)

Country	Year	1980 (Preliminary)	1981 (Expected)	1982	1983	1984
Japan	Capacity	107,903	107,903	107,903	107,903	107,903
	Domestic Demand	82,426 (100.7)	81,000 (98.3)	81,000 (100)	81,000 (100)	81,000 (100)
	Production	91,154 (84.5)	90,140 (83.5)	90,000 (83.4)	89,500 (82.9)	89,000 (82.5)
	Export	8,554	9,140	9,000	8,500	8,000
Korea	Capacity	22,185	23,463	23,463 (83.7)	25,000 (83.4)	26,000 (84.6)
	Domestic Demand	13,172 (83.2)	13,000 (98.7)	13,650 (105)	14,350 (105)	15,000 (105)
	Production	17,682 (79.7)	18,240 (77.7)	19,650	20,850	22,000
	Import	—	—	—	—	—
	Export	4,409	5,240	6,000	6,500	7,000
Taiwan	Capacity	15,960	17,760	18,500	19,600	20,500
	Domestic Demand	13,302 (115.2)	13,300 (160)	13,950 (105)	14,650 (105)	15,400 (105)
	Production	14,035 (87.9)	15,100 (85)	15,750 (85)	16,650 (85)	17,400 (85)
	Export	633	1,800	1,800	2,000	2,000
Philippines	Capacity	5,657	5,657	5,657	5,657	5,900
	Domestic Demand	3,646 (103.1)	3,800 (104.2)	4,000 (105)	4,200 (105)	4,400 (105)
	Production	4,516 (79.8)	4,700 (83.1)	4,900 (86.6)	5,100 (90)	5,300 (90)
	Export	794	900	900	900	900
Thailand	Capacity	5,925	8,725	8,725	8,725	9,500
	Domestic Demand	6,341 (103.5)	6,700 (105.7)	7,000 (105)	7,350 (105)	7,700 (105)
	Production	5,302 (89.5)	6,870 (78.7)	7,400 (84.8)	7,750 (88.3)	8,100 (85)
	Import	947	130	—	—	—
	Export	—	300	400	400	400
Indonesia	Capacity	8,500	8,500	8,500	10,800	11,800
	Domestic Demand	5,475 (133.4)	6,500 (118.7)	7,150 (110)	7,850 (110)	8,650 (110)
	Production	5,818 (68.5)	6,540 (76.9)	7,450 (87.6)	8,350 (77.3)	9,350 (79.2)
	Import	127	500	300	200	100
	Export	466	540	600	700	800
Total	Capacity	166,130	172,008	172,748 (84.0)	177,685	181,603
	Domestic Demand	124,362 (101.1)	124,300 (100)	126,750 (102)	129,400 (102.1)	132,150 (102.1)
	Production	138,507 (83.4)	141,590 (82.3)	145,150	148,200 (83.4)	151,150 (83.2)
	Import	1,074	630	300	200	100
	Export	14,856	17,920	18,700	19,000	19,100

Note : 1. ( ) in domestic demand : over previous year (%)

2. ( ) in production : operation rate (%)

Table V-1-5 Demand and Supply Estimates in Southeast Asian Countries (except Major Exporting Countries)

(In '000 M/T)

Country	Year	1980 (Preliminary)	1981 (Expected)	1982	1983	1984
China	Domestic Demand	58,900 (104.7)	61,600 (104.7)	64,300 (104.7)	67,300 (104.7)	72,000 (104.7)
	Production	58,100	60,800	63,200	66,200	70,700
	Import	1,500	1,500	2,000	2,000	2,000
	Export	700	700	700	700	700
Hong Kong	Domestic Demand	3,000 (107)	3,100 (103)	3,200 (103)	3,300 (103)	3,400 (103)
	Production	—	—	350	1,400	1,400
	Import	3,000	3,100	2,850	1,900	2,000
Singapore	Domestic Demand	1,400 (107)	1,450 (103)	1,500 (103)	1,550 (103)	1,600 (103)
	Import	1,800	1,850	1,900	1,950	2,000
	Export	400	400	400	400	400
East Malaysia and Brunei	Domestic Demand	500	550	600	650	700
	Import	500	550	600	650	700
West Malaysia	Domestic Demand	2,600 (110.2)	2,850 (110)	3,150 (110)	3,450 (110)	3,800 (110)
	Production	2,350	2,750	3,400	4,100	4,500
	Import	300	100	—	—	—
	Export	50	—	250	650	700
Vietnam	Domestic Demand	1,100	1,200	1,300	1,400	1,500
	Production	800	800	800	800	800
	Import	300	400	500	600	700
India	Domestic Demand	22,500 (105)	23,000 (103)	23,700 (103)	24,400 (103)	25,100 (103)
	Production	20,700	21,200	21,700	22,400	23,100
	Import	1,800	1,800	2,000	2,000	2,000
Sri Lanka	Domestic Demand	600	650	700	750	800
	Production	400	400	400	400	400
	Import	200	250	300	350	400
Bangladesh	Domestic Demand	800	850	900	950	1,000
	Import	800	850	900	950	1,000
Pakistan	Domestic Demand	4,200 (107)	4,300 (103)	4,400 (103)	4,500 (103)	4,650 (103)
	Production	4,000	4,000	4,000	4,000	4,000
	Import	200	300	400	500	650
Total	Domestic Demand	95,600 (103.3)	99,550 (104.1)	103,950 (104.4)	108,450 (104.3)	114,550 (105.6)
	Production	86,350	89,950	93,850	99,300	104,900
	Import	10,400	10,700	11,450	10,900	11,450
	Emport	1,150	1,100	1,350	1,750	1,800

Note: 1. Supply and Demand Estimates in China are made on the following assumptions:

Actual Production in 1976 : 49,100,000 tons

Growth Rate since 1978 : 4.7%

(This figure is an actual growth rate between 1976 and 1975)

2. ( ) in domestic demand : over previous year (%)

Table V-1-6 Demand and Supply Estimates in Middle East

(In '000 M/T)

Country	Year	1980 (Preliminary)	1981 (Expected)	1982	1983	1984
Saudi Arabia	Domestic Demand	13,250 (112)	14,600 (110)	16,100 (110)	17,700 (110)	19,500 (110)
	Production	3,600	4,400	6,000	8,000	10,000
	Import	9,650	10,200	10,100	9,700	9,500
Kuwait	Domestic Demand	2,550 (111)	2,650 (105)	2,800 (105)	2,950 (105)	3,100 (105)
	Import	2,550	2,650	2,800	2,950	3,100
U.A.E.	Domestic Demand	1,900 (105)	2,000 (105)	2,100 (105)	2,200 (105)	2,300 (105)
	Production	1,350	1,850	2,850	3,000	3,200
	Import	750	400	400	300	200
	Export	200	250	1,150	1,100	1,100
Bahrain	Domestic Demand	250	300	300	350	350
	Import	250	300	300	350	350
Qatar	Domestic Demand	450	500	550	600	650
	Production	250	250	250	250	250
	Import	200	250	300	350	400
Oman	Domestic Demand	550	600	600	650	650
	Import	550	600	600	650	650
Iraq	Domestic Demand	4,250 (118)	3,900 (92)	4,300 (110)	4,600 (110)	5,100 (110)
	Production	3,100	3,100	3,100	3,100	3,600
	Import	1,150	800	1,200	1,500	1,500
South-North Yemen	Domestic Demand	550	600	600	650	650
	Import	550	600	600	650	650
Iran	Domestic Demand	7,000 (100)	6,300 (90)	7,000 (110)	7,700 (110)	8,500 (110)
	Production	6,900	6,200	6,500	6,700	7,500
	Import	100	100	500	1,000	1,000
Jordan	Domestic Demand	1,100	1,200	1,300	1,400	1,500
	Production	500	500	500	1,000	1,500
	Import	600	700	800	400	
Total	Domestic Demand	31,850 (107.6)	32,650 (102.5)	35,650 (109.2)	38,800 (108.8)	42,300 (109)
	Production	15,700	17,300	19,200	22,050	26,050
	Import	16,350	16,600	17,600	17,850	17,350
	Export	200	250	1,150	1,100	1,100

Note: ( ) in domestic demand: over previous year (%)

Within the Pan Pacific countries South Asia and the Middle East (East of Suez Canal) there were some 29.1 million tons of the import demand in 1980 and this will gradually increase and reach 30.1 million tons in 1984. On the other hand the export potential at Southeast Asian countries was 18.2 million tons in 1980 and this will grow to 23.1 million tons in 1984. Besides, there were some 10.9 million tons of export into this area from Western countries in 1980 and this supply will decrease very slightly to 10.6 million tons in 1984. Therefore, it is estimated that between 1981 and 1984 there will be over supply in the cement export market. This situation will naturally lower the export price and profitability.

Though the export market situation after 1984 cannot be forecast quantitatively with high accuracy, the followings can be said:

a) The cement is the essential building material and must be produced in each consuming country as economically as possible.
b) In principle every country would like to be self sufficient as far as the cement supply is concerned.
c) The cement is the heavy cargo which can hardly be transported economically over the very long distance especially as far as it is shipped in bag.

Considering above characters of the cement it can be said that the cement is not a commodity which can be exported very profitably and the export ratio of which can not be very high. Therefore in the long run, the export ratio should not exceed 10% or some more of the total sales, so as to maintain the profitability and stability in operation of the plant.

Besides, there are some disadvantage in Peninsular Malaysia in that four existing companies and the Perak Halla and Pahang Cement projects are all well inland, which will make the FOB cost increases, thereby, limiting the export possibility. There will be only one cement company (Kedah Cement) which may export much because it is located near the port. However, even this company cannot export all the product, because it is generally more profitable to sell it within the domestic market. Summarizing we may safely say that Peninsular Malaysia will be able to export, at reasonable price, some quantity amounting to 10% or some more of the total consumption mainly to the neighboring areas such as Thailand, Vietnam, East Malaysia, Indonesia (eg. Kalimantan and Sumatra), Pakistan, Bangladesh as long as there are demand.

V-1-3 Supply forecast

As discussed before there are five cement manufacturers in Malaysia. One of them is CMS in East Malaysia which is engaged in grinding the imported clinker (the rated capacity is 432 thousand tpy.) The rest four are located in the western area of the Peninsular Malaysia. The total rated production capacity in Peninsular Malaysia was 2560 thousand tpy in 1980, and the actual capacity was 2400 thousand tons. The actual production was 2354 thousand tons that yera. With APMC's Rawang plant of 1200 thousand tpy completed, the rated capacity has become 3760 thousand tpy and the actual capacity is expected to become 2760 thousand in 1981, and 3380 thousand in 1982.

At the time of our field study in Malaysia between May and June in 1981 there were three approved but not implemented projects and three applications were submitted later to Goverment for approval which are one new project (Kedah Cement) and two expansion projects (Tasek and CIMA). Those are shown as follows:

Project	Rated Capacity (In '000 M.TPY)
Approved but yet to be implemented	
Simen Perak	500
Pahang Cement	500
Perak Halla	1,200
Application of new project	
Kedah Cement	1,200
Application for expansions	
Tasek	1,500
CIMA	1,000
Total	5,900
(Application of the clinker producing plant Sarabah Cement in East Malaysia	440*)

(* Sarabah Cement is to produce the clinker only which is to be ground by CMS. As CMS's capacity is already counted, Sarabah's is not counted this time.)

Concerning the supply in the future, MIDA had made three possible case studies at the beginning of 1981 depending upon the possibilities of implementation by those projects mentioned above.

Case I: This assumes the approved three projects (Perak Halla, Pahang Cement and Simen Perak) and one new comer of Kedah Cement will start at earliest opportunity (not later than 1984).

Case II: In this case the start up years of each project were determined considering the actual progress of implementation (Perak Halla and Kedah Cement will start in 1984 and Pahang Cement come two years later). Simen Perak is written off.

Case III: Beside the Case II's idea the new assumption is added. Tasek's and CIMA's expansions will start in 1983 and Kelantan Cement come in 1986.

The supply forecast by MIDA in three cases are shown already in Table II-2-6 to II-2-11.

In case of the total Malaysia, CMS or Sarabah Cement is to be added to each of three cases of supply in Peninsular Malaysia. Sarabah Cement's rated capacity is 440 thousand tpy and it is expected that it will start clinker production from 1984. Once Sarabah starts production, both Sarabah Cement and CMS are to be deemed as one integrated cement company.

V-1-4 Forecast of demand and supply balance, and possibility of new entry

As discussed in V-1-1 the demands in both Malaysia and Peninsular Malaysia are estimated to grow at the average annual rate of 11.5% during the present decase, from 3050 thousand and 2608 thousand tons, respectively in 1980. On the other hand the supply in Malaysia and Peninsular Malaysia are expected to increase in three cases as discussed in V-1-3.

The projected demand and supply balance in Malaysia becomes as shown in Table V-1-8. In case of "Case III Revised" in the table The Kelantan Cement's capacity is excluded from the supply just for calculation of finding the most appropriate timing of entry into the industry by it.

The projected demand and supply balance for the Peninsular Malaysia is shown in the same manner, without CMS or Sarabah Cement included (cf. Table V-1-9).

Table V-1-7 Projected Demand and Supply of Cement in Malaysia

(In '000 M/T)

Year	Demand (A)	Case I		Case II		Case III		Case III Revised	
		Supply (B)	Balance (B – A)	Supply (C)	Balance (C – A)	Supply (D)	Balance (D – A)	Supply (E)	Balance (E – A)
1981	3,401	3,160	Δ 241	3,160	Δ 241	3,160	Δ 241	3,160	Δ 241
1982	3,792	3,780	Δ 12	3,780	Δ 12	3,780	Δ 12	3,780	Δ 12
1983	4,228	4,800	572	3,780	Δ 448	4,530	302	4,530	302
1984	4,714	6,330	1,616	5,220	506	7,470	2,756	7,470	2,756
1985	5,256	6,840	1,584	5,940	684	8,190	2,934	8,190	2,934
1986	5,861	6,840	979	6,240	379	9,210	3,349	8,490	2,629
1987	6,535	6,840	305	6,390	Δ 145	9,720	3,185	8,640	2,105
1988	7,286	6,840	Δ 446	6,390	Δ 896	9,720	2,434	8,640	1,354
1989	8,124	6,840	Δ1,284	6,390	Δ1,734	9,720	1,596	8,640	516
1990	9,058	6,840	Δ2,218	6,390	Δ2,668	9,720	662	8,640	Δ 418

Table V-1-8 Projected Demand and Supply of Cement in Peninsular Malaysia

(In '000 M/T)

Year	Demand (A)	Case I		Case II		Case III		Case III Revised	
		Supply (B)	Balance (B – A)	Supply (C)	Balance (C – A)	Supply (D)	Balance (D – A)	Supply (E)	Balance (E – A)
1981	2,907	2,760	Δ 147	2,760	Δ 147	2,760	Δ 147	2,760	Δ 147
1982	3,240	3,380	140	3,380	140	3,380	140	3,380	140
1983	3,611	4,400	789	3,380	Δ 231	4,130	519	4,130	519
1984	4,025	5,930	1,905	4,820	795	7,070	3,045	7,070	3,045
1985	4,486	6,440	1,954	5,540	1,054	7,790	3,304	7,790	3,304
1986	5,000	6,440	1,440	5,840	840	8,810	3,810	8,090	3,090
1987	5,573	6,440	867	5,990	417	9,320	3,747	8,240	2,667
1988	6,212	6,440	228	5,990	Δ 222	9,320	3,108	8,240	2,028
1989	6,924	6,440	Δ 484	5,990	Δ 934	9,320	2,396	8,240	1,316
1990	7,715	6,440	Δ1,275	5,990	Δ1,725	9,320	1,605	8,240	525

From the Tables the following can be found out.

a) When considered from the viewpoint of whole Malaysia, if three old approved projects plus one new project (Kedah Cement) were implemented as in Case I, or if two approved projects plus one new project (Kedah Cement) replacing one old approved project were implemented as in Case II and the existing cement manufacturers would not make expansions in both cases, and also, if the export were 10% or some more of the total consumption (the domestic consumption plus export), there will be the possibility that the new project can enter the industry from 1986 in Case II and 1978 in Case I.

b) Beside the assumption of Case II, if the existing manufacturers would make expansion, and one new project (Kelantan Cement) were added early there will be over supply through 1989, which cannot be overcome by the export accounting for 10% or some more of the total consumption. (cf. Case III)

c) In Case III Revised the Kelantan cement project is excluded from the supply just for calculation purpose as mentioned before. It is apparent that there will be possibility that the Kelantan Cement may start operation from 1989.

d) However, if the demand and supply balance is considered only within Peninsular Malaysia, it may be said that there will be possibilities of new entry in 1988 for Case I and in 1987 for Case II.

e) In Case III and Case III Revised the situations in Peninsular Malaysia only are worse than those in total Malaysia, and there will be oversupply up to 1990 in Case III and there will be room for new entry in 1990 in Case III Revised.

Summarizing those findings the following can be said:

a) There will be no serious problem if all the old approved projects are implemented. Rather it becomes important for the Government to check the exact progress of those implementation programs. Otherwise there will be shortage of cement. (Sarabah Cement's construction of the clinker production plant is assumed.)

b) If there is possibility of any further delay of implementation by the old approved projects, some measures will have to be taken. One practical example might be to allow any capable existing manufacturers to make expansion. Another approach might be to invite the new projects. This will serve as one of the main reasons why the two expansions (Tasek and CIMA) and the new project (Kedah) were approved in September, 1981 by the Government during our feasibility study.

c) With the above government measures taken already we are left free to discuss only Case III Revised and we may say that there will be room for new entry by the Kelantan Cement of 740 thousand ~ 1200 thousand tpy in 1989 if we look the situation from the viewpoint of the total Malaysia (cf. Table V-1-10)

d) If we look it from the viewpoint of the Peninsular Malaysia only the Kelantan Cement may enter the industry in 1990 with its plant of 740 thousand tpy ~ 1200 thousand tpy.

e) On the other hand if either one of the Perak Halla and Pahang Cement fails to implement for any reason, the Kelantan Cement can start earlier. It seems that there still remains this possibility.

f) Furthermore, it should be considered that the cement was exported from Peninsular Malaysia to East Malaysia in the past and there also will be the chance in the future. Also this type of export is virtually the domestic trade which has nothing to do with the international balance of payment.

g) In conclusion, it is preferable that demand and supply balance should be considered in terms of whole Malaysia, and then the earliest possibility of new entry by Kelantan Cement is 1989 for the ordinary size between 740 thousand to 1200 thousand tpy, as long as it is economically viable.

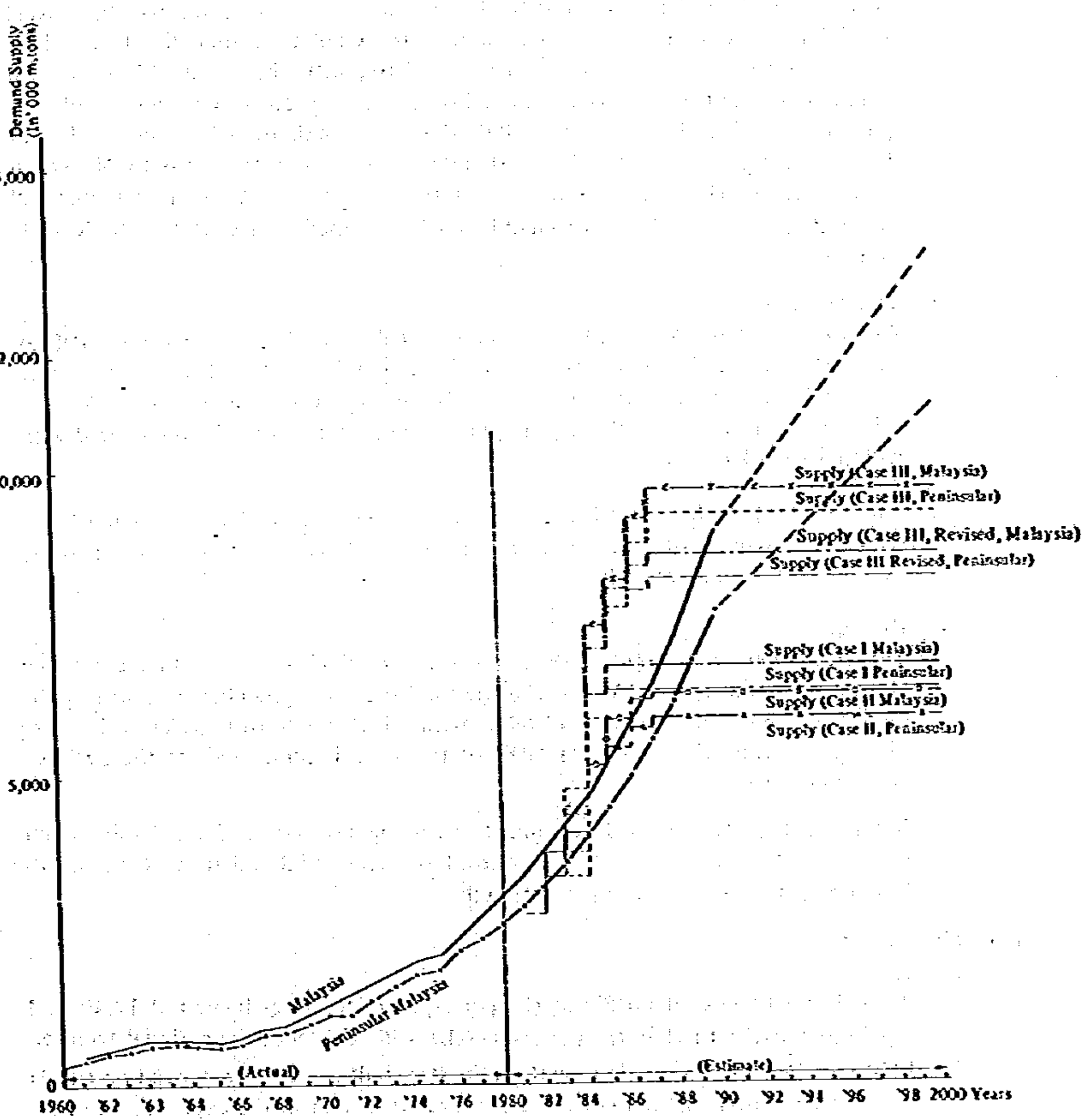
Table V-1-9 Estimated Demand and Supply Situation in Case Kelantan Cement Starts Operation in 1989

(In '000 M/T)

			Case III Revised			In Case Kelantan Cement Enters			
		Year	Demand (A)	Supply (B)	Balance (B − A)	Supply by Kelantan Cement (C)	Total Supply (B + C)	Balance (Export) (B + C−A)	Export Ratio*2 $\left(\frac{B+C-A}{B+C}\right)$ (%)
Malaysia	740 thousand tpy plant	1989	8,124	8,640	516	444	9,084	960	10.6
		1990	9,058	8,640	Δ 418	666	9,306	248	2.7
	1200 thousand tpy plant	1989	8,124	8,640	516	720	9,360	1,236	13.2
		1990	9,058	8,640	Δ 418	1,080	9,720	662	6.8
Peninsular Malaysia	740 thousand tpy plant	1990	7,715	8,240	525	444	8,684	969	11.2
		1991	8,038	8,240	202	666	8,906	868	9.7
	1200 thousand tpy plant	1990	7,715	8,240	525	720	8,960	1,245	13.9
		1991	8,038	8,240	202	1,080	9,320	1,282	13.8

Notes: 1. 100% operating ratio against the actual capacity is assumed.
2. Export Ratio = Export ÷ (Domestic Demand + Export)

Fig. V-1-2 Estimated Demand and Supply of Cement in Malaysia and Peninsular Malaysia



V-2 Local Demand Forecasts in Eastern Coast States

V-2-1 Overview of the economy in Three States (Kelantan, Trengganu and Pahang)

(1) The past decade

a) Kelantan

As shown in Table V-2-1, at the beginning of the decade the per capita GDP of this state was $564.1 which was 0.48 of the national average and was the lowest in Malaysia. Up to the end of the decade, the GDP grew annually at 7.4% [the national GDP growth rate 8.1% (1972–1980)], with the remarkable growth in manufacturing, utilities, government and other service sectors. With the population growth of 2.7%, the per capita GDP showed growth of 4.6% compared with the national per capita GDP growth rate of 5.1% and the ratio to Malaysian average remained more or less same at the beginning. Agriculture sector still accounts for most (33.6%) of GDP here, though there was considerable decrease in share.

b) Trengganu

As shown in Table V-2-2, at the beginning of the decade, the per capita GDP of this state was $614.8 which is 0.52 of the national average. However, this state showed the remarkable growth both in GDP and per capita income at 12.3% and 8.8% respectively despite the high population growth rate of 3.2% (compared with national average of 2.8%)

The offshore petroleum production which began late in the decade and the large-scale land development program in Trengganu Tengah have contributed most to the remarkable economic growth.

c) Pahang

This state's per capita GDP in 1971 was $1169.8 which is same with the national average as shown in Table V-2-3. The GDP and the per capita GDP grew during the decade at 7.3% and 2.7% respectively. With a higher rate of population increase (4.5%), however, the per-capita GDP of the state became 0.81 of the national average in 1980.

It was the large-scale land development in Pahang Tenggara and Jengka areas and the subsequent establishment of resource-based industrial activities which contributed most to the state's economic growth.

(2) The present decade

a) Kelantan

Annual growth rate of GDP and the per-capita GDP are estimated at 12.4% and 9.9% respectively. In 1990 the per-capita GDP will be 0.69 of the national average.

FMP says that the economic growth in the state will continue to depend on trends in the productivity in the existing agricultural areas and in the exploitation of resources in Kelantan Selatan area.*1 Kota Bharu Airport will be developed to cater for wide bodied aircraft, which is to be completed in 1983. There is prospect that the natural gas will be produced from offshore.*2

It seems that the Kelantan state is interested in production of the cement because it is essential for them to secure the stable supply of the material for the purpose of implementing smoothly the economic development plans, and also because establishing the cement plant will create new oppurtunity for increasing employ-

Table V-2-1 GDP by Industry of Origin in Kelantan, 1971 – 1990

	GDP ($million in 1970 prices)				Average Annual Growth Rate (%)				Share of GDP (%)			
	1971	1980	1985	1990	1972~1980	1981~1985	1986~1990	1981~1990	1971	1980	1985	1990
Agriculture, Forestry and Fishing	184	264	390	547	4.1	8.1	7.0	7.6	44.6	33.6	25.9	21.7
Mining and Quarrying	1	2	3	4	8.0	8.4	5.9	7.2	0.2	0.3	0.2	0.2
Manufacturing	14	41	131	261	12.7	26.2	14.8	20.3	5.2	5.2	8.7	10.3
Construction	20	39	59	94	7.7	8.6	9.8	9.2	4.8	5.0	3.9	3.7
Electricity, Gas and Water	4	14	35	63	14.9	20.1	12.5	16.2	1.0	1.8	2.3	2.5
Transport, Storage and Communications	27	65	104	168	10.3	9.9	10.1	10.0	6.5	8.3	6.9	6.7
Wholesale and Retail Trade, Hotels and Restaurants	32	69	147	256	8.9	16.3	11.7	14.0	7.7	8.8	9.8	10.1
Finance, Insurance, Real Estate and Business Service	67	100	166	268	4.6	10.7	10.1	10.4	16.2	12.7	11.0	10.6
Government Services	52	158	380	678	13.1	19.2	12.3	15.7	12.6	20.1	25.2	26.9
Other Services	1	12	50	100	31.8	33.0	14.9	23.6	0.2	1.5	3.3	4.0
Total	402	764	1,465	2,439	7.4	13.9	10.7	12.3	–	–	–	–
GDP at Purchaser's Value	413	786	1,507	2,524	7.4	13.9	10.9	12.4	100	100	100	100
Population ('000)	732.2	933.6	1,052.7	1,170.1	2.7	2.4	2.1	2.3	–	–	–	–
Per Capita GDP ($)	564.1	842	1,431.6	2,157.1	4.6	11.2	8.5	9.9	–	–	–	–
Ratio to Malaysian Average	0.48	0.46	0.61	0.69	–	–	–	–	–	–		

Source: FMP

Table V-2-2 GDP by Industry of Origin in Trengganu, 1971 – 1990

	GDP ($million in 1970 prices)				Average Annual Growth Rate (%)				Share of GDP (%)			
	1971	1980	1985	1990	1972~1980	1981~1985	1986~1990	1981~1990	1971	1980	1985	1990
Agriculture, Forestry and Quarrying	120	234	336	489	7.7	7.5	7.8	7.6	44.8	30.8	24.5	21.7
Mining and Quarrying	12	166.6	282.13	380.16	33.9	11.1	6.1	8.6	4.5	21.9	20.5	16.9
Manufacturing	12	50	126	248	17.2	20.3	14.5	17.4	4.5	6.6	9.2	11.0
Construction	5	19	45	86	16.0	18.8	13.8	16.3	1.9	2.5	3.3	3.8
Electricity, Gas and Water	2	13	31	59	23.1	19.0	13.7	16.3	0.7	1.7	2.3	2.6
Transport, Storage and Communications	10	18	35	64	6.7	14.2	12.8	13.5	3.7	2.4	2.5	2.8
Wholesale and Retail Trade, Hotels and Restaurants	22	42	77	131	7.4	12.9	11.2	12.0	8.2	5.5	5.6	5.8
Finance, Insurance Real Estate and Business Services	39	68	126	222	6.4	13.1	12.0	12.6	14.6	9.0	9.2	9.8
Government Services	38	117	262	478	13.3	17.5	12.8	15.1	14.2	15.4	19.1	21.2
Other Services	1	10	13	22	29.2	6.6	11.1	8.2	0.4	1.3	1.0	1.0
Total	261	737	1,333	2,179	12.2	12.6	10.3	11.4	–	–	–	–
GDP at Purchasers' Value	268	759	1,373	2,254	12.3	12.6	10.4	11.5	100	100	100	100
Population ('000)	435.9	576.9	668.7	761.7	3.2	3.0	2.6	2.8	–	–	–	–
Per Capita GDP ($)	614.8	1,316	2,053.2	2,959.2	8.8	9.3	7.6	8.4	–	–	–	–
Ratio to Malaysian Average	0.52	0.72	0.88	0.95	–	–	–	–	–	–	–	–

Source: FMP

Table V-2-3 GDP by Industry of Origin in Pahang, 1971 – 1990

	GDP ($million in 1970 prices)				Average Annual Growth Rate (%)				Share of GDP (%)			
	1971	1980	1985	1990	1972~1980	1981~1985	1986~1990	1981~1990	1971	1980	1985	1990
Agriculture, Forestry and Fishing	305	458	690	969	4.6	8.5	7.0	7.8	47.1	39.6	26.9	22.0
Mining and Quarrying	36	26	48	63	-3.4	13.0	5.0	9.3	5.6	2.1	1.9	1.4
Manufacturing	41	191	725	1,469	18.6	30.6	15.2	22.6	6.3	15.7	28.3	33.3
Construction	26	39	106	202	4.6	22.1	13.8	17.9	4.0	3.2	4.1	4.6
Electricity, Gas and Water	5	20	63	119	16.7	25.8	13.6	19.5	0.8	1.6	2.5	2.7
Transport, Storage and Communications	27	52	149	279	7.6	23.4	13.4	18.3	4.2	4.3	5.8	6.3
Wholesale and Retail Trade, Hotels and Restaurants	39	83	178	309	8.8	16.5	11.7	14.0	6.0	6.8	6.9	7.0
Finance, Insurance, Real Estate and Business Services	54	97	193	329	6.7	14.8	11.3	13.0	8.3	8.0	7.5	7.5
Government Services	83	194	306	475	9.9	9.5	9.2	9.4	12.8	15.9	11.9	10.8
Other Services	13	23	33	51	6.5	7.5	9.1	8.3	2.0	1.9	1.3	1.2
Total	629	1,183	2,491	4,265	7.3	16.1	11.4	13.7	–	–	–	–
GDP at Purchaser's Value	647	1,218	2,565	4,413	7.3	16.1	11.5	13.7	100	100	100	100
Population ('000)	553.1	819.8	1,003.6	1,201.9	4.5	4.1	3.7	3.9	–	–	–	–
Per Capita GDP ($)	1,169.8	1,486	2,555.8	3,671.7	2.7	11.5	7.5	9.5	–	–	–	–
Ratio to Malaysian Average	1.00	0.81	1.09	1.17	–	–	–	–	–	–	–	–

Source: FMP

ment, the value added, and many other benefits.

b) Trengganu
The GDP and the per-capita GDP of the state will grow at the rate of 11.5% and 8.4%, respectively, making the per-capita GDP in 1990 at 0.95 of the national average.

Due to the petroleum and gas production, and the increased industrial and agricultural output, the economy of this state will grow remarkably. Rapid industrialization will take place with the establishment of resource-based and heavy industries.*3

c) Pahang
The GDP and the per-capita GDP of Pahang will increase at the annual rate of 13.7% and 9.5% respectively and the per-capita GDP will become 1.17 of the national average in 1990.

This remarkable growth will be attributable to the increased agricultural production which arises from the new land development program, timber extraction and expansion of the manufacturing sector.*4

*1. FMP, cf. p.178.
*2. cf. Brief Notes on Kelantan Economic Prospects, by SEPU, Kelantan, May, 1981
*3. FMP, cf. p.178.
*4. Ibid, cf.

V-2-2 Situation of cement demand and supply

(1) Demand and supply balance
There were overall shortage of cement in Peninsular Malaysia in 1980 and the first half of 1981. In Kelantan and Trengganu this shortage was felt most, because there were shortage of wagons and locomotive power for transportation of cement from the plants to Kelantan and secondly because there were least incentives for the manufacturers to supply the cement to Kelantan or Trengganu, which are farthest away, by paying the highest transportation charges themselves and this applied especially during the uniform price system all over Peninsular Malaysia between November 1980 and March 1981...

The cement consumption in Eastern Coast States. – Kelantan, Trengganu and Pahang is reported as follows:

Table V-2-4 Cement Consumption in Kelantan, Trengganu and Pahang

(in '000 M/T)

Year \ State	Kelantan	Trengganu	Pahang	Total
1979	82.6	41.4	111.0	235.0
1980	118.2 (143.1)*2	81.5 (196.9)	132.5 (119.4)	332.2 (141.4)
1981*1	151.7 (128.3)	103.3 (126.7)	160.2 (120.9)	415.2 (125.0)

Note: *1 Estimated from the actual consumption between January and October (Jan ~ Oct x 10)
*2 Figures in parentheses denote growth rate from the previous year
Source: MTI, Domestic Trade Div.

As shown in Table V-2-4, the eastern three states consumed some 235 thousand tons in 1979 and some 332 thousand tons in 1980, and will be consuming some 415 thousand tons in 1981. Each state has shown remarkable growth of cement consumption from 1979 to 1980, some 19% in Pahang, some 43% in Kelantan and 97% in Trengganu. The growth rate from 1980 to 1981 is expected to be some 21% in Pahang, 27% in Trengganu and 28% in Kelantan.

As shown in Table V-2-4, the eastern three states consumed some 235 thousand tons in 1979 and some 332 thousand tons in 1980. Each state has shown remarkable growth of cement consumption from 1979 to 1980, some 19% in Trengganu to some 44% in Kelantan and some 96% in Pahang.

In spite of the very rapidly increasing cement demand, it seems that the actual consumption in these areas were much limited by the short supply though the manufacturers might have been very much encouraged by the Government and others.

It is estimated that about two thirds of cement consumption in the Kelantan state is for the public sector.

(2) Demand by packaging
All the cement which are consumed in the Eastern States are in bag.

(3) Means of transportation
It is estimated that some 90% of the cement brought into Kelantan in 1980 are by rail, about half of which is through Thailand. Some 10% of the total delivery to Kelantan is carried by lorry.

The transportation cost of the cement brought into Kelantan by rail through Thailand is M$1.15/bag, that by rail through Peninsular Malaysia is M$2.50/bag and that by lorry is M$3.00/bag.

Almost all cement consumed in Trengganu and Pahang are brought into by lorries.
The transportation costs are some M$2.50/bag and M$1.50/bag, respectively.

V-2-3 Cement demand forecasts for Eastern Coast States

As the actual consumption in three Eastern States for the past ten years were not known, the future consumption in those states are forecast by dividing the estimated demand for total Malaysia in 1990 proportionately with GDP in each state in the same year, assuming that the demand will grow annually at the same rate between 1980 and 1990. Though the demand forecast is not required after 1990, for the planning of the sales activities and calculation of the profitability for the Kelantan Cement Project, some estimate of the demand was conducted for trial.

By the three year moving average the per capita cement consumption of Malaysia in 1979 was 202 kg. This is nearly equal to that in Japan of 211 kg in 1960, as shown in Table V-2-6. In Japan, Taiwan and Singapore it took roughly 10 years for the per capita consumption to grow from 202 ~ 223 kg level to 459 ~ 481 kg which is nearly twice of the former figures. And in Japan the per capita consumption has become 3.31 times over 19 years since 1960. Considering the pretty close growth rates in Malaysia between 1979 and 1989 and that in Japan between 1960 and 1969, it may be assumed that the per capita consumption of Malaysia in 2000 will become some 600 kg, which is some 3 times as large as that in 1979, as has been realized in Japan over 19 years between 1960 and 1979.

Table V-2-6 Growth of the Per Capita Cement Consumption in Several Asian Countries By the Three Year Moving Average

(In M.Ton)

Malaysia	Peninsular Malaysia	Japan	Taiwan	Korea	Singapore
'79 202	'79 212	'60 211	'68 214	'73 206	'67 223 (single year)
X2.27	X2.25	X2.29	X2.21	X1.83	X2.15
'89 459	'89 478	'69 484	'76 474	'78 377	'72 481
		X3.31			
		'79 699			

Besides, the followings were assumed:

(1) The population in Malaysia will grow at the same rate during 1990s as it is estimated during the latter half of 1980s by FMP.

(4) Cement consumption by brand

The cement consumption by brand in the eastern coastal states are as follows:

Table V-2-5 Cement Consumption by Brand in the Eastern Coastal States

(Unit: '000 M/T)

State \ Brand (Maker) / Year		TASEK	%	APMC	%	CIMA	%	MIMC	%	Total	%
Kelantan	1979	24.0	29.0	46.3	56.1	12.3	14.9			82.6	100.0
	1980	29.0	24.6	44.0	37.2	45.2	38.2			118.2	100.0
	1981	34.2	22.5	62.9	41.5	54.6	36.0			151.7	100.0
Trengganu	1979	11.4	27.5	30.0	72.5					41.4	100.0
	1980	43.0	52.7	38.5	47.3					81.5	100.0
	1981	48.1	46.6	55.2	53.4					103.3	100.0
Total of Kelantan and Trengganu	1979	35.4	28.5	76.3	61.6	12.3	9.9			124.0	100.0
	1980	72.0	36.1	82.5	41.3	45.2	22.6			199.7	100.0
	1981	82.3	32.3	118.1	46.3	54.6	21.4			255.0	100.0
Pahang	1979	57.7	52.0	53.2	47.9			0.1	0.1	111.0	100.0
	1980	73.8	55.7	57.9	43.7	0.8	0.6			132.5	100.0
	1981	85.1	53.1	75.0	46.8			0.1	0.1	160.2	100.0
Total of Three states	1979	93.1	39.6	129.5	55.1	12.3	5.2	0.1	0.1	235.0	100.0
	1980	145.8	43.9	140.4	42.3	46.0	13.8			332.2	100.0
	1981	167.4	40.3	193.1	46.5	54.6	13.1	0.1	0.1	415.2	100.0

Note: The figures for 1981 are estimated from the actual figures between Jan. and Oct., 1981.
Source: MTI

In Kelantan APMC's cement was consumed most in 1979. Tasek's cement was second most and CIMA's was third. However, in both 1980 and 1981 APMC's and CIMA's were consumed nearly equally, and consumption in the market of each of two makers' cement were more than Tasek's, respectively. It seems that this is mainly due to geographical situations, because CIMA and APMC are closer to the market in case they transport their cements by rail.

In Trengganu, only Tasek's and APMC's cement were used almost equally in 1980 and 1981.

As for Pahang, only Tasek's and APMC's cement were consumed. However, Tasek's has been used slightly more than APMC's these three years.

(5) Price

By 25th of March, 1981 the cement price in Kelantan, Trengganu and Pahang was M$8.20/bag., but the price was increased to M$9.60/bag on an ex-retail basis since then.

(2) In 2000 the disparity of the per capita income among states will be virtually eradicated and the cement consumption in each state will be proportionate as the population there, though in 1990 it was assumed that the disparity in the per capita income will be much reduced but not totally eradicated yet and the cement consumption is proportionate with the GDP in each state.

Based on the above assumptions the cement demand in 2000 for Malaysia, Peninsular Malaysia, and the eastern three states (Kelantan, Trengganu and Pahang) were calculated. The demand for each year in between for each of those are calculated assuming that the demand will grow by the same amount. The estimated demand are shown in Table V-2-7.

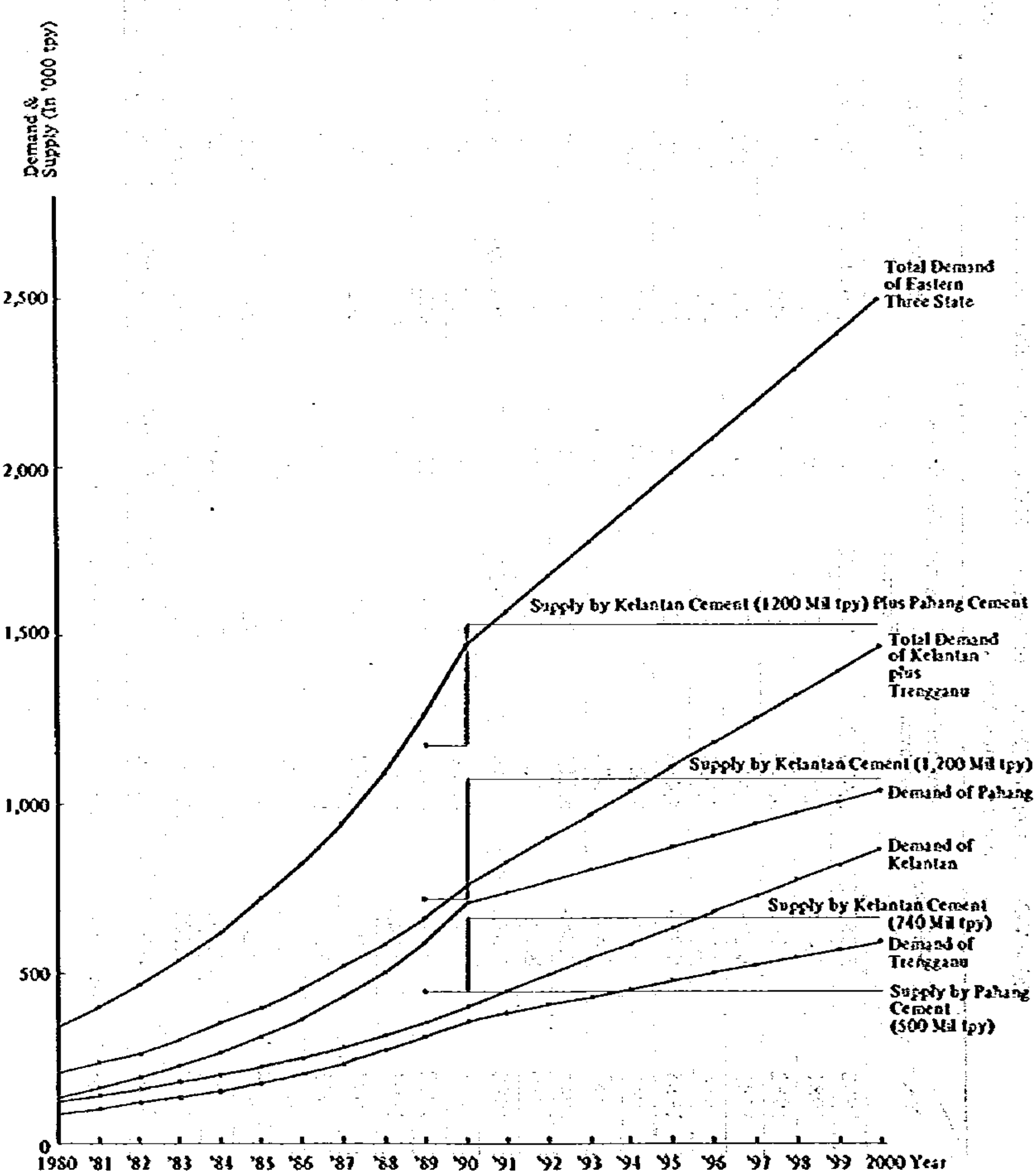
Table V-2-7 Estimated Demand of Cement in Malaysia, Peninsular Malaysia and Eastern Three States

(1 (In '000 M/T)

Year	Malaysia	Peninsular Malaysia	Eastern Two States		Sub-Total	Pahang	Total of Eastern Three States
			Kelantan	Trengganu			
1980	3,050 (214)	2,608 (220)	123 (132)	86 (149)	209 (138)	138 (168)	347 (150)
1981	3,401	2,907	138	99	237	162	399
1982	3,792	3,240	156	114	270	191	461
1983	4,228	3,611	175	132	307	225	532
1984	4,714	4,025	198	152	350	265	615
1985	5,256	4,486	222	176	398	312	710
1986	5,861	5,000	250	203	453	367	820
1987	6,535	5,573	282	234	516	431	947
1988	7,286	6,212	317	270	587	508	1,095
1989	8,124	6,924	357	311	668	598	1,266
1990	9,058 (499)	7,715 (521)	403 (344)	360 (473)	763 (395)	704 (586)	1,467 (468)
1991	9,519	8,038	450	383	833	737	1,570
1992	9,979	8,361	496	407	903	770	1,673
1993	10,040	8,684	543	430	973	803	1,776
1994	10,900	9,007	589	453	1,042	836	1,878
1995	11,361	9,331	636	477	1,113	869	1,982
1996	11,821	9,654	682	500	1,182	902	2,084
1997	12,281	9,977	729	523	1,252	935	2,187
1998	12,742	10,300	775	546	1,321	968	2,289
1999	13,202	10,623	822	570	1,392	1,001	2,393
2000	13,664 (600)	10,946 (600)	868 (600)	593 (600)	1,461 (600)	1,034 (600)	2,495 (600)

Note: Figures in parentheses denote the per capita demand (kg).

Fig. V-2-1 Estimated Demand and Supply of Cement in Eastern Coast States



V-3 Determination of the Local Market

V-3-1 Area and size

In case the Pahang Cement is implemented at Bukit Senyum in 1986 as foreseen in Case III by MIDA it is natural for them to try to sell all their cement within the nearest market from the plant. Then in 1989 or 1990 when the Kelantan Cement starts operation, Pahang Cement will be selling all their cement within Pahang, because the cement demand of Pahang in 1989 (598 thousand) will be larger than the total production of 450 thousand tons.

If the local market for the Kelantan Cement is selected in the same manner from the viewpoint of least transportation cost the following can be said.

Firstly, considering competition between Pahang Cement, which is nearest to Kelantan Cement, and APMC's Rawang Factory, which in turn is nearest to Pahang Cement, APMC can hardly come into Pahang by rail, because the midpoint of railway, Gemas between Rawang and K. Kerau, which is the nearest railway station to Pahang Cement, is outside Pahang state. And also the midpoint of the road between Rawang and Bukit Senyum is somewhere, Raub and Bentong. Suppose the market of Raub and Bentong are taken by APMC, the rest of Pahang amounting at least to some 90% or more of the total is virtually left for Pahang Cement to take the nearest market from the plant so as to sell all their cement at the lowest total transportation cost.

Secondly, the midpoints of railway and road between Kelantan Cement (either in Tanah Merah or Gua Musang) and Pahang Cement are somewhere Mentara, which is located at the border of two states, in case Kelantan Cement is located in Tanah Merah, and somewhere Kuala Lipis, which is in Pahang, in case it is in Gua Musang.

Thirdly, the midpoint of Thai railway between Kelantan Cement and CIMA is Sungai Kolok on the border between Thailand and Malaysia even in case the Kelantan Cement is located deeper south (Gua Musang), and the midpoint of the road between Kelantan Cement in Gua Musang (which is more south) on one hand, and the CIMA or Tasek or Kanthan Factory of APMC on the other is somewhere between Gerik and Jeli both of which are outside of Kelantan.

Furthermore if we consider competition from APMC's Rawang Factory in the same manner the midpoint of railway between Rawang and Tanah Merah (in case the Kelantan Cement is in more north), is somewhere Jarantut in Pahang. In case Rawang and Tanah Merah are connected by road via Gua Musang in future the midpoint is somewhere near Merapoh in Pahang. Assuming that the road which connects Gua Musang with Kuala Borang, that is the starting point of the highway going to Kuantan, is to be completed in 1986, the midpoint of the road, via this new road and Kuantan, between Rawang and Gua Musang is somewhere between Chukai and Kuantan. The midpoint of the old east bound road via Kuantan between Rawang and Tanah Merah is somewhere near Chukai.

Therefore, the Kelantan Cement is to take the nearest market from the plant, either in Tanah Merah or Gua Musang, within virtually all of Kelantan and Trengganu. And there remains further possibility that the Kelantan Cement might be able to sell in the partial market of Pahang and export outside.

Then the timing of entry into the market by the Kelantan Cement has also to be checked further from the viewpoint whether there will be enough cement demand in the local market.
Suppose the size of the cement plant is 740 thousand tpy, the Kelantan Cement will be able to start operation from 1989 at the earliest because in that year production will be 444 thousand tpy (60% operating ratio) and the demand in Kelantan and Trengganu will be 668 thousand. In 1990 the second year when the plant will be operating at its full capacity the production will be 666 thousand and the demand will be 763 thousand tons. Therefore, the plant of 740 thousand tpy can be started in 1989.

In case the plant size is 1200 thousand tpy it will be producing 720 thousand and 1080 thousand tons in 1989 and 1990 respectively. Then the Kelantan Cement will have to sell outside Kelantan plus Trengganu.

Now, at this stage, it is to be considered that the demand in the eastern coast states was estimated from the viewpoint of Macro – starting from estimating demand in whole Malaysia and then that being devided for each state proportionately with GDP for each state, because there was no statistics of cement consumption in the eastern coast states for the past ten years and there were no way of making the mathematical estimates thereof based on the past data. Besides, Kelantan and Trengganu have been left less developed in the past.

Also looking those three states during the present decade we must be careful not to overlook the big potential of development in Trengganu and Kelantan of couse, and in Pahang to some extent, because there is now oil or natural gas being developed offshore of Trengganu and in addition the related industries are being developed, and in Kelantan there is also the same possibility of natural gas production in offshore.
So it can be expected that the cement demand in this area will show much growth accordingly. There is already some sign of very rapid increase of the cement demand seen in these states between 1979 and 1981 as shown in Table V-2-4.
Therefore it is said that there still remains much possibility that the local cement demand in eastern three states will increase more than those estimated from Macro basis as shown in Table V-2-7.
This means that the Kelantan Cement may be able to depend more on Kelantan plus Trengganu market than the estimates of Table V-2-7 will allow, thus decreasing the necessity that the company will have to sell cement either in Pahang or export.

V-3-2 Sales and delivery plan

From the cement industry situation as discussed before, the followings are assumed also in case of the Kelantan Cement.

a) Type of cement to be produced is an ordinary portland cement.

b) At the beginning all the cement to be shipped from the plant will be the bagged cement, However, after a few years there will be necessity of shipping some cement in bulk to the ready mixed concrete companies and/or the secondary product companies which are to be established towards that time and/or to the large customers.

c) Considering the present and future transportation system, most of the cement produced will be transported by lorries.

d) Practically all the cement produced will be sold by the distributor and some of which will be sold to the dealer by the distributor for resale. The distributor will be required to submit the manufacturer the bank guarantee for assurance of their payment of the cement price. The commission of the distributor is some 5.0 ~ 7.5% of the net sales price and the sight of payments is some 60 days.

e) The credit which will be given to the customer by the distributor will fluctuate depending upon demand and supply situation.

f) There will be possibility of exporting some to Thailand by rail or lorry, and to East Malaysia by vessel, assuming that the port in Kelantan is ready.

g) The cement price will still be controlled by the government.

V-4 Determination of Study Case

The feasibility study has been carried out in two stages. In preliminary, nine cases are determined to cover three levels of the plant capacity at three proposed plant sites. The results of these studies are described in Appendix I in this report. The best case is screened out from these nine cases, which is the rated capacity of 740,000 tons per year plant at Tanah Merah. This is called as Case A in this section but an assumption is different from the preliminary case studies. In the early stage of this study, Dabong is assumed as a limestone quarry for Tanah Merah plant because of saving limestone transportation cost, however, it is found in later that Dabong limestone deposits may have a difficulty to develope if Dabong dam project being refreshed again. Therefore in Case A, the proposed cement plant at Tanah Merah has to receive limestone from Gua Musang. Case B in this section is newly added to improve the profitability proposing a large plant at Gua Musang. As described in Section V-1, V-2 and V-3, it is possible to say that there is a room in 1989 for a new entry having a large rated capacity as 1.2 million tons per year from the point of view in marketing.

As aforementioned, Case A and Case B in this Section are decided as listed bellow and location maps are shown in Fig. V-4-1 and Fig. V-4-2.

	Case A	Case B
Plant Site	Tanah Merah	Gua Musang
Production capacity (t-cl/d)	2,000	3,300
Net annual production clinker (ton/year)	634,000	1,039,000
cement (ton/year)	666,000	1,080,000
Rated annual production cement (ton/year)	740,000	1,200,000

Fig. V-4-1 Location of the Plant Site in Tanah Merah

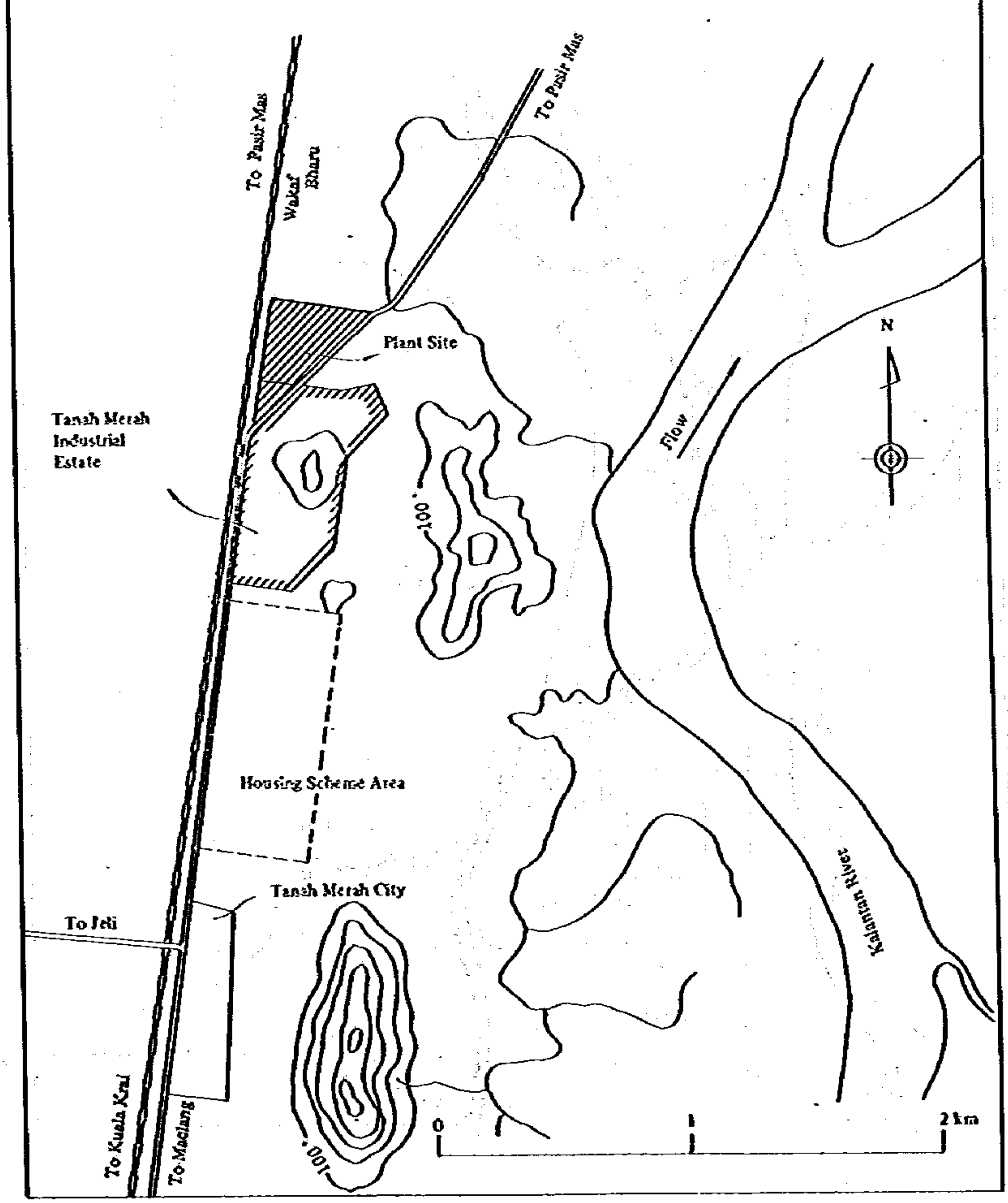
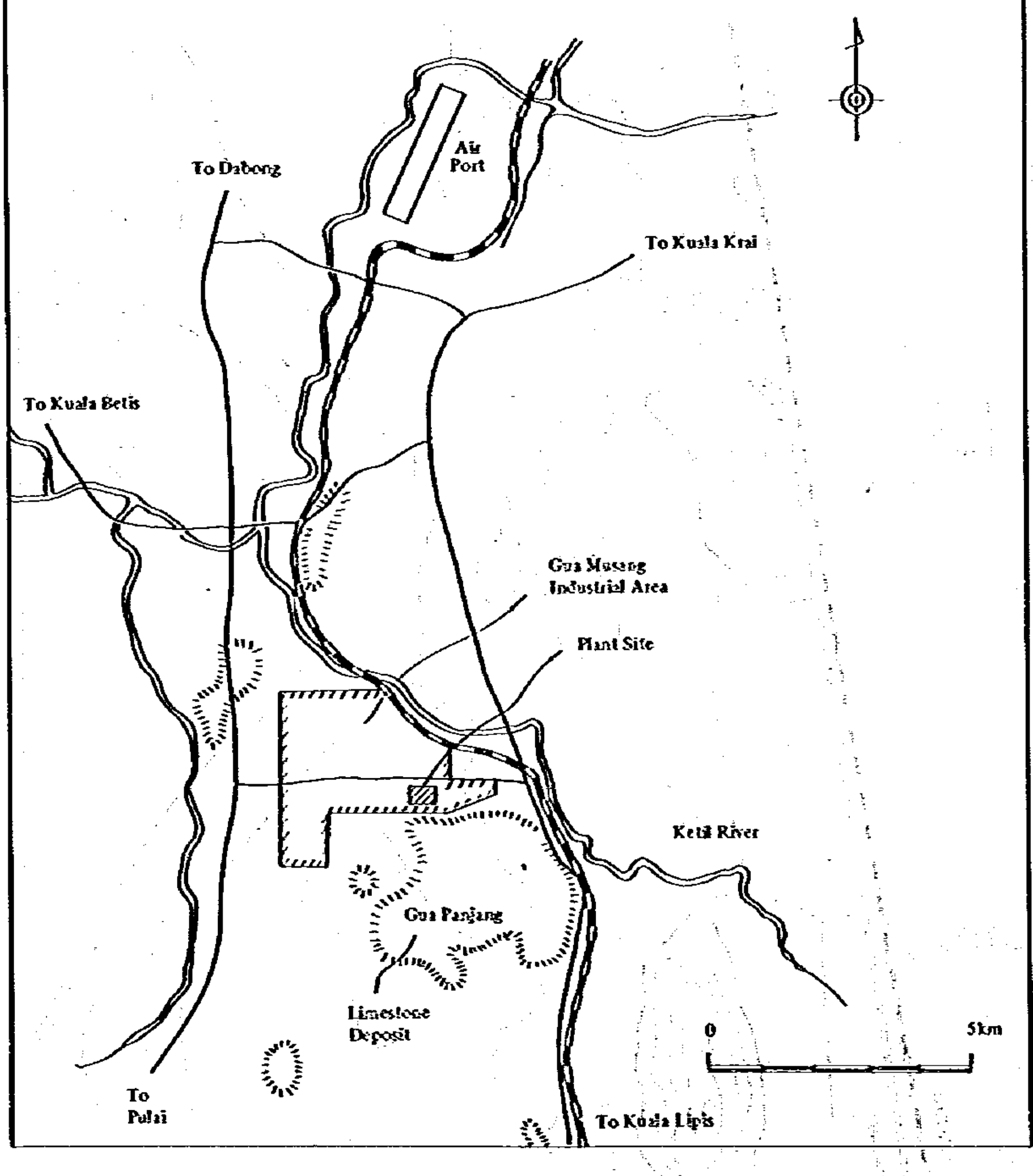


Fig. V-4-2 Location of the Plant Site in Gua Musang



V-4-1 Raw materials supply

(1) Limestone

Tanah Merah has a possibility to receive limestone from three deposits, however, it is the most economical to get it from Dabong by rail. But Dabong deposit may be surrounded by water when a dam project is progressed in near future as described above. Next deposit to be proposed, therefore, is Gua Panjang.

Transporting facility and distance from quarry to plant site are as follows:

Case	Plant site	Limestone quarry	The way of transportation	Distance (km)
A	Tanah Merah	Gua Panjang	Railway	155
B	Gua Musang	Gua Panjang	Belt conveyor	1

(2) Clay

At each site, clay is available at the nearest deposit to the plant site. Distance and transporting facility from quarry to the site are as follows:

Case	Plant site	Quarry	The way of transportation	Distance (km)
A	Tanah Merah	Tanah Merah (West)	Lorry	9
		(North)	Lorry	1
B	Gua Musang	Gua Musang (South)	Lorry	3

(3) Silicious material

Tanah Merah has high silica clay near the site, therefore silicious material is not required. Gua Musang has to use silica sand from the Kelantan river near Kota Bharu. It may be possible to find silicious materials near the site by the farther investigation. Distance and transporting facility from quarrry to the site are as follows:

Case	Plant site	Quarry	The way of transportation	Distance (km)
A	Tanah Merah	—	—	—
B	Gua Musang	Kelantan river	Railway	202

(4) Iron ore

Iron ore from Bukit Lata is used in all cases, because reliable iron deposit couldn't be confirmed in Temangan and Bukit Kuang.

Distance and transportation facility from quarry to the site are as follows:

Case	Plant site	Quarry	The way of transportation	Distance (km)
A	Tanah Merah	Bukit Lata	Lorry	46
B	Gua Musang	Bukit Lata	Railway	208

(5) Gypsum

Gypsum imported from Thailand by rail is used in all cases.

Distance and transportation facility from Sungai Golok station, where the entrance point is located, to the site are as follows:

Case	Plant site	Quarry	The way of transportation	Distance (km)
A	Tanah Merah	Thailand	Railway	47
B	Gua Musang	Thailand	Railway	202

V-4-2 Utility and Labour condition

V-4-2-1 Electric power

Electric power required for cement manufacturing is possible to be supplied from 275 kv transmission line for case A and 132 kv Kuala Krai–Kuala Lipis transmission line for case B by LLN. The 275 kv line is now under construction and will be completed by 1983. The 132 kv line is now under planning and will be scheduled to be completed by the end of 1986. In this regard, these lines will be completed by the time when this plant being operated.

These lines also have sufficient capacity for this project.

(1) Power demand

Electric power requirement for cement plant is assumed as follows.

No.	Item	Unit	Case A	Case B
1	Production capacity	t-cement/hour	87.5	144.4
2	Unit consumption	KWH-t-cement	118	116
3	Average power	KW (1 x 2)	10,300	16,700
4	Load factor $\left(\frac{\text{Average power}}{\text{Max. demand power}}\right)$	%	75	75
5	Max. demand power	KW (3 ÷ 4)	13,800	22,300
6	Installed power	KW	14,500	22,000

(2) Unit price

Based on the above conditions and the tariff of LLN, the unit price of power is calculated as follows.

No.	Item	Unit	Case A	Case B
1	Max. power demand	KW	13,800	22,300
2	Unit power consumption	KW/t-cement	118	116
3	Annual cement production	10^3 t/y	666	1,080
4	Annual power consumption	10^6 KWH/y	78.6	125.3
5	Demand charge	10^3 M\$/y	1,900	3,000
6	Energy charge	10^3 M\$/y	13,400	21,300
7	Total charge	10^3 M\$/y	15,300	24,300
8	Unit price	M$/KWH	0.20	0.20
9	Unit power cost	M$/t-cement	23.6	23.2

V-4-2-2 Water

As each plant site is situated near the source of river water, i.e. Tanah Merah to Kelantan river, Gua Musang to Ketil river, industrial water is available from river or ground water.
Drinking water is supplied by JKR to all sites.
The following are estimated requirements of water in the case of one-way use – not recirculating –.

Case	A	B
Industrial water t/h	250	410
Drinking water t/d	31	35

V-4-2-3 Labour

The population of the cities relating to the plant site at present are as follows:

Tanah Merah	about	70,000
Gua Musang	about	5,000

If the project is established in Gua Musang, it may encounter difficulties in securing locally adequate labor force. The project may require to recruit them from the other places including skilled workers and engineers.

V-5 Process and Fuel Study

V-5-1 Process study

Major factors for the selection of the most suitable cement manufacturing process are as follows.

(1) Moisture and plasticity of raw materials available
(2) Composition of raw materials (trace elements)
(3) Heat consumption (burnability)
(4) Fuel costs
(5) Investment and production cost
(6) Special requirements for clinker

Comparison of various cement manufacturing processes is shown in Table V-5-1 with the expected performance data. Judging from Table V-5-1, the SP and NSP kiln processes are superior to the other processes from the view point of fuel consumption, operation and maintenance. In addition, based on analysis of raw materials, the alkaline and chlorine content are so little that it is possible to adopt SP and NPS kiln process in this study.

The differences between SP and NSP are mainly explained by the kiln design. Heat duty of the kiln in the NSP process is decreased by means of an additional firing at the calciner. This merit becomes bigger at the case of large capacity such as Case B in saving refractory maintenance and reducing electricity consumption due to the smaller size of kiln relatively. In Case A, the capacity is in a permissible range of standard SP process in any aspects and it is expected to be able to operate the plant easily.

At the early stage of cement industry, batch type shaft kilns were originally used for manufacturing cement. But as soon as the rotary kiln was once introduced into the cement industry, these type of kiln disappeared from the cement industries.

German companies – Polysius and Loesche – have once manufactured the newly designed shaft kiln and these kilns have been used widly in Europe, especially in Germany.

Nowadays shaft kilns have been completly driven out from the market on account of it's small capacity, it's system not being able to produce the high quality of cement, requirement of good quality of coke or anthracite and requirement of good pelletizability of raw material.

Table V-5-1 Comparison of Various Kiln System

Type of kiln process	Wet Kiln Process	Semi-Wet Kiln Process	Lepol Kiln Process	SP Kiln Process	NSP Kiln Process
Kiln dimension 1,500 T/D 2,000 T/D 2,500 T/D 3,300L/D	$4.8^{m\phi} \times 170^{mL}$ $5.3^{m\phi} \times 186^{mL}$ $5.7^{m\phi} \times 200^{mL}$ $6.3^{m\phi} \times 220^{mL}$ 30 – 40	$4.8^{m\phi} \times 156^{mL}$ $5.3^{m\phi} \times 170^{mL}$ $5.7^{m\phi} \times 184^{mL}$ $6.3^{m\phi} \times 200^{mL}$ 30 – 35	$4.2^{m\phi} \times 72^{mL}$ $4.6^{m\phi} \times 80^{mL}$ $5.0^{m\phi} \times 85^{mL}$ $5.5^{m\phi} \times 90^{mL}$ 15 – 17.5	$4.3^{m\phi} \times 68^{mL}$ $4.7^{m\phi} \times 76^{mL}$ $5.1^{m\phi} \times 81^{mL}$ $5.6^{m\phi} \times 90^{mL}$ 15 – 17	$3.4^{m\phi} \times 54^{mL}$ $3.8^{m\phi} \times 60^{mL}$ $4.1^{m\phi} \times 65^{mL}$ $4.5^{m\phi} \times 70^{mL}$ 15 – 17
Heat consumption (Lower calorific value)	1,350 – 1,500 Kcal/Kgcl'	1,300 – 1,450 Kcal/Kgcl'	900 – 1,000 Kcal/Kgcl'	750 – 850 Kcal/Kgcl'	750 – 850 Kcal/Kgcl'
Specific output	about 18 – 22 Kgcl'/m³hr.	about 20 – 24 Kgcl'/m³hr.	about 60 – 70 Kgcl'/m³hr.	about 60 – 70 Kgcl'/m³hr.	about 115 – 130 Kgcl'/m³hr.
Water contents of raw material	32 – 35% Slurry	20% Cake	20% Pellet	Less than 0.5% Powder	Less than 0.5% Powder
Kiln waste heat gas temperature	180 – 220°C	400 – 600°C	100 – 250°C	320 – 350°C	330 – 360°C
Treatment of waste gas	The gas is fed directly to electrostatic precipitator. (High temperature range)	The gas is utilized for waste heat boiler and other heat exchanger. And then it is fed to electrostatic precipitator.	The gas is fed to electrostatic precipitator.	The gas is utilized for dryer or raw material grinding mill and then it is fed to electrostatic precipitator.	The gas is utilized for dryer or raw material grinding mill and then it is fed to electrostatic precipitator.
Technical comment	The productive efficiency is the lowest among prevailing kiln process, that is, fuel consumption is very high and specific output is the lowest.	The water content of 35–40 % in slurry is reduced to 20% in cake, by means of the vacuum type filter, and then fuel consumption also is reduced, but temperature of the waste gas from the kiln is raised. The heat exchanger is required before the waste gas is fed into electrostatic precipitator.	The pelletized raw material is preheated and precalcined while passing through Lepol movable grate. Fuel consumption is reduced and temperature of the waste gas from kiln is also lowered. But the operation of lepol is very difficult and the maintenance cost is high. In addition, if the plastic clay is not available for raw materials, this Lepol system can not be adopted.	The dry powdered raw material is preheated and about 50% of decarbonization is achieved by suspension preheater. At the movable parts are not integrated in suspension preheaters, the operation and maintenance are very easy. The productive efficiency is very high and then the cement manufacturing cost is very low. The operation is easier than that of NSP kiln because SP kiln does not have precalciner with burner.	The dry powdered raw material is preheated about 80–95% of decarbonization is achieved by new suspension preheater. As the preheater is equipped with precalciner, the ratio of decarbonization is very high and then specific output is the highest.

V-5-2 Fuel study

In order to select the most suitable fuel for the project, heavey oil, coal and natural gas are studied as follows.

V-5-2-1 Heavy oil

Heavey oil is now used for all existing cement manufacturers in Malaysia. The control price of government is now at M$585 per ton F.O.R., quite expensive compared with coal. Therefore, all existing cement manufacturers are planning or under construction to convert from heavy oil to coal.
Typical analysis and physical properties of heavy oil are shown in Table V-5-2.

Table V-5-2 Typical analysis and physical properties of heavy oil

Item		Figure
Specific gravity	60°F	0.963
Viscosity, kinetic	50°C Cst	281
	R.I. 100°F Sec	2,500
Flash point (closed cup)	°F	174
Water content	% Vol	< 0.05
Ash content	% Wt	0.018
Gross calorific value	kcal/kg	10,140
Ultimate analisis		
Carbon	%	85.5
Hydrogen	%	10.3
Sulphur	%	3.7
Oxygen		Trace

source : Associated Pan Malaysia Cement Sdn. Bhd.

V-5-2-2 Natural Gas

Natural gas will be produced in the offshore field about 200 km from the east coast of Trengganu, and it's reserve is estimated to be about 15 trillion standard cubic feet according to the PETRONAS report. Oil and associated gas pipeline is under construction and it will be completed in 1984.
Gas processing plant is planned to process 400 million cubic feet per day of natural gas from the offshore field by 1990 at Kerteh industrial area according to PETRONAS.
In Japan, prices of liquid natural gas are nearly equal to those of heavy oil on a per calorie basis. This means LNG is for more expensive than coal.
The typical gas composition is reported as follow by PETRONAS.

Natural Gas Composition

Component	Mol %
C_1	82
C_2	8
C_3	3
C_4	2
C_5^+	2
CO_2	2
N_2	1
Total	100

V-5-2-3 Coal

As for coal, there are some low-grade lignite deposits of the Miocene Epoch in Peninsular Malaysia, the largest of which occurs in Batu Arang (Selangor). They are not mined today.
In East Malaysia, coal occurs in the Silantek, Bintulu, Long Hill, Merit-Pila, Mukah-Balingian, Labuan and Silimpopon, out these coal mines are also closed.
(Annual Report, Geological Survey of Malaysia issued by Ministry of Primary Industries.)
Therefore, coal has to be imported mainly from Indonesia today.
There are two coal mines in Indonesia, the one is Ombilin in Sumatora whose capacity is 200,000 T/Y, and the other is Bukit Assam in Sumatra whose capacity is 300,000 T/Y.
Considering that the project requires coal of about 80,000~125,000 T/Y, coal mines in Indonesia mentioned above are too small in capacity to keep stable supply, even though they are less costly than Australian coal.
Typical analysis of Indonesian coals is shown in Table V-5-3.

Table V-5-3 Typical analysis of Indonesian coal

Item		Ombilin	Bukit Assam
Industrial analysis			
Moisture	%	4.5	5.8
Ash	%	1.9	0.3
Volatile matter	%	43.3	38.5
Fixed carbon	%	50.2	55.4
Gross calorific value	kcal/kg	7,862	7,540
Ultimate analysis			
Carbon	%	80.50	79.0
Hydrogen	%	5.85	5.8
Oxygen	%	11.56	–
Nitrogen	%	1.66	14.7
Sulphur	%	0.34	0.06~2.51

On the other hand, there are several large coal mines in Australia whose capacities are about 3~5 million tons per year.
It is said that even Australian mines can not afford to export coal to the newly emerging market in the immediate future, but they will no doubt have surplus capacities after 1985.
Therefore Australian coal is recommended as fuel for clinker burning for the project.
Fuel cost to be incurred when using Australian coal will be approx. M$22~25/t-cement, only 50% of approx. M$44~48/t-cement required when using heavy oil.

Securing a steady supply of coal, it is necessary to make long term supply contract with a coal supplier during 20 ~ 30 years.
For steady transporting of coal, marine transporting up to Port Kelang may select a exclusive forwarder and railway transporting from Port Kelang to the cement plant should be shuttle service by exclusive train.
Furthermore, absorbing fluctuation of offshore and onshore transporting, it is necessary to maintain open strageyard having about 10,000 ~ $20{,}000^{T}$ capacity in Port Kelang Harbor.

The following are the specifications of Hunter Valley coal, which is one of the typical Australian coal.

Source: Coal & Allied. Industries Ltd.

(a) Gross calorific value
  average 6,800 kcal/kg at air dry base
(b) Industrial analysis

Moisture	3.5%
Ash	13.5%
Volatile matter	34.0%
Fixed carbon	49.0%

(c) Chemical composition

Carbon	82.2%
Hydrogen	5.1%

Oxygen	10.5%
Nitrogen	1.8%
Sulphur	0.4%

(d) Chemical composition of coal ash

SiO_2	68.6
Al_2O_3	24.0
Fe_2O_3	2.7
CaO	0.7
MgO	0.6
SO_3	0.3
Na_2O	0.5
K_2O	1.1

(e) Size distribution

50 mm pass	100%
30 mm pass	94%
20 mm pass	70%
10 mm pass	35%
5 mm pass	22%
2.5 mm pass	14%

(f) Others

Hardgrove Index	55
Button No.	2 ~ 3
Total moisture at recieved	9.0%

V-6 Quality of Cement and Mixing Proportion of Raw Materials

V-6-1 Quality of cement

It is assumed in this study that the type of cement to be produced is ordinary portland cement, even though the raw materials in the Kelantan area are suitable for manufacturing not only ordinary portland cement but also rapid-hardering portland cement, low-heat portland cement and sulphate-resisting portland cement.
The quality of ordinary portland cement in this study is assumed to satisfy the following three quality requirements.

1. To satisfy the standards of ordinary portland cement in B.S and portland cement Type-I in ASTM.
2. To be equal or superior to the quality of cement produced in Malaysia at present.
3. To be able to export to the Southeast Asian market.

The result of chemical analysis and physical properties of ordinary portland cement tested in Japan and in Malaysia, and the representative standards of ordinary portland cement are shown in Table V-6-1 and Table V-6-2, respectively.

V-6-2 Mixing proportion of raw materials

(1) Moduli of cement
The moduli of cement should be determined by taking account of the quality of cement to be produced, the characteristics of raw materials to be used and the production cost, etc. The moduli in Table V-6-3 are one of the standard value for ordinary portland cement and are used as a basis for calculating the mixing ratio.

Table V-6-3 The Moduli of Ordinary Portland Cement

Modulus	Value	Formulae
Hydraulic modulus (H.M.)	2.10	$\frac{CaO}{SiO_2 + Al_2O_3 + Fe_2O_3}$
Silica modulus (S.M.)	2.60	$\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$
Iron modulus (I.M.)	1.80	$\frac{Al_2O_3}{Fe_2O_3}$

(2) Chemical composition of raw material
Average values of chemical composition of raw materials used in this calculation are shown in Table V-6-4.

Table V-6-1 Chemical Analysis of Ordinary Portland Cement made in Malaysia

			Chemical Composition (%)											Moduli of Cement				Mineral Composition (%)			
			L.O.I.	Insol.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Total	HM	SM	IM	LSD	C_3S	C_2S	C_3A	C_4AF
Malaysian Cement	A*1		1.38	0.23	20.97	5.82	3.36	63.50	2.50	1.85	0.01	0.05	99.67	2.06	2.28	1.73	0.916	49.9	22.6	9.7	10.2
	B*1		0.66	0.24	22.42	5.54	3.66	63.15	0.48	2.75	0.03	0.71	99.64	1.94	2.44	1.51	0.853	36.3	37.0	8.5	11.1
	C*2		1.1	0.4	20.1	5.7	4.0	65.0	1.4	2.2	–	–	99.9	2.13	2.07	1.43	0.966	61.6	11.2	8.3	12.2
	D*2		0.8	0.2	20.6	6.5	3.5	65.2	1.3	1.8	–	–	99.9	2.09	2.06	1.86	0.944	55.1	17.5	11.3	10.7
	E*2		0.7	0.1	21.8	6.1	3.4	65.1	0.9	1.6	–	–	99.7	2.04	2.29	1.79	0.907	48.9	25.6	10.4	10.3
Specification	BS12 (1978)	U.K	Max. 3.0*3 4.0*4	Max. 1.5					Max. 4.0	$C_3A \leqq 5$ Max. 2.5 $C_3A > 5$ Max 3.0							LSF*6 0.66~1.02				
	ASTMC150 (1980)	U.S.A.	Max. 3.0	Max. 0.75					Max. 6.0	$C_3A \leqq 8$ Max. 3.0 $C_3A > 8$ Max. 3.5											
	JIS R 5210 (1979)	Japan	Max. 3.0						Max. 5.0	Max. 3.0											
	DIN1164 (1970)	Germany	Max. 5.0						Max*5 5.0	Max. 3.5	Cl^- Max. 0.10	CO_2 Max. 2.5									

Note:
*1: Cement samples were received at Malaysia and tested at UBE Cement Factory in Japan – High L.O.I. is due to weathering –
*2: These tests were carried out in Japan by Cement Association of Japan and the results were published as technical report No.66-5-A.
*3: in temperate climates
*4: in tropical climates
*5: MgO in clinker
*6:

$$LSF = \frac{(CaO) - 0.7\,(SO_3)}{2.8\,(SiO_2) + 1.2\,(Al_2O_3) + 0.65\,(Fe_2O_3)}$$

Table V-6-2 Physical Properties of Ordinary Portland Cement made in Malaysia

		Specific Gravity	Fineness*			Softing Time*		Bending Strength (kgf/cm²)*			Compresive Strength (kgf/cm²)*		
			Specific Surface Area (cm²/g)	88 μR (%)	44 μR (%)	Initial Set (h – m)	Final Set (h – m)	3 days	7 days	28 days	3 days	7 days	28 days
Malaysian Cement	A	3.19	2850	8.9	25.3	2 – 15	2 – 56	*-2 22.0	*-2 33.0	*-2 60.0	76*-2 (22.3)	124*-2 (29.2)	310 (51.2)
	B	3.15	2890	5.2	23.6	2 – 56	3 – 49	28.0	42.0	64.1	98 (25.7)	176 (36.8)	344 (54.0)
	C	3.15	2920	4.0	–	1 – 50	2 – 36	26.9	38.2	65.4	107 (27.0)	167 (35.5)	341 (53.8)
	D	3.18	3400	1.6	–	1 – 40	2 – 34	25.0	35.6	61.4	99 (25.9)	150 (33.2)	318 (51.9)
	E	3.17	3100	5.8	–	2 – 50	3 – 46	23.9	38.9	63.6	93 (25.0)	167 (35.5)	368 (55.8)
Specification BS12 (1978)	U.K		Le Nurse Min. 2250			Min. 0 – 45	Max. 10 – 00				Min. *-1 23 MN/m²		Min. *-1 41MN/m²
ASTMC150 (1980)	U.S.A.		Air Permeability Min. 2800			Min. 0 – 45	Max. 8 – 00					Min. 1800 psi	Min. 2800 psi
JISR5210 (1979)	Japan		Blaine Min. 2500			Min. 1 – 00	Max. 10 – 00				Min. 70 kgf/cm²	Min. 150 kgf/cm²	Min. 300 kgf/cm²
DIN1164 (1970)	Germany					Min. 1 – 00	Max. 12 – 00					100 kp/cm²	250~450 kp/cm²

Note: * All tests were carried out in accordance with JIS R5201 so that test results are indicated based on JIS method.
*-1 Mortar method
( ): Compressive strength by JIS method converted to BS method using following equation. $Y = (-0.001545X^2 + 1.8561X + 94.9790) \times 0.09810$
Where Y; compressive strength by BS method (MN/m²) X; compressive strength by JIS method (kgf/cm²)
*-2 This sample shows low strength due to weathering considerably.

Table V-6-4 Chemical Composition of Raw Materials

Materials		Sample		Moisture (%)	Chemical Composition (wt. %)										P_2O_5* (ppm)	Cl'* (ppm)
					L.O.I	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Total		
Lime-stone	(1)	Gua Panjang	(C)	2.5	40.28	6.71	1.11	0.26	50.43	0.56	0.04	0.07	0.17	99.63	280	50
	(2)		(D)	2.5	43.24	1.02	0.25	0.06	54.65	0.49	0.07	0.01	0.03	99.82	200	40
Clay	(1)	Tanah Merah	West	14.6	5.93	70.50	14.91	7.04	0.28	0.05	0.04	0.09	1.14	99.98	320	35
	(2)		North	26.4	13.76	40.86	27.68	16.50	0.28	0.25	0.03	0.13	0.50	99.99	600	58
	(3)	Gua Musang	South	17.5	7.06	62.04	20.57	6.22	0.35	0.40	0.02	0.22	3.10	99.98	340	19
Silica Sand		S. Kelantan		2.9	0.51	90.41	4.70	0.62	0.38	0.00	0.00	0.60	2.76	99.98	200	50
Iron Ore		Bt. Lata		–	11.43	11.40	12.99	61.20	0.63	0.76	0.12	0.12	1.21	99.86	6350	23
Coal Ash		Australia	Hunter Valley Coal	–	–	68.6	24.0	2.7	0.7	0.6	0.3	0.5	1.1	98.5	–	–

* dry basis

(3) Mixing proportion of raw materials

The mixing proportion of raw materials based on dry basis for each case is shown in Table V-6-5.

The chemical composition of raw meal is shown in Table V-6-6.

The chemical composition and mineral composition of clinker are shown in Table V-6-7 and Table V-6-8, respectively.

Table V-6-5 Mixing Proportion of Raw Materials

Plant site			Tanah Merah	Gua Musang
Limestone	Gua Panjang	(C)	–	41.23
		(D)	79.60	41.23
Clay	Tanah Merah	West	17.92	–
		North	1.79	–
	Gua Musang		–	12.00
Silica Sand	S. Kalantan		–	3.72
Iron ore	Bt. Lata		0.69	1.82

(wt % in dry basis)

Table V-6-6 Chemical Composition of Raw Meal

Plant Site		Tanah Merah	Gua Musang
Chemical Composition (wt % in dry basis)	L.O.I	35.81	35.51
	SiO_2	14.26	14.20
	Al_2O_3	3.46	3.44
	Fe_2O_3	2.03	2.02
	CaO	43.56	43.39
	MgO	0.41	0.49
	SO_3	0.06	0.05
	Na_2O	0.03	0.08
	K_2O	0.25	0.58
	Total	99.87	99.76
	P_2O_5 (ppm)	271	361
	CL (ppm)	39	42
Moduli of raw meal (Calculated)	H.M	2.20	2.21
	S.M	2.60	2.60
	I.M	1.70	1.71

Table V-6-7 Chemical Composition of Clinker

Plant Site		Tanah Merah	Gua Musang
Chemical Composition (wt % in dry basis)	SiO_3	22.78	22.78
	Al_2O_3	5.63	5.63
	Fe_2O_3	3.13	3.13
	CaO	66.45	66.45
	MgO	0.70	0.77
	Total	98.69	98.76
Moduli of Clinker (Caluculated)	H.M	2.10	2.10
	S.M	2.60	2.60
	I.M	1.80	1.80

Note: SO_3 content in clinker estimate 0.3%.

Table V-6-8 Mineral Composition of Clinker

Plant Site		Tanah Merah	Gua Musang
Mineral Component*-1 (wt + in dry basis)	C_3S	54.1	53.2
	C_2S	24.6	24.1
	C_3A	9.6	9.5
	C_4AF	9.5	9.4
L.S.F*-2		0.913	0.912

Note: *-1 ; Mineral component of clinker are calculated according to ASTM C150.
The symbols of each mineral stands for as follows.

C_3S (3Ca O. SiO_2) ; Tricalcium Silicate
C_2S (2CaO. SiO_2) ; Dicalcium Silicate
C_3A (3CaO. Al_2O_3) ; Tricalcium Aluminate
C_4AF (3CaO · Al_2O_3 · Fe_2O_3); Tetracalcium Aluminoferrite

*-2 ; L.S.F. (Lime Saturation Factor)
L.S.F. are calculated according to the equation stipulated in BS12.

In the above calculation, the quantity of coal ash to be mixed in clinker is calculated by neglecting the loss of raw meal.
Quality of coal, coal consumption and quantity of coal ash to be mixed are shown in Table V-6-9.

Table V-6-9 Quality of Coal

Total* Moisture (%)	Inherent Moisture (%)	Ash (%)	Volatile Matter (%)	Fixed Carbon (%)	Calorific Value (Kcal/kg)	Total Sulfur (%)
9.0	3.5	13.5	34.0	49.0	6,800	0.5

* As received

Heat Consumption of Clinker (Kcal/t Cl')	Coal Consumption of Clinker (t/t Cl')	Quantity of Ash to be mixed in 1t Clinker (t/t Cl')
760,000	0.112	0.0151
780,000	0.115	0.0155

In the actual operation, the mixing proportion of raw materials will be changed to much possible changes in the moisture and chemical composition of each raw material.

(5) Theoretical unit consumption of raw materials
Theoretical unit consumption of raw materials is calculated using the mixing proportion of raw materials and is shown in Table V-6-10.

Table V-6-10 Unit Consumption of Raw Materials (Theoretical Value)

Plant site			Tanah Merah			Gua Musang		
			Dry	Wet	Moisture %	Dry	Wet	Moisture %
Limestone	Gua Panjang	C				0.6314	0.6476	2.5
		D	1.2142	1.2453	2.5	0.6314	0.6476	2.5
Clay	Tanah Merah	West	0.2734	0.3201	14.6			
		North	0.0273	0.0371	26.4			
	Gua Musang					0.1839	0.2229	17.5
Silica sand	S. Kelantan					0.0569	0.0586	2.9
Iron ore	Bt. Lata		0.0105	0.0113	7.0	0.0279	0.0300	7.0
Coal ash			0.0155	0.0170	9.0	0.0151	0.0166	9.0
Total			1.5409 (1.5254)	1.6308 (1.6138)		1.5466 (1.5315)	1.6233 (1.6067)	

Figures in the blanket show the material consumption at kiln feed and don't include the coal ash.

(6) Actual unit consumption of raw materials

In the above theoretical calculation, the loss in process was neglected. Actual unit consumption of raw materials is calculated by taking account of the possible loss in process and is shown in Table V-6-11.

Table V-6-11 Unit Consumption of Raw Materials (Actual value)

Plant site			Tanah Merah			Gua Musang		
			Dry	Wet	Moisture %	Dry	Wet	Moisture %
Limestone	Gua Panjang	C				0.6440	0.6605	2.5
		D	1.2385	1.2703	2.5	0.6440	0.6605	2.5
Clay	Tanah Merah	West	0.2789	0.3266	14.6			
		North	0.0278	0.0378	26.4			
	Gua Musang					0.1876	0.2274	17.5
Silica sand	S. Kelantan					0.0580	0.0597	2.9
Iron ore	Bt. Lata		0.0107	0.0115	7.0	0.0285	0.0306	7.0
Coal ash			0.0155	0.0170	9.0	0.0151	0.0166	9.0
Total			1.5714 (1.5559)	1.6632 (1.6462)		1.5772 (1.5621)	1.6553 (1.6387)	

Figures in the blanket show the material consumption at kiln feed and don't include the coal ash.

V-7 Outline of Plant

V-7-1 Capacity of main equipment and storage

Design Basis for the proposed plant is fixed as follows.

(1) Raw material and utilities to be required

	Case A	Case B
Clinkerization factor :		
Raw material/clinker	1,556	1,562
Raw material composition :		
Limestone	79.6%	82.5%
Clay	17.9%	12.0%
Silicious material	1.8%	3.7%
Iron ore	0.7%	1.8%
Additives :		
Gypsum	0.0486 t/t cement	
Fuel :		
Heat consumption (kcal/kg clinker)	780	760
Calorific value (kcal/kg coal)	6,800	
Coal consumption (kg coal/kg clinker)	0.117	0.114
Raw material and additive to be required :	Table V-7-1	Table V-7-2

Table V-7-1 Raw Material and Additive to be required (Case A)

Material	t/y (dry)	t/week (dry)	Moisture content % (wet)
Raw meal	987,000	21,790	0.5
Limestone	785,600	17,340	2.5
Clay	176,700	3,900	14.6
Silicious material	17,800	400	26.4
Iron ore	6,900	150	7.0
Gypsum	32,400	680	3.0
Coal	74,200	1,640	9.0

Table V-7-2 Raw Material and Additive to be required (Case B)

Material	t/y (dry)	t/week (dry)	Moisture content % (wet)
Raw meal	1,606,700	36,110	0.5
Limestone	1,325,500	29,790	2.5
Clay	192,800	4,330	17.5
Silicious material	59,500	1,340	2.9
Iron ore	28,900	650	7.0
Gypsum	52,500	1,100	3.0
Coal	117,300	2,640	9.0

(2) Operating hours

The following operating hours per day, days per week and operating hours per week have been considered.

Table V-7-3 Operating Hours

Department	Hours/Day	Days/Week	Hours/Week	Weeks/Year	
				Case A	Case B
Limestone crusher	8	6	48	52	52
Material receiving	8	7	56	52	52
Raw mill	20	7	140	45.3	44.5
Kiln	24	7	168	45.3	44.5
Coal mill	22	7	154	45.3	44.5
Cement mill	20	7	140	48	48
Packing and dispatch	8	6	48	52	52

(3) Capacity of main equipment

The nominal capacity of each main equipment is calculated based on the consideration described previously.

1) Limestone crusher

		Case A	Case B
Material to be crushed per week	:	17,340t	29,790t
Operating hours per week	:	48	48
Safety factor	:	1.1	1.1
Moisture	:	2.5%	2.5%
Capacity	:	408 t/h	697 t/h
Nominal capacity	:	410 t/h	700 t/h

2) Raw mill

Material to be ground per week	:	21,790t	36,110t
Operating hours per week	:	140 h	140 h
Safety factor	:	1.08	1.08
Capacity	:	168 t/h	279 t/h
Nominal capacity	:	170 t/h	140 t/h x 2 sets

3) Kiln

Nominal capacity	:	2,000 t/d	3,300 t/d

4) Coal mill

Material to be ground per week	:	1,640t	2,640t
Operating hours per week	:	154 h	154 h
Safety factor	:	1.1	1.1
Capacity	:	11.7 t/h	18.9 t/h
Nominal capacity	:	12 t/h	19 t/h

5) Cement mill

Material to be ground per week	:	13,875t	22,500t
Operating hours per week	:	140 h	140 h
Safety factor	:	1.2	1.2
Capacity	:	119 t/h	193 t/h
Nominal capacity	:	120 t/h	100 t/h x 2 sets

6) Packer

Material to be packed per week	:	12,810t	20,770t
Operating hours per week	:	48 h	48 h
Safety factor	:	1.1	1.1
Capacity	:	294 t/h	476 t/h
Nominal capacity	:	100 t/h x 3 sets	100 t/h x 5 sets

(4) Capacity of storages

1) Crushed limestone storage

		Case A	Case B
Required reserves	:	10 days of nominal kiln operation	
Storage capacity (wet material)	:	2 x 13,000t	2 x 22,000t

2) Crushed clay/Silicious material/Iron ore storage

		Case A	Case B
Required reserves	:	10 days of nominal kiln operation	
Storage capacity (wet material)	:		
Clay		6,600t	7,600t
Silicious material (slica rich clay)	:	800t	2,000t
Iron ore	:	250t	1,100t

3) Raw meal storage/Blending silo

		Case A	Case B
Required reserves	:		
Storage silo		2.5 days of nominal kiln operation	
Blending silo	:	12 hours of nominal kiln operation	
Storage capacity (dry material)	:		
Storage silo		7,780t	12,900t
Blending silo		1,600t	2,600t

4) Coal/Gypsum storage

		Case A	Case B
Required reserves	:	20 days of nominal kiln operation	
Storage capacity	:		
Coal		4,700t	7,600t
Gypsum		2,000t	3,300t

5) Clinker silo

		Case A	Case B
Required reserves	:	10 days of nominal kiln operation	
Storage capacity	:	20,000t	33,000t

6) Cement silo

		Case A	Case B
Required reserves	:	5 days of nominal kiln operation	
Storage capacity	:	2 x 5,500t	3 x 6,000t

V-7-2 Plant description

(1) Process description

The following drawings are prepared for this project.

Fig. V-7-1 Layout at Tanah Merah (Case A)
Fig. V-7-2 Layout at Gua Musang (Case B)
Fig. V-7-3 Flow diagram at Tanah Merah (Case A)
Fig. V-7-4 Flow diagram at Gua Musang (Case B)
Fig. V-7-5 Typical side view of kiln plant
Fig. V-7-6 Single line diagram at Tanah Merah (Case A)
Fig. V-7-7 Single line diagram at Gua Musang (Case B)

a) Limestone crusher

For both cases limestone crushing plant will be located at Gua Panjan limestone quarry. Limestone will be quarried and hauled to the crusher by dump trucks. It will then be discharged into hopper and from which it is fed to the crusher by means of an inclined steel apron conveyor.

Two stage crushing system is provided for reduction of the quarried limestone to meet the requirements of the raw mill feed. The primary crusher is Jaw type with a capacity of 400 tph in case A, 700 tph in case B and the secondary crusher is impact type with the same capacity of primary one. The crushed limestone in case A will be carried by belt conveyor and piled in a stock yard. The limestone withdrawn beneath the stockpile will be transported to a rail loading station.

In case B, crushed limestone will be sent to the cement plant site directly by an about 1,000 m long distance conveyor.

b) Raw material handling and storage

– Limestone

Case A

Limestone will arrive by rail and be unloaded directly into receiving hopper. The discharged limestone from the hopper will be carried by a belt conveyor to a covered storage and preblending hass with capacities of 2 x 13,000 t (10 days of nominal kiln operation)

The preblending equipment consists of overhead travelling belt coveyor – Tripper conveyor – and bridge type reclaimer.

Case B

Limestone will be carried by a belt conveyor over a distance of about 1,000 m from quarry to a covered storage and preblending hall, which has capacities of 2 x 22,000 t (10 days of nominal kiln operation)

The preblending equipment consists of the same ones as the Case A.

– Clay

Clay will arrive by truck and dumped directly into receiving hopper. The discharged clay from hopper will be carried by a belt conveyor to a covered storage with capacities of 6,600t and 800t for case A – 800t is for silica rich clay – and 7,600t for case B (10 days of nominal kiln operation)

– Other materials

Other materials, iron ore in case A, will arrive at the plant site by commercial trucks, and silica sand and iron ore in case B by rail. These materials will be unloaded into the clay receiving system and transported by the same conveyor system to the covered storage hall.

c) Extraction and transportation of reclaimed material

Limestone will be reclaimed by reclaimer and conveyed to a mill feed bin. Clay will be withdrawn underneath the clay stockpile as needed by means of feeders and transported to a mill feed bin.

Other materials, iron ore and/or silica sand, will be withdrawn underneath the material stockpile by each feeder and transported by the same conveyor system to the mill feed bins.

The bins are equipped with weigh feeders for doesing the raw material to the raw mill.

d) Raw material drying and grinding

The raw materials will be extracted from the respective bin by means of constant weigh feeders in proportion to the raw material mixing ratio and collected onto a belt conveyor led to the raw mill. In case B, material collected onto a conveyor will be carried to another two mill feed bins installed in front of each of two raw mills. At the bottom of each feed bin, a weigh feeder will be provided to feed the material in a correct portion into each raw mill.

The raw material mix will be ground by a roller mill which is capable of handling a large quantity of hot gas. Mill capacity is 170 tph in case A, 140 tph each in case B. Kiln exhaust gas will be used as hot gas for drying of raw material. An auxiliary hot gas furnance will provide the hot air during start-up of the kiln.

The raw mix will be fed via tripple airlock damper into the middle of mill table which rotates on its center axis. Material on the table moves by centrifugal force into the direction of the rim of the table and is ground between rollers and a mill table.

A large quantity of hot gas introduced from kiln into mill will dry and blow the ground material to a separator which is installed on the top of the mill. Coarse materials separated there will return to the mill. Fine materials transported by the gas stream will be separated in cyclones as finished products and dedusted gas will be sent to electrostatic precipitator, where it is cleared in such a level that air pollution laws allows. Electrical precipitator will also be used to clean the gas by-passing the mill when it's stopped.

The raw mill product, together with dust recovered in the electrostatic precipitator, will be delivered by a bucket elevator via airslides and chain conveyor to a blending silo standing above the storage silo.

e) Raw meal homogenizing and storage

Raw meal will be homogenized in a blending silo operating according to a continuous airmarge blending system.

The silo bottom is covered with porous blending units which is divided in several radial sections. Each of these sections is activated in a programmed sequence as the blending section while the others serve as aeration sections. The difference of the material density between blending section and aeration sections creates the active internal circulation and a continuous blending of the raw material.

The homogenized raw meal overflown from blending silo will be fed into two storage silos by gravity force. The raw meal will be discharged from each storage silo through regulating valves in proportion to the silo's storage capacity and will be transported to kiln feed bin by means of a bucket elevator.

f) Kiln and burning

The raw meal discharged from kiln feed bin by means of regulation valve will be weighted by enclosed rubber belt conveyor type weigher and will be fed to the kiln via on bucket elevator.

For case A, four stage preheater is provided for heating up the raw meal in counter flow of kiln exhaust gases.

For case B, four stage preheater with precalciner is provided for the same purpose as in case A. This system contributes the decrease of kiln size and the consumption of refractory and it gives a lot of adventages against the conventional SP from the economical point of view. Clinkerization will take place in a rotary kiln of capacity of 2,000 t of clinker per day in case A, of 3,300 t of clinker per day in case B.

The hot clinker leaving the rotary kiln will be cooled in a grate cooler. The kiln will be fired with coal. Light fuel oil will be required during the warming up phase. Kiln exhaust gas will be cooled down in a conditioning tower and dedusted in an electrostatic procipitator when the raw mill stops.

g) Coal grinding and handling

Coal will be arrived by rail and unloaded directly into receiving hopper. The discharged coal from the hopper will be carried by a belt conveyor to a covered storage with capacity of 4,700 t in case A, of 7,600 t in case B respectively and will be stacked by a stacker conveyor in circle. The coal will be reclaimed from the stockpile by means of bridge scraper type reclaimer onto a belt conveyor via discharged hopper of the conical bunker underneath the center column and conveyed to a mill feed bin.

The roller mill with a capacity of 12 tph in case A, 19 tph in case B will be provided to grind the coal to suitable grain size. The product which is carried away from the mill with air stream passes through a separator and a bag filter, and conveyed to a pulverized coal bin. The coal will also be dried in the same mill using part of the cooler exhaust gas or auxiliary hot gas furnace.

h) Clinker and gypsum handling and storage

The clinker leaving the grate cooler will be conveyed by a pan conveyor to a clinker silo with capacity 20,000 t in case A and capacity 33,000 t in case B, where a two way chute will be provided to make it possible to discharge the unburnt clinker to the outside of the clinker silo.

Gypsum will be arrived by rail and unloaded directly into receiving hopper. The discharged gypsum from the hopper will be carried by the same conveyor as the coal is. Gypsum covered storage has a capacity 2,000 t in case A, 3,300 t in case B. The gypsum will be reclaimed from the stockpile by means of feeders and conveyed to a mill feed bin.

i) Extraction and transportation of clinker

The clinker fed onto a pan conveyor from clinker silo by means of clinker feeders will be transported to a mill feed bin. The bin is equipped with weigh feeders for dosing the material into the cement mill.

j) Clinker grinding

The materials extracted from the respective bin by means of constant feed weighers in the correct portion onto a belt coneyor led to the cement mill. The materials will be ground by the two compartment tube mill working in closed circuit system. Ground materials left from tube mill will be fed to the airseparator

via a bucket elevator, and separated into two products.
One is coarse and the other is fine. The former will return again into cement mill via airslides and latter will be collected as finished products onto airslides connected to pneumatic pumps.
The mill and the airseparator will be ventilated by a suction fan. The fine particles with the air stream will be collected in the bag filter and fed onto product's conveying airslides.
The products will be transported pneumatically through pipelines into cement silos. The used air for conveying the products will be cleaned in the bag filter installed on the silo.

k) Packing and shipping

The cement discharged from silos will be conveyed to packer bins via bucket elevators. Rotary type packer with 8 spouts will be provided and working at the rate of 2,000 – 2,200 bags per hour. All cement will be packed in 50 kg bags and delivered to the truck and rail loading stations.

(2) Electrical equipment

a) Power supply

Case A

Power will be supplied from Tanah Merah power station to the factory through a double system 33 KV overhead-line system. Sufficient capacity shall be prepared for future extension.

Case B

The power will be supplied from local power station connected a 132KV power line which will be expected to be completed in 1986. A double system overhead-line will be installed between power station and the factory.

b) Power distribution

The main substation will be located in the center of the plant. The power fed from Tanah Merah power station or local station at the Gua Musang will be stepped down from 33 KV to 6.6 KV by two transformers with a capacity of 18,000 KVA in case A, 29,000 KVA in case B at this substation.
This 6.6 KV power line is distributed to the different transformer stations which are located in the different load center of the plant.
This 6.6 KV high tension power will be used for driving high tension motor while for low tension motor it will be further stepped down to 380 V at the transformer stations.
The transformer station comprises 6.6 KV cubicles, 6.6 KV/380 V step down transformers, low voltage circuit breakers and motor control centers, etc.

c) Control and instrumentation

The plant will also have all necessary instruments to control the process and to modulate any variation for the sake of maintaining uniformity and consistency in the process line.
Central control console, instrumentation and control equipment for this plant will be centralized in the center control room. The operator will intervene in the

process from this center control room and the most important process variables will be displayed and signalled here. For packing and shipping process, another control room will be provided at the packing house.
Computer will be provided for final raw meal control. Data supplied by the on-line analyzer will be introduced into computer and, adjustment information of raw material mixing will be pulsed out by the computer to all feeder set point stations.

(3) Civil work

a) Plant site development

The plant site will be developed to uniform plane so as to accommodate all equipment at appropriate place in the plant.
The site preparation will be done so that a minimum amount of earth-moving is necessary. A separate storm water system is required to cope with the frequent heavy rainfalls. All these engineering, development's works shall be executed by the authority, SEDC. The road inside the plant will be paved as shown in the layout. The boundary of the plant will be fenced.

b) Structure and Building

1.) Preblending/Raw material storage

Covered storage hall for all the materials and coal will be a steel framed structure with asbestos or corrugated galvanized iron sheeting.

2.) Buildings of raw mill, cement mill and coal mill

The building will be steel framed and partially a reinforced concrete framed structure with overhead crane's girder. The mill foundations will be suitably designed and isolated from the main structure.

3.) Blending and storage silo, Cement silo

The silos will be reinforced concrete structure using the slip-form technique. The ceiling of these silos will be steel framed structure.

4.) Preheater tower

This will be steel framed structure.

5.) Kiln and drive foundation

Each separated foundation will be of either solid or hollow type concrete construction.

6.) Burner platform

This building will be of one-story reinforced concrete construction covered with steel framed roof. Under the burner platform, cooler foundation will be installed. This foundation will be suitably designed to support the cooler.

7.) Clinker silo

The foundation up to the silo buttom will be reinforced concrete. The silo wall and top will be steel.

8.) Packing house

This building will be a steel framed structure with ashestos or corrugated galver-nized iron sheeting.

9.) Auxiliary Building

These will included the main substation, work shop, office, control room and laboratory, truck-weigh bridge house, gate house and warehouse. Most of these buildings will be constructed using concrete blocks.

(4) Utilities

a) Cooling water system

The total amount of water to be required for the cement plant is estimated to some 700 m^3/day in case A, 1100 m^3/day in case B. The required quantity of water can be taken from Kelantan river in case A, from Ketil river in case B. However, above mentioned water will require the water treatment. Closed cooling water circulation system shall be applied to these plants so as to minimize the cooling water consumption.

b) Compressed air system

A suitable numbers of air compressor will be provided to meet the following requirement:

- industrial air for pneumatic operation valves in the process line, pneumatic tools, etc.
- instrumentation air free of moisture and oil

Compressors will be located in the individual plant sections to minimize the line losses.

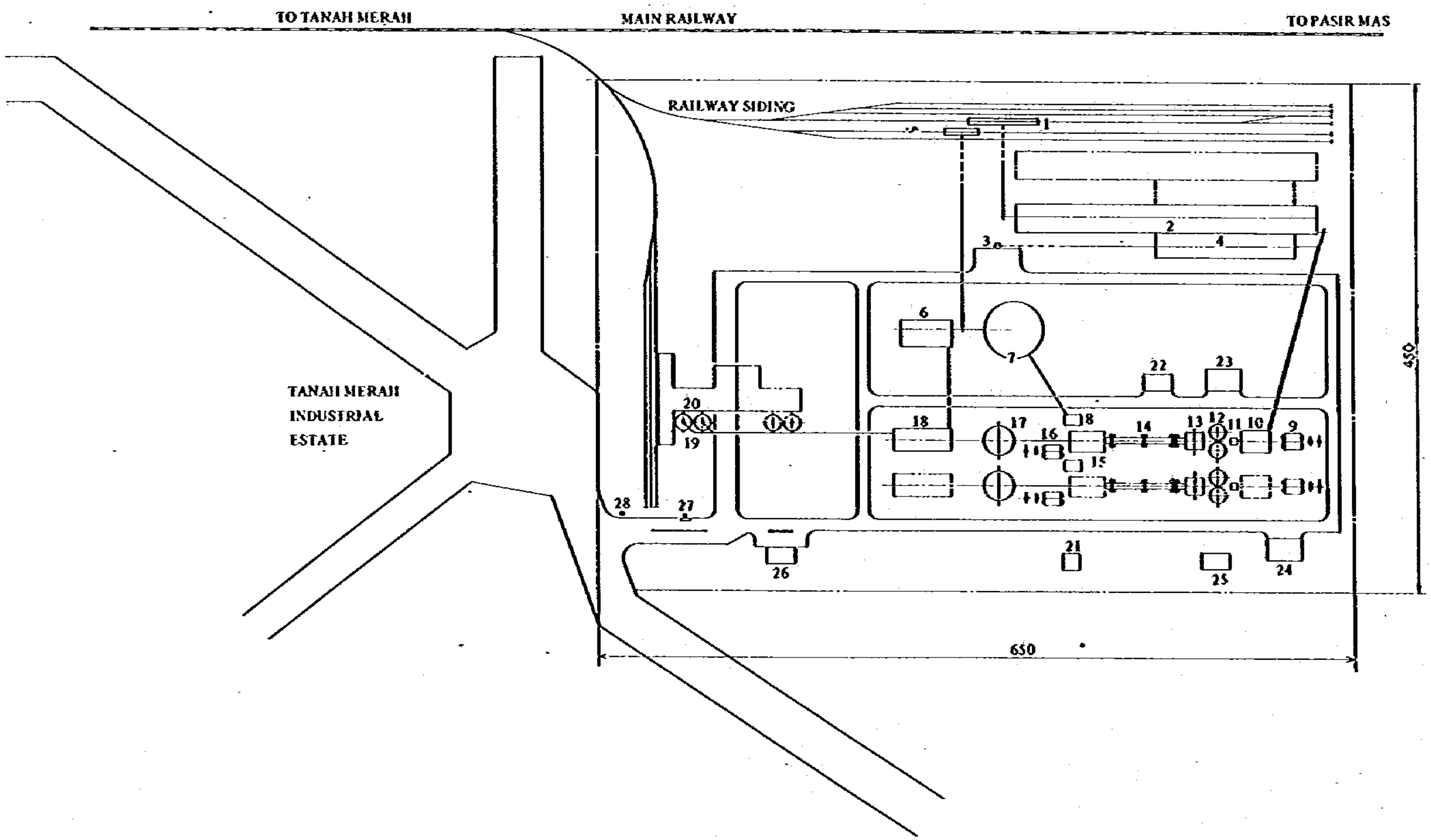
(5) Laboratory

The laboratory will be located in the center of plant adjoining to the center control room and will have the facilities for both physical and chemical testing.

X-ray-analyzer will be provided to analize the material at receiving points, raw mill feed-out and storage feed-out point.

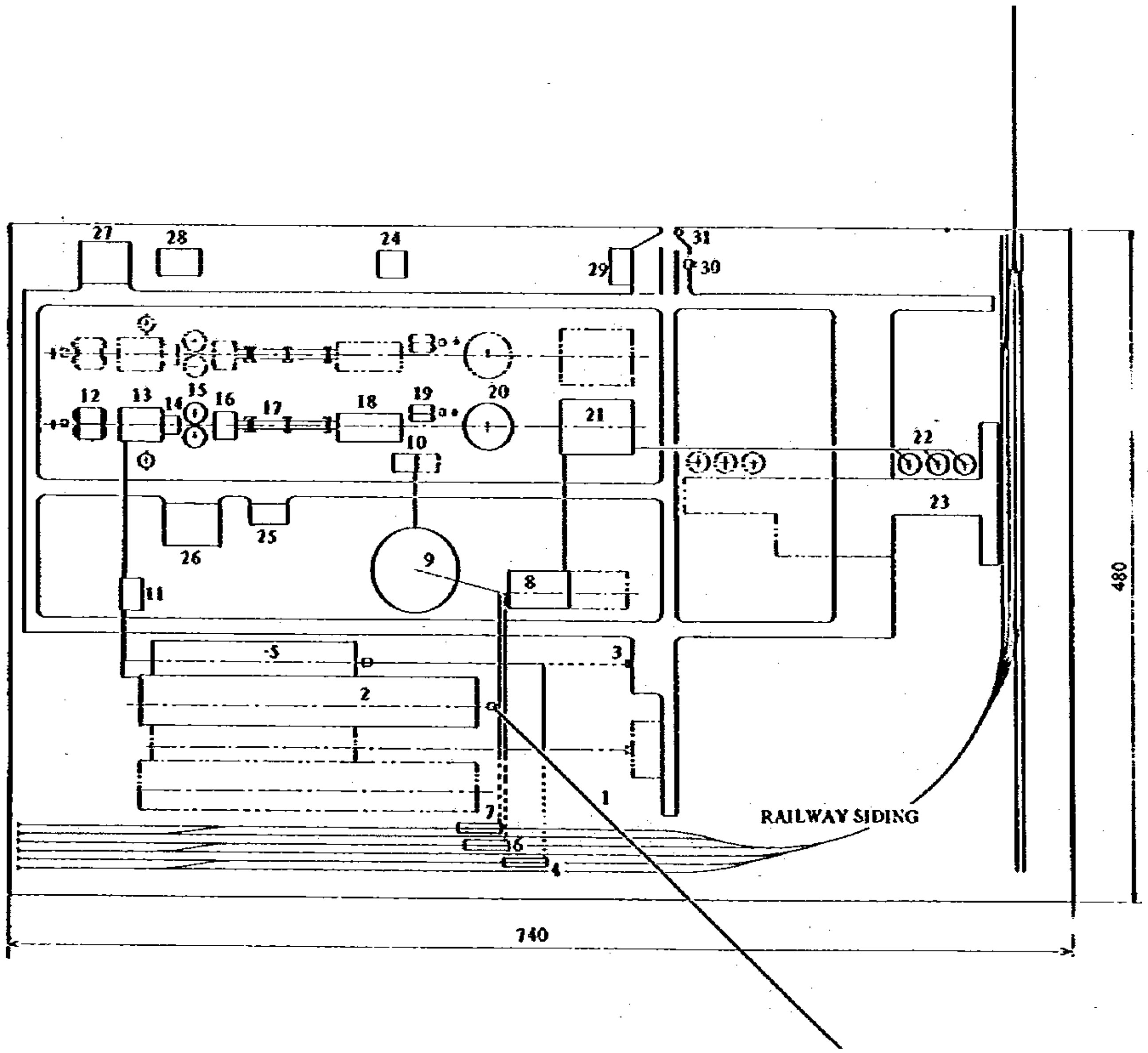
Sampling for raw mill and storage feed-out point will be executed automatically and for receiving point will be done manually.

Fig. V-7-1 Plant Layout-Case A



1. LIMESTONE RECEPTION HOPPER
2. LIMESTONE PREBLENDING SHED
3. CLAY/IRON SOURCE RECEPTION HOPPER
4. CLAY/IRON SOURCE STORAGE SHED
5. COAL/GYPSUM RECEPTION HOPPER
6. GYPSUM STORAGE SHED
7. COAL STORAGE SHED
8. COAL MILL
9. ELECTROSTATIC PRECIPITATOR ROTARY KILN/RAW MILL
10. RAW MILL
11. CYCLONE
12. BLENDING AND STORAGE SILO
13. SUSPENSION PREHEATER
14. ROTARY KILN
15. BURNER PLATFORM/CLINKER COOLER
16. ELECTROSTATIC PRECIPITATOR CLINKER COOLER
17. CLINKER SILO
18. CEMENT MILL
19. CEMENT SILO
20. PACKER AND BAGGED CEMENT LOADING
21. SUBSTATION
22. CENTER CONTROL ROOM
23. WAREHOUSE
24. REPAIR SHOP
25. WATER RESERVOIR
26. OFFICE
27. TRUCK WEIGHBRIDGE
28. GATEHOUSE

Fig. V-7-2 Plant Layout-Case B



1. LIMESTONE RECEPTION BELT CONVEYOR
2. LIMESTONE PREBLENDING SHED
3. CLAY RECEPTION HOPPER
4. SILICA SOURCE/IRON SOURCE RECEPTION HOPPER
5. CLAY/SILICA SOURCE AND IRON SOURCE STORAGE SHED
6. GYPSUM RECEPTION HOPPER
7. COAL RECEPTION HOPPER
8. GYPSUM STORAGE SHED
9. COAL STORAGE SHED
10. COAL MILL
11. RAW MILL FEED BIN
12. ELECTROSTATIC PRECIPITATOR–ROTARY KILN/RAW MILL
13. RAW MILL
14. CYCLONE
15. BLENDING/STORAGE SILO
16. SUSPENSION PREHEATER WITH CALCINER
17. ROTARY KILN
18. BURNER PLATFORM/CLINKER COOLER
19. ELECTROSTATIC PRECIPITATOR–CLINKER COOLER
20. CLINKER SILO
21. CEMENT MILL
22. CEMENT SILO
23. PACKER AND BAGGED CEMENT LOADING
24. SUBSTATION
25. CENTER CONTROL ROOM
26. WAREHOUSE
27. REPAIR SHOP
28. WATER RESERVOIR
29. OFFICE
30. TRUCK WEIGHBRIDGE
31. GATEHOUSE

Fig. V-7-3 Flow Diagram at Tanah Merah-Case A

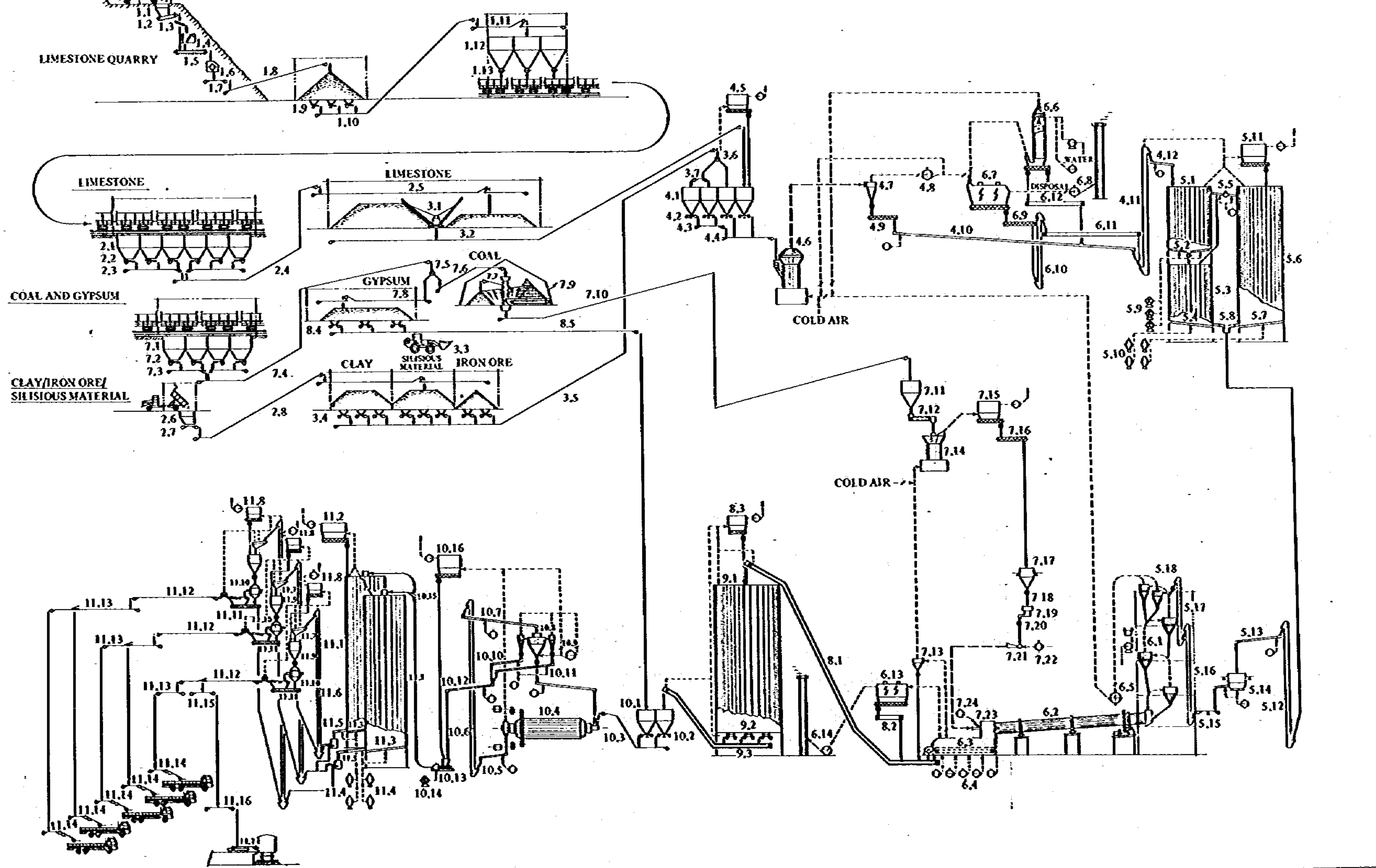


Fig. V-7-3

Item	Equipment
– Limestone crushing	
1.1	Limestone receiving hopper (200 t)
1.2	Apron conveyor
1.3	Grizzly
1.4	Primary crusher (Jaw type, 400 t/h)
1.5	Apron conveyor
1.6	Secondary crusher (Impact type, 400 t/h)
1.7	Belt conveyor
1.8	Piling conveyor
1.9	Extraction Feeders
1.10	Belt conveyor
1.11	Tripper conveyor
1.12	Crushed limestone bins
1.13	Rail loaders
– Raw material handling and storage	
2.1	Limestone receiving hopper (280 t)
2.2	Feeders
2.3	Belt conveyors
2.4	Belt conveyor
2.5	Limestone stacking conveyor (Tripper type, 400 t/h)
2.6	Clay/Iron ore / Silisious material receiving hopper
2.7	Feeder
2.8	Belt conveyor
2.9	Clay / Iron ore stacking conveyor (Tripper type)
– Extraction and transportation of reclaimed material	
3.1	Limestone reclaimer (Bridge scraper type, 200 t/h)
3.2	Belt conveyor
3.3	Front whell loader
3.4	Clay / Iron ore / Silisious material feeders
3.5	Belt conveyor
3.6	Two way chute
3.7	Belt conveyor
– Raw material drying and grinding	
4.1	Raw material bins (Limestone 200 t, Clay 200 t, Silicious material 70 t, Iron ore 50 t)
4.2	Constant feed weighers
4.3	Belt conveyor
4.4	Belt conveyor
4.5	Bag filter / Exhaust fan
4.6	Raw mill (Vertical roller mill, 170 t/h)
4.7	Cyclones
4.8	Mill fan (5,100 m^3/min, 1150 mm H_2O)
4.9	Screw conveyors
4.10	Air slide
4.11	Bucket elevator
4.12	Air slide
– Raw meal homogenizing and storage	
5.1	Blending silo (13.0 mφ, 1,600 t)
5.2	Blending units
5.3	Storage silo 1 (13.0 mφ, 2,480 t)
5.4	Aeration units
5.5	Overflow airslide
5.6	Storage silo 2 (13.0 mφ, 5,300 t)
5.7	Aeration units
5.8	Discharging unit
5.9	Air compressors for blending silo
5.10	Roots blowers
5.11	Bag filter / Exhaust fan
5.12	Bucket elevator
5.13	Airslide
5.14	Kiln feed bin (60 t)
5.15	Kiln feed weigher
5.16	Bucket elevator
5.17	Bucket elevator
5.18	Rotary valve
– Kiln and burning	
6.1	Suspension preheater
6.2	Rotary kiln (4.7 m dia. x 76 m length)
6.3	Clinker grate cooler (Grate area 64 m^2)
6.4	Cooler cooling fans
6.5	S.P fan (5,400 m^3/min. x 600 mm H_2O)
6.6	Conditioning tower
6.7	Electrostatic precipitator (5,500 m^3/min.)
6.8	B.P fan
6.9	Screw conveyor
6.10	Bucket elevator
6.11	Chain conveyor
6.12	Chain conveyor
6.13	Electrostatic precipitator (4,800 m^3/min.)
6.14	Exhaust fan

Item	Equipment
– Coal handling and grinding	
7.1	Coal / Gypsum receiving hopper (280 t)
7.2	Feeder
7.3	Belt conveyors
7.4	Belt conveyor
7.5	Two way chute
7.6	Belt conveyor
7.7	Coal stacking conveyor (Circular type)
7.8	Gypsum stacking conveyor (Tripper conveyor)
7.9	Coal reclaimer (Circular type, 20 t/h)
7.10	Belt conveyor
7.11	Coal bin
7.12	Chain feeder
7.13	Cyclone
7.14	Coal mill (Vertical roller mill, 12 t/h)
7.15	Bag filter / Exhaust fan (290 m^3/min.)
7.16	Screw conveyor
7.17	Pulverized coal bin (30 t)
7.18	Rotary feeder
7.19	Weight feeder
7.20	Rotary valve
7.21	Injector
7.22	Blower
7.23	Coal burner
7.24	Primary fan
– Clinker and gypsum handling and storage	
8.1	Pan conveyor
8.2	Screw conveyor
8.3	Bag filter / Exhaust fan
8.4	Gypsum feeder
8.5	Belt conveyor
– Extraction and transport of clinker	
9.1	Clinker silo (20,000 t)
9.2	Clinker feeders
9.3	Pan conveyor
– Clinker grinding	
10.1	Clinker / Gypsum bins (200 t, 100 t)
10.2	Constant feed weigher
10.3	Belt conveyor
10.4	Cement mill (Closed circuit, 120 t/h)
10.5	Airslide
10.6	Bucket elevator
10.7	Airslide
10.8	Air separator (Cyclone type)

Item	Equipment
10.9	Circulation fan
10.10	Airslides
10.11	Airslide
10.12	Airslide
10.13	Pneumatic pump
10.14	Air compressor
10.15	Two way valve
10.16	Bag filter / Exhaust fan
– Packing and shipping	
11.1	Cement siles (2 x5,500 t)
11.2	Bag filter
11.3	Aeration units
11.4	Roots blowers
11.5	Discharging units
11.6	Bucket elevators
11.7	Vibrating screens
11.8	Bag filters
11.9	Packer bins
11.10	Rotary packers
11.11	Screw conveyors
11.12	Belt conveyors
11.13	Belt conveyors
11.14	Truck loading conveyors
11.15	Belt conveyor
11.16	Belt conveyor
11.17	Rial loading conveyors

Fig. V-7-4 Flow Diagram at Gua Musang-Case B

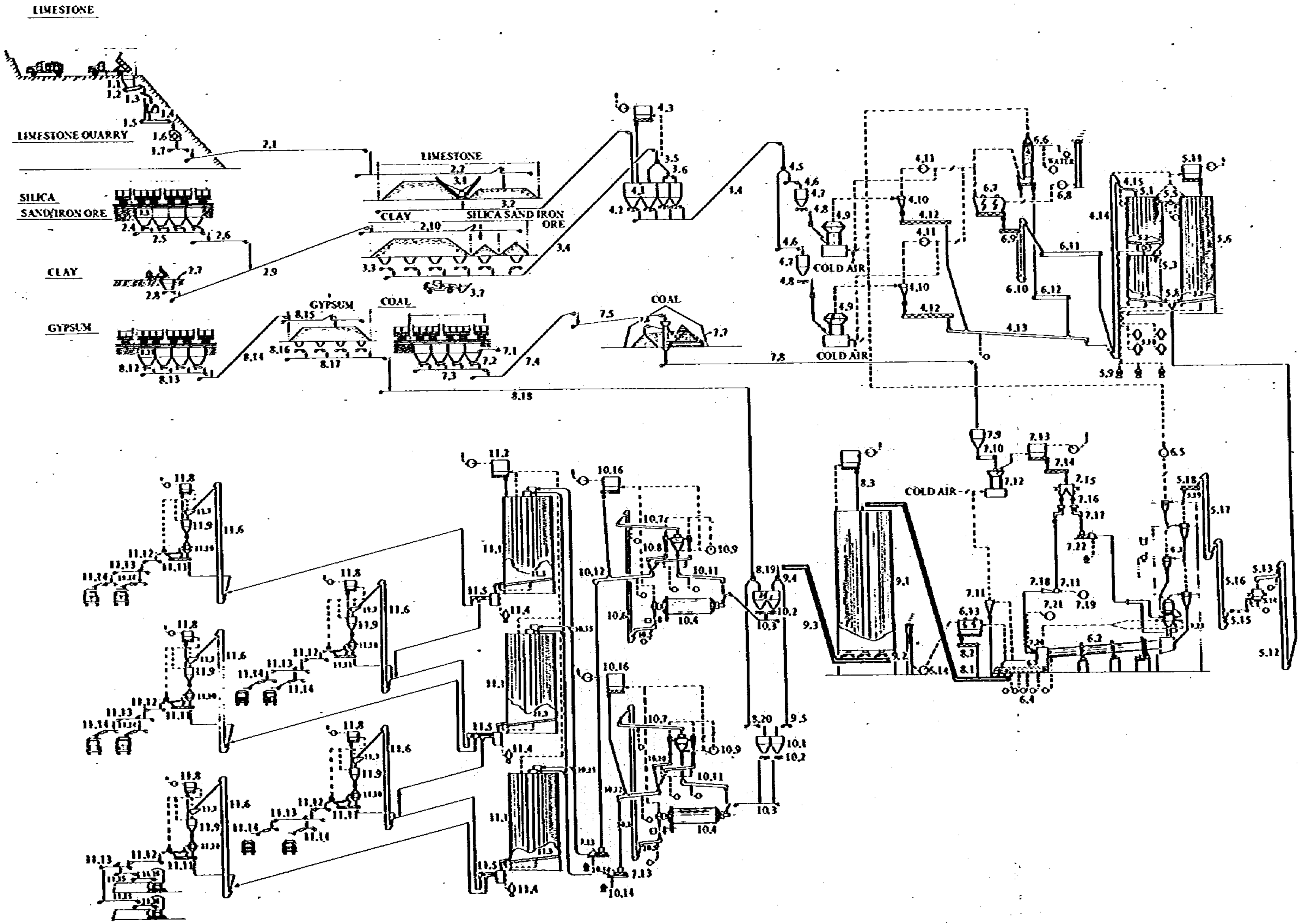


Fig. V-7-4

Item	Equipment
	– Limestone crushing
1.1	Limestone receiving hopper (200 t)
1.2	Apron conveyor
1.3	Grizzly
1.4	Primary crusher (Jaw type, 700 t/h)
1.5	Apron conveyor
1.6	Secondary crusher (Impact type, 700 t/h)
1.7	Belt conveyor
	– Raw material handling and storage
2.1	Long distance conveyor
2.2	Limestone stacking conveyor
2.3	Silica sand / Iron ore receiving hopper (280 t)
2.4	Feeders
2.5	Belt conveyor
2.6	Belt conveyor
2.7	Clay receiving hopper (100 t)
2.8	Feeder
2.9	Belt conveyor
2.10	Clay / Silica sand / Iron ore stacking conveyor (Tripper type)
	– Extraction and transportation of reclaimed material
3.1	Limestone reclaimer (Bridge scraper type, 400 t/h)
3.2	Belt conveyor
3.3	Feeders
3.4	Belt conveyor
3.5	Two way chute
3.6	Belt conveyor
3.7	Front wheel loader
	– Raw material drying and grinding
4.1	Raw material bins (Limestone 300 t, Clay 300 t, Silicious material 220 t, Iron ore 100 t)
4.2	Constant feed weighers
4.3	Bag filter / Exhaust fan
4.4	Belt conveyor
4.5	Two way chute
4.6	Belt conveyors
4.7	Raw mix feed bins (50 t)
4.8	Extraction feeders
4.9	Raw mills (Vertical roller mill, 2 x 140 t/h)
4.10	Cyclones
4.11	Mill fans (4,300 m^3/min x 1,100 mm H_2O)
4.12	Screw conveyors
4.13	Airslide
4.14	Bucket elevator
4.15	Airslide
	– Raw meal homogenizing and storage
5.1	Blending silo (15 mϕ, 2,600 t)
5.2	Blending units
5.3	Storage silo 1 (15 mϕ, 3,890 t)
5.4	Aeration units
5.5	Overflow airslide
5.6	Storage silo 2 (15 mϕ, 9,010 t)
5.7	Aeration units
5.8	Discharging unit
5.9	Air compressors for blending silo
5.10	Roots blowers
5.11	Bag filter / Exhaust fan
5.12	Bucket elevator
5.13	Airslide
5.14	Kiln feed bin (60 t)
5.15	Kiln feed weigher
5.16	Bucket elevation
5.17	Bucket elevator
5.18	Screw conveyor
5.19	Rotary valve
	– Kiln and burning
6.1	Suspension preheater with precalciner
6.2	Rotary kiln (4.5 m dia. x 70 m length)
6.3	Clinker grate cooler
6.4	Cooler cooling fans
6.5	S.P. fan (9,500 m^3/min x 600 mm H_2O)
6.6	Conditioning tower
6.7	Electrostatic precipitator (9,000 m^3/min.)
6.8	E.P. fan
6.9	Screw conveyor
6.10	Bucket elevator
6.11	Chain conveyor
6.12	Chain conveyor
6.13	Electrostatic precipitator (7,900 m^3/min.)
6.14	Exhaust fan
	– Coal handling and grinding
7.1	Coal receiving hopper (280 t)
7.2	Feeders

Item	Equipment
7.3	Belt conveyor
7.4	Belt conveyor
7.5	Belt conveyor
7.6	Coal stacking conveyor (Circular type)
7.7	Coal reclaimer (Circular type, 40 t/h)
7.8	Belt conveyor
7.9	Coal bin
7.10	Chain feeder
7.11	Cyclone
7.12	Coal mill (Vertical roller mill, 19 t/h)
7.13	Bag filter / Exhaust fan
7.14	Screw conveyor
7.15	Pulverized coal bin
7.16	Rotary feeders
7.17	Weigh feeders
7.18	Injector
7.19	Blower
7.20	Kiln coal burner
7.21	Primary fan
7.22	Pneumatic pump / Air compressor
7.23	Precalciner / Coal burners

– Clinker and gypsum handling and storage

8.1	Pan conveyor
8.2	Screw conveyor
8.3	Bag filter /Exhaust fan
8.11	Gypsum receiving hopper (280 t)
8.12	Feeders
8.13	Belt conveyor
8.14	Belt conveyor
8.15	Gypsum stacking conveyor (Tripper conveyor)
8.16	Feeders
8.17	Belt conveyor
8.18	Belt conveyor
8.19	Two way chute
8.20	Belt conveyor

– Extraction and transprt of clinker

9.1	Clinker silo (33,000 t)
9.2	Clinker feeders
9.3	Pan conveyor
9.4	Two way chute
9.5	Belt conveyor

– Clinker grinding

Item	Equipment
10.1	Clinker / Gypsum bins (200 t, 100 t)
10.2	Constant feed weighers
10.3	Belt conveyors
10.4	Cement mills (Closed circuit, 100 t/h)
10.5	Airslides
10.6	Bucket elevators
10.7	Airslides
10.8	Air separator (Cyclone type)
10.9	Circulation fan
10.10	Airslides
10.11	Airslides
10.12	Airslides
10.13	Pneumatic pumps
10.14	Air compressors
10.15	Two way valves
10.16	Bag filters / Exhaust fans

– Packing and shipping (3 x 6,000 t)

11.1	Cement silos
11.2	Bag filter
11.3	Aeration units
11.4	Roots blowers
11.5	Discharging units
11.6	Bucket elevators
11.7	Vibrating screens
11.8	Bag filter / Exhaust fan
11.9	Packer bins
11.10	Rotary packers
11.11	Screw conveyors
11.12	Belt conveyors
11.13	Belt conveyors
11.14	Truck loading conveyors
11.15	Belt conveyors
11.16	Rail loading conveyors

Fig. V-7-5 Typical Side View of Kiln Plant

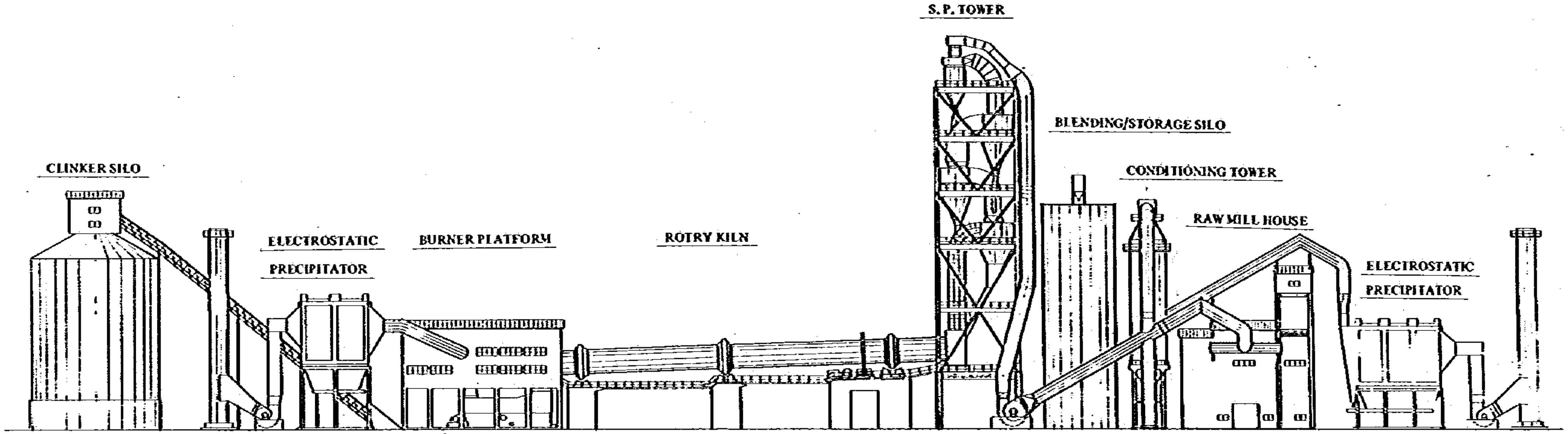


Fig. V-7-6 Single Line Diagram at Tanah Merah

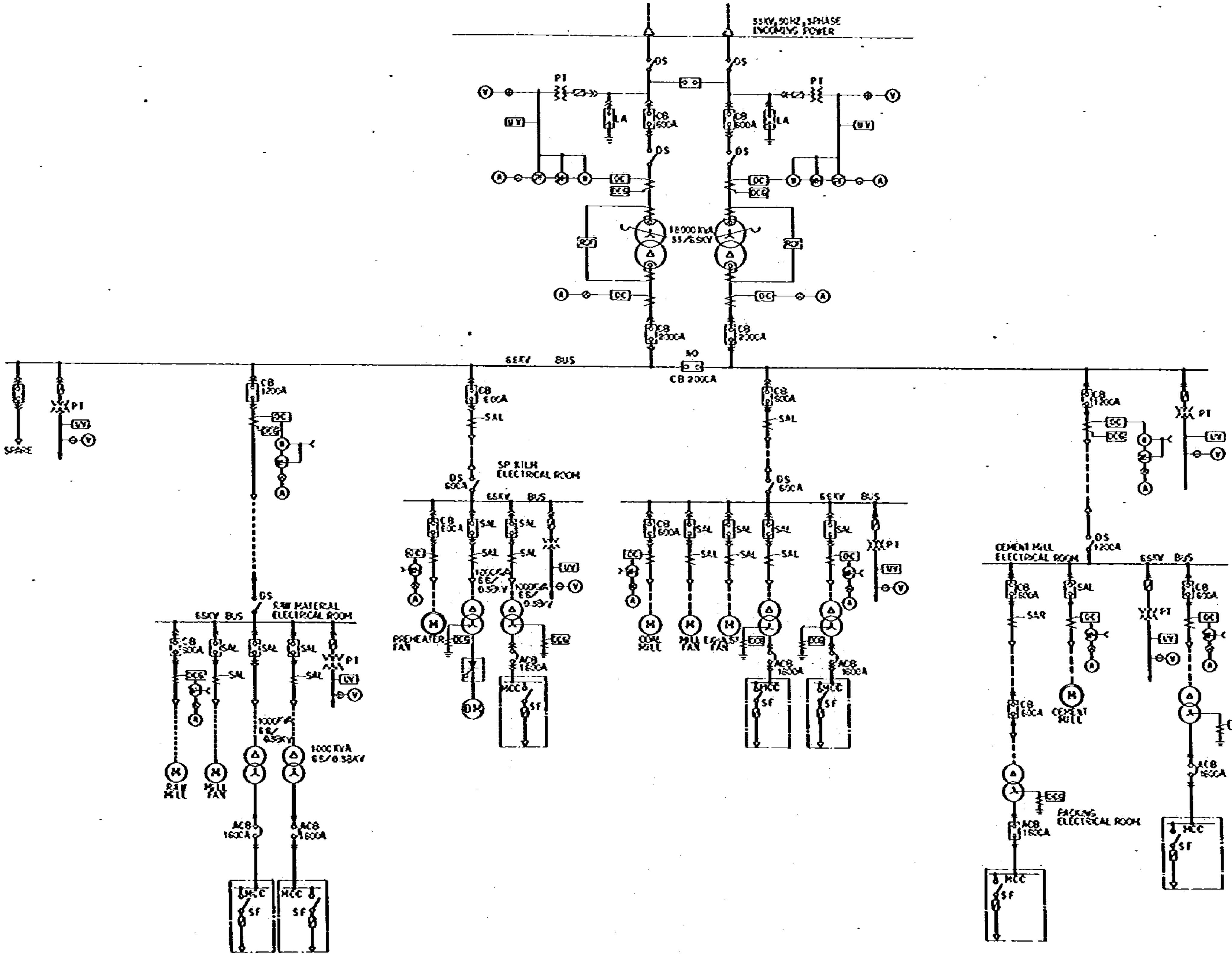
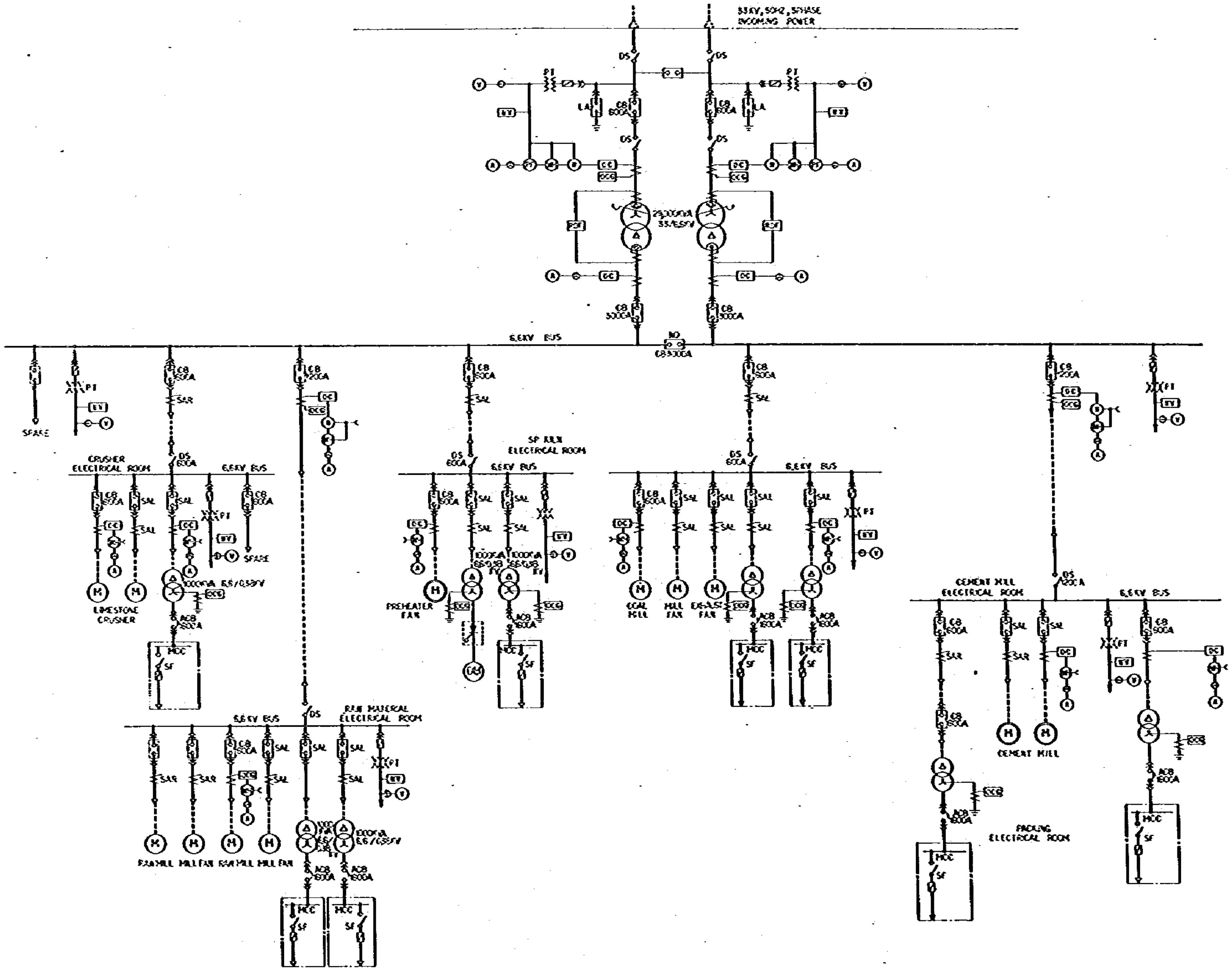
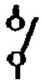


Fig. V-7-7 Single Line Diagram at Gua Musang



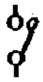
DESCRIPTION

- ACB AIR CIRCUIT BREAKER
- EDG EMERGENCY DIESEL GENERATOR
- SF SWITCH FUSE
- THR THERMAL RELAY
- MCC MOTOR CONTROL CENTER
- EB EXCHANGING BREAKER
- VD VOLTAGE DETECTOR


ISOLATOR


CIRCUIT BREAKER


POWER FUSE


ELECTROMAGNETIC CONTACTOR

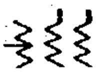

POWER TRANSFORMER


ARRESTER


STATIC CAPACITOR


CURRENT TRANSFORMER

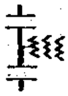

POTENTIAL TRANSFORMER


GROUNDING POTENTIAL TRANSFORMER


BUS DUCT

- IM INDUCTION MOTOR
- WIM WOUND-ROTOR INDUCTION MOTOR
- ISM INDUCTION SYNCHRONOUS MOTOR
- DCM DC MOTOR


NEUTRAL GROUNDING RESISTOR


COUPLING CAPACITOR POTENTIAL TRANSFORMER


ZERO-PHASE-SEQUENCE TRANSFORMER


BUSHING CURRENT TRANSFORMER

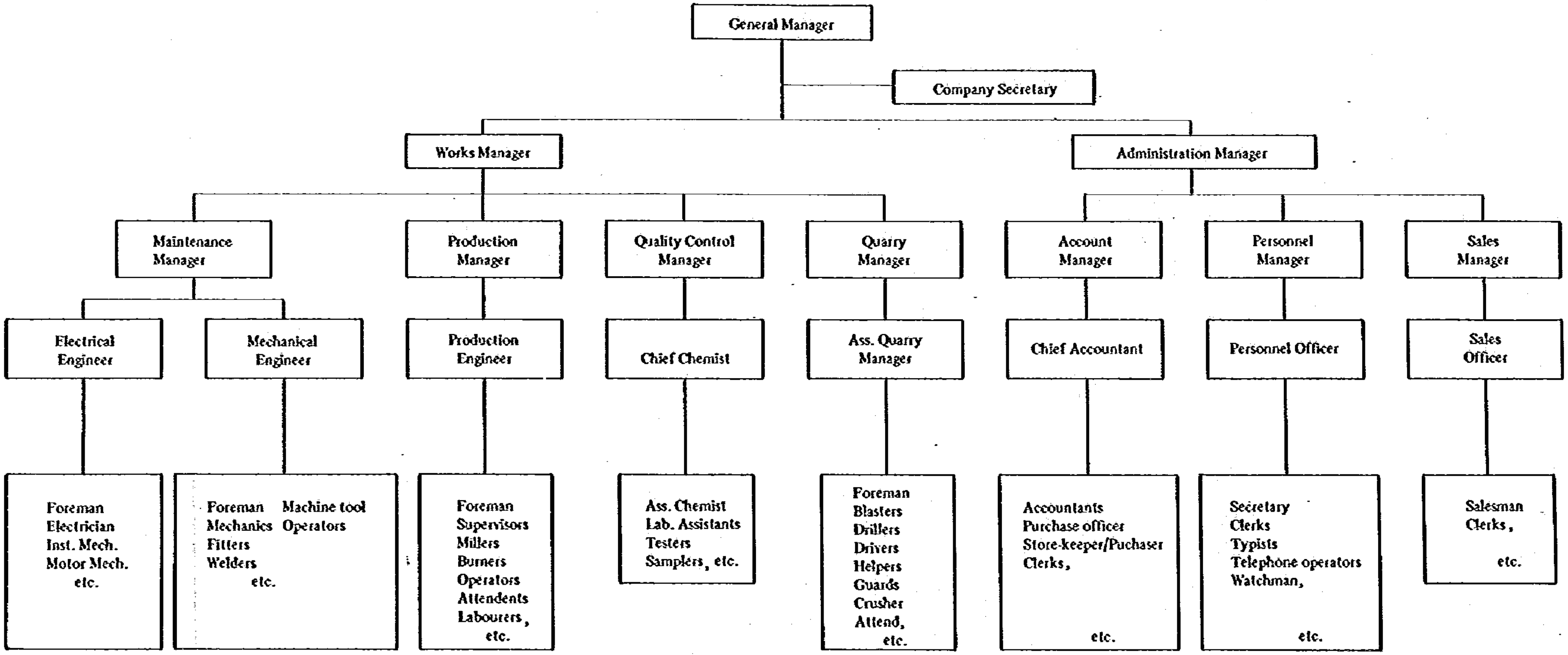
- OC OVER-CURRENT RELAY
- OCL OVER-CURRENT RELAY (LOW)
- OCH OVER-CURRENT RELAY (HIGH)
- OCG OVER-CURRENT GROUND RELAY
- UV UNDER-VOLTAGE RELAY
- OVG OVER-VOLTAGE GROUND RELAY
- RDF PERCENTAGE DIFFERENTIAL RELAY
- DG DIRECTIONAL GROUND RELAY
- W WATTMETER
- WH WATT-HOUR METER
- VAR VARMETER
- VARH VAR-HOUR METER
- PF POWER-FACTOR METER
- F FREQUENCY METER
- A AMMETER
- V VOLTMETER
- RV RECORDING VOLTMETER
- V_0 ZERO-PHASE VOLTMETER
- EL EARTH LAMP
- S.A.L. SAME AS LEFT

V-7-3 Plant organization

(1) Organization

The organization chart of this plant is shown in Fig. V-7-8. The plant has been functionaly separated into several major sections, for example the maintenance, production, quality control and the integration objective is exculed by having a common plant manager (General manager) to whom each of the sectional heads reports directly. By this way, each section is able to function effectively.

Fig. V-7-8 Organization Chart



(2) Personal requirements

A summary of the requirement is shown in Table V-7-4. Total estimated manpower is 308 persons for case A, 351 persons for case B respectively.

Some of the key supervisory personnel should be employed before the starting of election of equipment. Key local personnel will be recruit in early stage of plant construction and sent for training in operating factories. These personnel will return to be involved with the installations and the commissioning the factory.

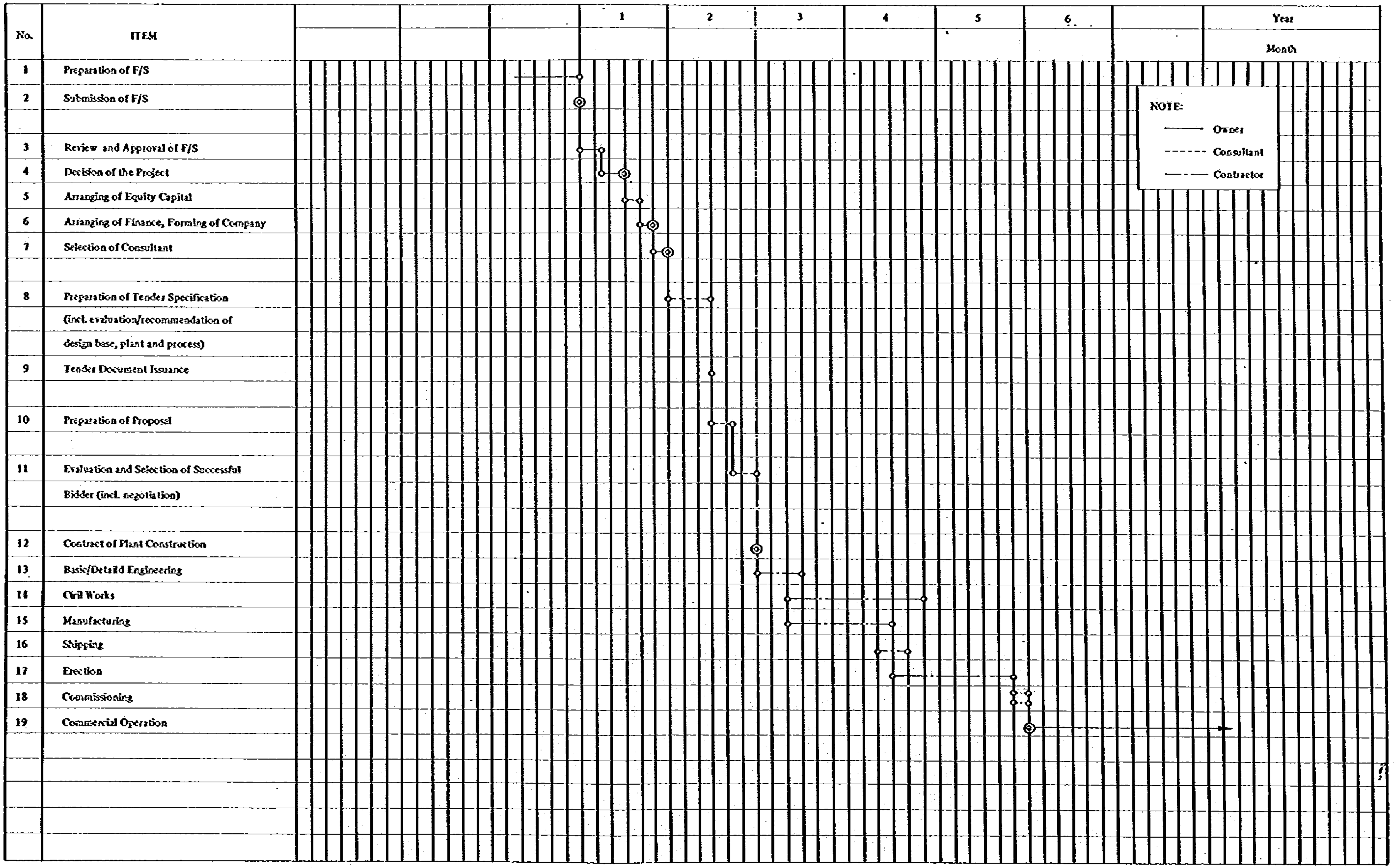
Table V-7-4 Summary of Manpower Requirements

	Case A			Case B		
	No. of Person	Unit Cost M$/M. Month	Annual Cost M$/Year	No. of Person	Unit Cost M$/M. Month	Annual Cost M$/Year
Administration						
General manager	1	6,000	72,000	1	7,200	86,400
Company secretary	1	3,500	42,000	1	4,200	50,400
Administration manager	1	5,000	60,000	1	6,000	72,000
Account manager	1	3,500	42,000	1	4,200	50,400
Personnel manager	1	3,500	42,000	1	4,200	50,400
Sales manager	1	3,500	42,000	1	4,200	50,400
Chief accountant	1	2,500	30,000	1	3,000	36,000
Personnel officer	1	2,500	30,000	1	3,000	36,000
Sales officer	1	2,500	30,000	1	3,000	36,000
Administration	3	800	28,800	3	1,000	36,000
Accountants	5	600	36,000	5	700	42,000
Salesmen	3	600	21,600	3	700	25,200
Clerks	12	500	72,000	12	600	86,400
Others	10	500	60,000	10	600	72,000
Subtotal	42		608,400	42		729,600
Production						
Works manager	1	7,500	90,000	1	9,000	108,000
Mechanical engineer	3	3,500	126,000	3	4,200	151,200
Electrical engineer	2	3,500	84,000	2	4,200	100,800
Process engineer	1	3,500	42,000	1	4,200	50,400
Chemical engineer	1	3,500	42,000	1	4,200	50,400
Asst. chemist	2	2,500	60,000	2	3,000	72,000
Master burner	1	5,000	60,000	1	6,000	72,000
Quarry engineer	1	3,500	42,000	1	4,200	50,400
Asst. Q.E.	2	2,500	60,000	2	3,000	72,000
Supervisor	18	1,200	259,000	21	1,400	352,800
Skilled workers	60	800	576,000	72	1,000	864,000
Semi-skilled workers	75	600	540,000	90	700	756,000
Un-skilled workers	90	400	432,000	100	500	600,000
Clerks	9	500	54,000	12	600	86,400
Subtotal	266		2,467,000	309		3,386,400
Total	308		3,075,400	351		4,116,000

V-7-4 Project schedule

The detail schedule of this project is presented in Fig. V-7-9. The period required for exculing this project is proposed approx. 5 years from the date on which the F/S is submitted. It can be expected that financing negotiations will occupy the first year, and that project execution starting with detailed design will start in the second year.

Fig. V-7-9 Schedule Sheet for Plant Construction



V-7-5 Environmental Influence

The possible effects of the cement plant upon its environment include air pollution by dust, SOx and NOx generated from the plant, river water contamination by waste water discharged from the plant, the noise of the plant in operation, and traffic increase for the transportation of raw materials and finished product.
For exhaust dust control, the installation, operation and maintenance of dust collecting equipment with a sufficient capacity are necessary.
For noise control, the best way will be to locate the Plant adequately distant from the neighboring residential areas, as judged from the plant surrounding conditions.
Considering necessarily increasing traffic, the plant should be located near the highway. The plant location should be selected also from the viewpoint of laying railway service lines over a distrance preferably not too long.
Mines for the raw materials will also produce noise and dust and make stream or river water turbid, and therefore should not be situated near residential areas.

(1) Dust

The dust produced within the plant will be collected with dust collecting equipment, diluted to a concentration 0.1 to 0.05 g/Nm^3 or below, and discharged from stacks into the air. The discharged dust will be diffused by wind into over a wide scope to fall upon the surrounding districts.

The ingredients of the dust are the raw materials such as limestone and clay, clinker and cement. They are not harmful but, when heavily falled and deposited on the roofs of houses, etc., can be problems. Such problems will be particularly troublesome where tobacco, mulberry, tea or other plants that need to be protected from dust are grown. In Japan, dust falling from above at a rate not exceeding 10 $tons/km^2/month$ in plant surrounding areas is generally considered to offer no particular problem.

Major cement plant exhaust gases are SP and raw mill exhaust gases and clinker cooler exhaust gases, while minor ones are finishing mill and coal mill exhaust gases and dust collector exhaust gases arising from the handling of raw materials, clinker and cement. The major, heavily produced SP and raw mill exhaust gases and clinker cooler exhaust gases should be forwarded to dust collectors, where their concentration should be reduced from an inlet concentration of 100 to 15 g/Nm^3 to an outlet concentration of 0.08 g/Nm^3 or below, and should be discharged from a tall stack into the atmospheric air over a wide scope.

The other exhaust gases from the finishing mill, coal mill, and from the handling of raw materials, etc., should be passed through bag filters which can reduce the inlet concentration of 50 to 10 g/Nm^3 to an outlet concentration of 0.05 g/Nm^3. The use of tall stacks also is desirable but not economical since many of them are required.

The total tonnage of dust produced from the plant is estimated as shown in the next page.

Case A (parenthesized values are for Case B)

Exhaust Gas Origin	Gas Volume Nm^3/min	Dust Concetration g/Nm^3	Dust Tonnage Tons/month
SP, Raw Mill	3,800 (6,300)	0.08	13.1 (21.8)
Clinker Cooler	2,600 (4,300)	0.08	10.0 (14.9)
Others	5,150 (8,400)	0.05	11.1 (18.1)
Total	11,550 (19,000)	—	34.2 (54.8)

Seeing that there exists no other significant dust producing sources in the vicinity of the plant, the use of stacks of appropriate height for SP, raw mill and clinker cooler exhaust gases can control the falling dust rate to a level of 5 t/km^2 /month or so, which is considered permissible.

The dust of exhaust gases from the "Others" will mostly fall within the premises of the plant since the stacks will be low in height. Cleaning in the plant premises will be therefore required to prevent fallen dust from being scattered secondarily. Preferably, no resisential buildings should be lying within 1-km vicinity of the plant.

(2) SOx Gases

By the combustion of fuel, part of the sulfur content in the fuel is oxidized to exist as SOx gases in the exhaust gas. It is said that SOx gas concentrations in the air at a level 0.1 ppm or higher for one year can affect human body.

The rates at which SOx gases are produced are variable depending on clinker burning processes. In the SP and NSP processes for this plant, SOx gases arising in the kiln are absorbed, contained and fixed in clinker within SP. Consequently, no SOx is released into that exhaust gases, and there can be no SOx problem.

(3) NOx Gases

NOx are produced as the fuel is burnt. In the process of the high-temperature combustion, NOx are produced mostly in the form of NO which is then oxidized after released into the air to NO_2. During this reaction process in the air, ultraviolet rays and certain hydrocarbons may act upon it to secondarily produce ozone and other peroxides which, under special climatic conditions, are said to give rise to photochemical smog.

Although NOx produced in the NSP process of this plant are negligible, they are produced to a higher level in the SP process to be released into the air. However, seeing that there exist no other NOx generating sources in the neighboring areas of the plant and that traffic on the highway is not so heavy, the concentration of hydrocarbons is considered too low in the environmental atmosphere to give rise to photochemical smog or other NOx problems.

(4) Waste Water

In the cement plant, industrial water is used only for cooling some of the equipment, and no harmful substances will be contained in the waste water from the plant.

Only possible contaminants are spilled oils, fallen dust or the likes washed with rain into the waste water and discharged. This kind of contamination can be easily controlled by taking some pertinent measures.

(5) Noise

The cement plant has large crushers, large fans, and other large machines which, when in operation, produce noise.

The noise level measured at a distance of 1 meter from the side of the large crusher, large fan or large motor in operation is more or less 90 to 110 db, and will be 70 to 75 db measured at the border of the plant.

The environmental areas of the plant are very quiet, presumably at a noise level of 50 to 60 db in the daytime and 40 to 50 db in the nighttime. In other words, the operation of the plant will add a noise of 15 to 20 db to the existing noise in the daytime add 25 to 30 db in the nighttime measured at the border of the Plant.

The control of the plant noise by the use of additional noise preventive equipment costs very high and is not economical. Since self-evidently noise is smaller as the distance from its source is longer, the best way to protect the plant from noise problem will be to locate the plant adequately spaced from residential areas. Preferably, no resisential houses should be seen within a range of about 1 kilometer.

(6) Traffic Increase

The net traffic increment constantly required for the receipt of the raw materials and the shipment of the product by the operation of the plant will be as follows.

Item	Transport	Quantity (t/m)	No. of Transports
Case A			
Limestone	Railway	77,000	129 trains/month
Coal	Railway	7,500	13 trains/month
Gypsum	Railway	3,200	6 trains/month
Cement	Railway	7,000	12 trains/month
Total		94,700	160 trains/month
Cement	Lorry	48,500	4,042 lorries/month
Clay	Lorry	19,800	1,650 lorries/month
High Silica Clay	Lorry	2,300	192 lorries/month
Iron Ore	Lorry	700	59 lorries/month
Total		71,300	5,943 lorries/month
Case B			
Silica Sand	Railway	5,900	10 trains/month
Iron Ore	Railway	3,000	5 trains/month
Gypsum	Railway	5,200	9 trains/month
Coal	Railway	11,800	20 trains/month
Cement	Railway	5,400	9 trains/month
Total		31,300	53 trains/month
Cement	Lorry	84,600	7,050 lorries/month
Clay	Lorry	22,200	1,850 lorries/month
Total		106,800	8,900 lorries/month

Each of the above transports must come and back, that is, the real traffic must be doubled to:

Case A:	Railway	320	trains/month	13	trains/day
	Lorry	11,886	lorries/month	475	lorries/dat
Case B:	Railway	106	trains/month	4	trains/day
	Lorry	17,800	lorries/month	712	lorries/day

In the Case A, the currently operating railway traffic will be doubled but to a level much below the railway capacity limit, and there could be no problem. But the location of the plant should be near the existing railway so that the length of the service railway lines can be not long. At the same time the transporting capacity and reliability of the existing railway should be improved.

For the lorry trucking, a wide highway to permit the additional traffic of 475 lorries per day in case A and 712 lorries per day in Case B. Hence, the plant should be located at a site near or having an easy access to the highway. Means should be provided for preventing the highway from being littered by the clay and iron ore carrying lorries.

(7) Mines

Conceivable factors for environmental polution by the mining are as follows:

a) Vibrations, noises and dust scatter by blasting.
b) Noises and dust from crushing equipment.
c) Dust during loading and transportation.
d) Turbid water flow when raining.

The following countermeasures should be taken for the above problems.

a) This cannot be a problem since the mine site is distant from residential areas.
b) The crushing equipment should be furnished with dust collector and, where necessary, water spraying equipment.
c) Water should be sprinkled upon the transportation roads for prevention of the dust.
d) Settling ponds should be made, where necessary, to prevent the flow of turbid water.

V-7-6. Supporting Industries

With the object of minimizing the initial investment and the number of required personnel in this planned cement plant for effecting low-cost construction, operation and maintenance of the plant, outside industries should preferably be employed as much as practicably available for the necessary supplementary operations of the plant.

The necessary supporting industries for the operations of the plant include:

a) Raw materials mining industries
b) Fuel and other material suppliers
c) Transportation industry
d) Cement dealers.
e) Electric power industry
f) Consumables and spare parts supplying industries
g) Repair and maintenance industry

Fuel and other material supplies, and cement dealers are not described here. The remaining five industries will be discussed in the following.

1) Raw Materials Mining

This Plant is planned to depend the supply of limestone, clay and iron ore on outside mining industries.

LIMESTONE: The limestone mining company is assumed to have its own mining equipment, to undertake mining operations including the development of mines, and to take charge of limestone supply up to the stage of loading it into the crusher of the plant. Approximately, limestone output of 810,000 tons/year, required fund of M$9,000,000.- and sales of M$3,260,000.- are expected in Case A (1,360,000 tons/year, M$15,000,000.- and M$4,980,000.-, respectively, in Case B).

This limestone mining company, therefore, is required to have a large financial capacity, expert limestone mining techniques, and rich experience in the control of mines. A competent Malaysian mining company should be selected.

CLAY: The clay mining company is assumed to have its own mining and transporting facilities, to undertake clay mining operations including the development of mines, and to take charge of clay transportation up to the plant. Approximately, clay output of 230,000 tons/year, required fund of M$1,100,000.- and sales of M$750,000.- are expected in Case A (230,000 tons/year, M$800,000.- and M$600,000.-, respectively, in Case B).

This clay mining company is therefore required to have a moderate financial capacity and medium-level techniques and experience in clay mining and mine control. An appropriate clay mining company will be available in Kelantan.

IRON ORE: The iron ore mining company is assumed to its own mining facilities, and to undertake mining operations including the development of mines. Approximately, iron ore output of 7,300 tons/year, required fund of M$300,000.-, and sales of M$100,000.- are expected in Case A (31,000 tons/year, M$300,000.- and M$130,000.-, respectively, in Case B).

This iron are mining company is therefore required to have medium-level techniques and experience in iron ore mining and mine control, with a small financial capacity. A local company will be fully serviceable.

In the Case B, silica sand should be purchased from river gravel suppliers.

(2) Transportation Industry

The transport facilities necessary for the operations of this plant are railway and trucks. Required transportations are as outlined below.

Case A		T/M		
Railway	Limestone	77,000	Gua Musang →	Tanah Merah
Railway	Coal	7,500	Port Kelang →	Tanah Merah
Railway	Gypsum	3,200	Sungai Golok →	Tanah Merah
Railway	Cement	7,000	Tanah Merah →	Ulu Kelantan
	Total	94,700		
Trucking	Cement	48,500	Tanah Merah →	Kelantan and Trengganu throughout
Trucking	Iron Ore	700	Bukit Lata →	Tanah Merah
	Total	49,200		

Case B		T/M		
Railway	Silica sand	5,900	Wakaf Bharu →	Gua Musang
Railway	Iron Ore	3,000	Rantau Panjang →	Gua Musang
Railway	Gypsum	5,200	Sungai Golok →	Gua Musang
Railway	Coal	11,800	Port Kelang →	Gua Musang
Railway	Cement	5,400	Gua Musang →	Temerloh
	Total	31,300		
Trucking	Cement	84,600	Gua Musang →	Kelantan and Trengganu throughout

For the railway transportation, the Malayan Railway will be used. However, the railway will be required to have more locomotives, freight cars, rails, improved reliability through reinforcement of communication facilities and maintenance systems, and the expansion of the marshaling yards at Tanah Merah and/or Gua Musang, in order to handle the additional large volume of cargoes to and from the plant. A great deal of capacity expansion and reliability improvement will be particularly required for the division between Gua Musang and Tanah Merah, in Case A because this division of the railway will be the main supply channel from mines to the plant, capable of greatly affecting the operations of the plant. Suspension in this railway transportation could stop the plant operation to cause big losses.

Owing to transport of limestone from Gua Musang to Tanah Merah in Case A, new hopper wagon will be required. Usually consignor bears investment for upper portion of hopper wagon and the railway discounts its fare. As amount of interest and depreciation cost for the consignor's share is approximately as same as amount of it's fare discount. The fare is calculated with no discount and the consignor's share isn't included in plant construction cost in this study.

Preliminary study of wagon for limestone transportation is as follows.

Transportation capacity		: 77,000 T/M
Transportation capacity	(25 day/month)	: 8,080 T/D
Capacity of wagon		: 30 T
No of trip		: 1 round trip/day
No of wagon	include 20% space	: 125 wagons
Unit price of wagon		: M$120,000
Total investment		: M$15,000,000
Consigner's share		: M$9,000,000
Railway's share		: M$6,000,000

Freight discount for the masstransportation and share in the manufacture of additional freight cars are subjects to be further studied in future.

For the trucking transportation, the principal function of trucks is to carry 48,500 tons/month in Case A, 84,600 tons/month in Case B of cement to over the entire districts of Kelantan and Trengganu. The estimated cement sales are approximately M$11,000 in Case A, and M$$19,000 in Case B. For this purpose, 100 ~ 200 each 10-ton and 15 ton trucks, 200 ~ 400 trucks altogether, will be required. Therefore, a large trucking company having a sufficiently large financial capacity, sufficient experience in the transportation of cement, and a widely spread trucking network throughout the Malaysian domain in the Penninsula, should be used.

(3) Electric Power Industry

The power necessary for the operations of the planned plant will be supplied from L.L.N. The required power in Case A is 12,300 kW for the cement plant in Tanah Merah and 700 kW for limestone mine in Gua Musang.

275 kV high-tension power lines run in Tanah Merah, and a 360-MVA transformer is to be installed during 1982/1983, so there will be no problem in the power supply to the cement plant. Their existing power supply capacity will be also quite sufficient to cover the additional consumption of 700 kW for the limestone mine.

In Case B, required power is 21,300 kW. 132 kV lines connecting between Tanah Merah and Kuala Lipis, to join the nationwide power supply network, are planned to be completed in 1986. So, the power supply requirement will be met only when the said power lines are complete. That is to say, the completion of those power lines is an essential prerequisite for the planning of Case B.

(4) Consumables and Spare Parts Industries

The main consumables and spare parts required for the operations of this plant include refractories, grinding media for the mill, lubricating oil, cement bags, replacing parts for worn or damaged machine parts, and spare parts and components such as electric and mechanical parts and instruments.

Adequate amounts of these must be constantly kept in stock in the plant under proper inventory control relative to the plant operation schedule and the delivery schedule of those items. Ideally, those of the items that are daily consumed in significant quantities should be available in short delivery period near the plant and should be stored in the plant at levels as low as practical, with their price, life, delivery term, etc. taken into account.

At present, however, there is no industry at all in Kelantan that produces such items. The industrial districts in or near Kuala Lumpur, Johore, Ipoh and Georgetown on the west side of Peninsula Malaysia have industries producing such consumables, etc., and it may be desirable to have their branch factories in neighboring districts of plant site. But the consumption by one cement plant is not sufficient enough to fully support such new branch factories, nor it seems likely that many heavy industries may be constructed in the neighboring districts. Thus, except for the minimum requirements, most of the consumables, etc. will have to be purchased from manufacturers on the west side of Peninsula Malaysia.

The minimum requirements mean that at least one machinery workshop capable of casting, forging and machining small machine parts, capable of metal fabrication, and capable of disassembling and reassembling machines. This machinery workshop, designed to produce and repair machines, vehicles and their parts not only of this cement plant and its associated mines and transportation companies but also of sawmills, lumber mills, palm oil factories and other industries in the neighboring districts, should preferably be as large-scaled as economically practicable and viable, and should have high-level techniques and skills.

The consumption of cement bags by the plant will be about 13,300,000 (21,600,000) bags/year, amounting to M$5,000,000 (M$9,000,000). Making of cement bags inside the cement plant will certainly save the transportation cost, but considering the increasing bulk cement shipment and decreasing demand for cement bags in future, purchase from existing bag makers is advisable. An appropriate bag supplier existing near the plant should be selected.

(5) Repair and Maintenance Industries

The amount of repair or maintenance work during the operation of the plant greatly differs from that at the time of periodical maintenance. It is not a good policy to constantly maintain cement plant repair and maintenance personnel to cover the maximum amount of such work. The proposed plan is designed to have minimum maintenance staff in the plant who are responsible only for the technical and economical control of the repairs and maintenance work during the operation of the plant and the periodical maintenance work by the machinery workshop, depending increased amount of periodical maintenance work on the machinery workshop.

It is also uneconomical to keep in the plant special engineers for the control and maintenance of X-ray analyzing apparatus, computers and other plant equipment that require special high techniques for their maintenance and control. Outside services available from specialized maintenance companies should be used for such purpose.

The periodical maintenance and repair work will include the replacement of the refractories of the kiln, cooler, etc., the replacement of worn parts of machines and instruments, and the inspection, correction and calibration of electric instruments. These periodical work will require 100 to 200 repair and maintenance workmen, comprising approximately one-third each of skilled, semiskilled and unskilled workmen. The total number of days spent for the periodical maintenance per annum will be roughly 50 days, or 13%. Therefore, the associated companies to undertake the periodical work should have a minimum of 15 to 30 regularly employed skilled workmen capable of performing the replacement of machines and instruments and metal fabrication, and should temporarily employ other workment only when the periodical repair and maintenance work is conducted or when the necessity of unexpected repairs occurs.

The repairs of cement carrying vehicles will assure a constant amount of work, which could be somehow stably handled by the machinery workshop jointly with the said repair-associated companies.

V-8 Capital Requirements and Financing Plan

V-8-1 Capital requirements

(1) General

Based on the plant layout and the process flowsheets as described in V-7, the total capital requirements for the Project have been estimated. The following conditions have been assumed as the bases for the estimation:

a) Basis of prices:
1981 constant prices

b) Exchange rate:
Japanese yen – ¥1 = M$0.01
U.S. dollars – US$1 = M$2.20

c) Import duty:
Assumed to be exempted

(2) The Project has been studied in Tanah Merah (rated capacity 740,000 ton/year, net capacity 666,000 ton/year) and Gua Musang (rated capacity 1,200,000 ton/year, net capacity 1,080,000 ton/year). The total capital requirements for each case, of which break down in shown in Table V-8-1, are as follows:

All costs quoted in the study are reasonable and competitive internationally.

Total Capital Requirements (M$ '000)

	Case A	Case B
(Rated Capacity / Location)	(740,000 ton/year / Tanah Merah)	(1,200,000 ton/year / Gua Musang)
Interest		
8% p.a.	239,706	341,594
10% p.a.	244,586	348,486

(3) Assumption for Capital Cost Estimation

Basic assumptions reflected in the estimation are as follows.

a) Machinery and Equipment

The cost of machinery and equipment covers main machinery, electric and instrumentation equipment and auxiliary equipment except mining equipment.

b) Erection, Building and Structures

The cost of civil and erection works has been estimated by taking account of the infrastructure and labor conditions in each of plant area.

c) Railway Siding

The costs of railway siding and road have been estimated based on the information from Malayan Railway.

Table V-8-1 Estimated Capital Requirements (1981 Prices)

(M$'000)

	Case A	Case B
Capacity Location	740,000 ton/year Tanah Merah	1,200,000 ton/tear Gua Musang
Plant cost		
Machinery and Equipment	96,800	135,300
Erection cost	31,900	47,400
Building and Structure	41,800	62,200
Sub-total	170,500	244,900
Others		
Railway Siding	6,494	6,396
Land Premium	9,868	12,492
Store and Spares	5,808	8,118
Sub-total	22,170	27,006
Total Constructioln Cost	192,670	271,906
Pre-Operating Expenses	9,377	13,071
Initial Working Capital	19,180	30,517
Total Contruction Cost	221,227	315,494
Interest During Construction	18,479	26,100
(Interest Rate: 8% p.a.)		
Total Capital Requirements	239,706	341,594

Note: The breakdown of machinery and equipment is shown in Table V-8-2.

Table V-8-2 Price Breakdown of Machinery and Equipment

(M$'000)

	Case A	Case B
Capacity Location	740,000 ton/year Tanah Merah	1,200,000 ton/year Gua Musang
Limestone crushing	5,100	6,900
Raw material handling and storage	4,600	6,300
Raw material drying and grinding including extraction and transportation	11,100	17,600
Raw meal homogenizing and storing	5,000	6,800
Kiln and burning	28,200	38,000
Coal handling and grinding	5,100	6,900
Clinker handling and grinding	13,700	20,500
Cement shipping	4,500	6,000
Utility	1,300	1,700
Electrical and instrumentation	18,200	24,600
Total	96,800	135,300

d) Land Premium

The cost of land premium has been set at M$3.00/s.q. feet on the assumption that the land levelling including drainage system would be completed ready for plant construction and electricity, water and telephone line shall be delivered to the boundary of the plant site.

e) Store and Spares

It is assumed that an initial store and spares needed for operation for two years will be procured at the same time as the plant equipment. On the basis of this assumption, the cost to be procured initially is estimated at 6% of the cost of machinery and equipment.

f) Pre-Operating Expenses, Initial Working Capital

The break-down of pre-operating expenses and initial working capital is shown in Table V-8-3.

V-8-2 Financing Plan

30% of the capital requirements for the Project will be financed by the equity capital and the remaining 70% by loans.
The paid-up schedule of the equity capital has been assumed to be as follows:

1986	30%
1987	40%
1988	30%
Total	100%

Regarding the loans, working capital will be financed by short term loan and the remaining from long term loans.
Since the source of financing for the Project has not yet been determined, the terms of financing are not known. In this report the terms and conditions used as the basis of financial planing are the interest rate on loans of 8% p.a., and repayment in 11 years (including a three-years grace period). Further studies using interest rate of 10% p.a. are shown in sensitibity analysis.
The interest rate of short term loan is assumed to be 10% p.a..
The results of financing planning are shown in Table V-8-4.

Table V-8-3 Pre-Operating Expenses & Initial Working Capital 1981 Prices

(M$'000)

	Case A	Case B
Capacity Location	740,000 ton/year Tanah Merah	1,200,000 ton/year Gua Musang
Pre-Operating Expenses:		
Consultant fee (3% of Plant Cost)	5,115	7,644
Land rent fee (3 years)	83	121
Labour cost (6 months)	1,538	2,058
Losees during test operation (1/3 month of variable cost and consumables)	1,641	2,248
Miscellaneous	1,000	1,000
Total	9,377	13,071
Initial Working Capital		
Accounts receivable (2 months)	14,297	23,081
Inventory		
Products (half month)	2,432	3,319
Raw Material, Coal (half month)	929	1,073
Accounts payable (Less) (One month of raw materials)	909	675
Minimum cash requirements, (half month of production cost except depreciation, interest)	2,431	3,719
Total	19,180	30,517

Table V-8-4 Tentative Financing Plan (1981 Prices)

(M$'000)

	Case A	Case B
Capacity Location	740,000 ton/year Tanah Merah	1,200,000 ton/year Gua Musang
Total Financing Required	239,706	341,594
Equity (30%)	71,912	102,478
Debt (70%);	167,794	239,116
(Long term loan	(148,614	(208,599
(Short term loan	19,180	30.517
Paid in Capital		
1986	21,573	30,743
1987	28,765	40,991
1988	21,574	30,744
Equity	71,912	102,478
Loan Disbursement		
Long term loan		
1986 (at Beginning)	21,562	30,203
1985 (at Middle)	102,774	146,441
1986 (at Middle)	24,278	31,955
Short term loan		
1989 (at Beginning)	19,180	30,517
Debt.	167,794	239,116

V-9 Financial Analysis

V-9-1 Main assumptions for cost estimation and financial projections

(1) General

The production cost estimates and the financial projections in this report are based on the assumption that commercial operation of the Plant will be started in 1989, and that the Plant has an economic life-span of 15 years after the start up.

These estimates and projections are given at 1981 constant prices.

(2) Production and Sales

Regarding operation of the cement plant, it is reasonable to assume from technical point of view that the rate of net capacity utilization will be 70% (rated capacity utilization 63%) for the first year, and 100% (rated capacity utilization 90%) for the subsequent years.

The projections of production and sales of products are as follows:

	Case A			Case B		
	Production	Sales	Inventory	Production	Sales	Inventory
	tons	tons	tons	tons	tons	tons
1989	466,200	446,775	19,425	756,000	724,500	31,500
1990	666,000	657,675	27,750	1,080,000	1,066,500	45,000
1991 onwards	666,000	666,000	27,750	1,080,000	1,080,000	45,000

As mentioned in V-3-1, the demand in Kelantan and Trengganu will be 668,000 tons in 1989 and 763,000 tons in 1990. All products in Case A will be sold at M$192/ton in those two states, but in Case B it is necessary to sell some portion of products outside Kelantan and Trengganu. It is assumed that the volume corresponding to 90% of the demand in Kelantan and Trengganu will be sold at M$192/ton, but the remaining 10% and the volume corresponding to 90% of the demand in Pahang less the Pahang Cement's production volume (450,000 tons per year) will be sold by discounting the sales price by M$5/ton. And, also, it is assumed that the remaining cement will be exported to Thailand at M$115/ton. According to the above assumptions, the sales plan of Case B is given in Table V-9-1.

(3) Taxation

The following taxation is assumed for the financial projections:

a) Coorporate tax

Coorporate tax will be imposed at a rate of 50% of taxable income, consisting of:

Company tax	40%
Development tax	5%
Excess profit tax	5%
Total	50%

Table V-9-1 Sales Plan of Case B

(In '000 M/T)

		1989	1990	1991	1992	1993	1994	1995	1996	1997 Onwards
Demand										
Kelantan & Trenggunu		668,000	763,000	833,000	903,000	973,000	1,042,000	1,113,000	1,182,000	1,252,000
Pahang		598,000	704,000	737,000	770,000	803,000	836,000	869,000	902,000	935,000
Sales	(Price)									
Kelantan & Trenggunu										
90%	M$192/ton	601,000	687,000	750,000	813,000	876,000	938,000	1,002,000	1,064,000	1,080,000
10%	M$187/ton	67,000	76,000	83,000	90,000	97,000	104,000	78,000	16,000	–
Pahang	M$187/ton	56,500	184,000	213,000	177,000	107,000	38,000	–	–	–
90% of the demand minus production of Pahang Cement										
Export	M$115/ton	–	119,500	34,000	–	–	–	–	–	–
Total Sales Volume		724,500	1,066,500	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000

b) Sales tax and Surtax

The cost of the equipment to be imported includes sales tax and surtax which are 5% of the equipment respectively except tax exempted items.

c) Excise duty

Excise duty which was lifted in October 1981 is excluded from the cost calculation.

d) Import duty

Assumed to be exempted

e) Capital allowance

For the computation of taxable income, neither depreciation nor amortization is deductable, but deduction is allowed for initial and annual capital allowance. The following allowance will be applied for this Project.

- Structures and buildings
  2% by straight line method. However, 12% of capital allowance can be made since 10% of special capital allowance can be additionally allowed for the initial year only.

- Machinery and equipment, erection cost, railway siding, and preoperating expenses 10% by straight line method. However, 30% of capital allowance can be made since 20% of special capital allowance can be additionally allowed for the initial year only.

V-9-2 Production Cost

(1) General

As shown in Table V-9-2, production cost in Case A (Tanah Merah, rated capacity 740,000 ton/year, net capacity 666.000 tons/year) is M$159/ton and M$146/ton in Case B (Gua Musang, rated capacity 1,200,000 ton/year, net capacity 1,080,000 ton/year) on the basis of utilizing capacity at 100% and interests on loans incurred in first operation year.

Actual costs are, as obtainable from the attached Income Statement sheets, in first operation year M$184/ton at 70% of net capacity utilization ratio in Case A and M$168/ton in case B.

With time passing, levels of operation become higher and interest cost becomes lower, thus production cost from 9th to 15th year is M$138/ton in Case A and M$128/ton in Case B.

Average production cost through 15 years of operation period is M$145/ton in Case A and M$134/ton in Case B.

When sales price is M$192/ton, profit per ton and ratio of profit on sales (   ) are M$47 (25%) in Case A and M$57 (30%) in Case B.

Break-even point in Case A, is 62.1% in first year and 44.9% of average through 15 years of operation period. In Case B, the point is 50.9% and 37.3% respectively.

Table V-9-2 Projected Production Cost (1981 Prices)

(Net capacity utilization 100%)

(M$/ton)

	Case A	Case B	
Capacity Location	740.000 ton/year Tanah Merah	1,200,000 ton/year Gua Musang	Average cost of existing factories
Valiable Cost			
Limestone	19.69	5.52	6.47 (Limestone, Clay, Silica sand, Iron ore)
Clay	1.01	0.56	
Silica sand	0.12	1.44	
Iron ore	0.23	0.74	
Gypsum	2.36	2.46	2.73
Fuel (Coal)	24.44	23.35	Oil 58.30
Electric power	23.60	23.20	17.75
Paper bag	8.30	8.70	7.66
Sub total	79.75	65.97	92.91
Fixed Cost			
Consumables	4.36	3.76	7.67 (Consumables, Maintenance Cost)
Maintenance Cost	4.36	4.51	
Labor	4.62	3.81	8.20
Overhead	1.62	1.33	2.61 (Overhead, Land cost)
Land cost	0.04	0.04	
Depreciation	16.83	14.12	5.77
			Others 1.49
Sub-total	31.83	27.57	25.74
Sales Expenses, Others			
Transportation cost	15.00	23.00	*
Agent fee	10.00	10.00	7.94
			Sales expenses
Amortization	1.85	1.61	1.16
Sub-total	26.85	34.61	9.10
Interest (First year base)			
Long term loan (8% p.a.)	17.29	14.97	4.34 (Long term loan, Short term loan)
Short term loan (10% p.a.)	2.88	2.83	
Sub-total	20.17	17.80	4.34
Total Production Cost	158.60	145.95	132.09

* Average cost of existing factories does not include transportation cost.

(2) Variable Cost

Regarding the cost of raw materials and fuel, the consumption and the price are calculated in wet base and the loss in process is estimated at 2% for the purpose of cost calculation. Those costs are different according to plant site and capacity as follows:

Capacity Location	Case A 740,000 ton/year Tanah Merah			Case B 1,200,000 ton/year Gua Musang		
	Consumption	Price	M$/ton cement	Consumption	Price	M$/ton cement
Limestone	1.210 t/t	16.27 M$/t	19.69 M$/t	1.258 t/t	4.39 M$/t	5.52 M$/t
Clay	0.312	3.24	1.01	0.216	2.58	0.56
Silica sand	0.036	3.24	0.12	0.057	25.24	1.44
Iron ore	0.011	20.57	0.23	0.029	25.36	0.74
Gypsum	0.050	47.20	2.36	0.050	49.20	2.46
Fuel (Coal)	0.122	200.32	24.44	0.119	196.24	23.35
Electric Power	118 KWH/t	0.20 M$/KWH	23.60	116 KWH/t	0.20 M$/KWH	23.20
Paper bag	-	-	8.30	-	-	8.70
Total			79.75			65.97

The details of consumption are shown Table V-6-10, V-6-11 and the bases of unit price are described as follows.

In estimating unit prices of raw materials, the quarries for limestone, clay and iron are assumed to be operated by other companies.

a) Limestone

Unit price of limestone (at delivered) consists of mining cost, quarry royalty and freight.

The mining cost consists of investment cost, explosive maintenance, consumable and spares, labour, depreciation and interest.

Depreciation: no residual value
10 years deduction

Interest: 8% p.a.

Unit price of limestone for each case is shown below.

	Case A	Case B
Investment cost	M$8,185,000	M$12,414,000
Mining quantity	806,000 t/y	1,359,000 t/y
Annual cost		
Explosive	M$320,000	M$580,000
Maintenance	434,000	748,000
Consumable	647,000	1,192,000
Labour	362,000	544,000
Depreciation	818,000	1,241,000
Interest	655,000	993,000
(total)	(3,236,000)	(5,298,000)
Mining cost	4.02 M$/t	3.90 M$/t
Royalty (*1)	0.49	0.49
Freight (*2)	11.76	-
Unit Price	16.27	4.39

Notes: *1 Quarry royalty
M$1.00/cu.yard = M$1.31/m³ = M$0.49/t
(specific weight 2.7 t/m³)

*2 Freight
Freight from Gua Musang to Tanah Merah is estimated based on the tariff of Malayan Railway
Distance: 154.7 km
Freight: 11.76 M$/t

b) Clay

Unit price of clay (at delivered) consists of mining cost (including freight) and quarry royalty.

Depreciation: no residual value
10 years deduction

Interest: 8% p.a.

Unit price of clay for each case is shown below.

	Case A	Case B
Investment cost	M$ 993,000	M$ 706,000
Mining quantity	232,000 t/y	233,000 t/y
Annual cost		
Maintenance	M$ 87,800	M$ 66,300
Consumable	181,600	126,900
Labour	116,400	106,800
Depreciation	141,800	100,900
Interest	79,400	56,500
(total)	(607,000)	(457,400)
Mining cost	2.62 M$/t	1.96 M$/t
Royalty (*1)	0.62	0.62
Unit Price	3.24	2.58

Note: *1 Quarry royalty
M$1.00/cu. yard = M$1.31/m³ = M$0.62/m³
(Specific weight 2.1 t/m³)

c) Silica sand

In Tana Merah, high silica clay is assumed to be used as silicous material and its quarry to be operated by the other company who would operate the clay quarry.

Therefore, the mining cost and the royalty of high silica clay are assumed the same cost and royalty as the clay mentioned above.

In Gua Musang, silica sand is assumed to be supplied from a sand supplier at the cost of M$6.00 (including royalty) per ton on an ex-factory basis.
Freight is added to the above cost.

Unit price of siliceous material for each case is shown below.

	Case A	Case B
Mining Cost	2.62 M$/t	4.69 M$/t
Royalty	0.62	1.31
Exfactory cost	–	6.00
Freight (*1)	–	19.24
Unit Price	3.24	25.24

Note: *1 Freight

Freight from a factory to Wakaf Bharu station
8 miles x 0.35 M$/t. mile = 2.8 M$/t
Charges for unloading and loading at the station: 6.0 M$/t
Freight from Wakaf Bharu station to Gua Musang is estimated based on the tariff of Malayan Railway.
Distance: 191.9 Km
Freight: 10.44 M$/t
Total freight 19.24 M$/t

d) Iron ore

Unit price of iron ore (at delivered) consists of mining cost, royalty and freight.
Depreciation: no residual value
7 years duration
Interest: 8% p.a.

Unit price of iron ore for each case is shown below.

	Case A	Case B
Investment cost	M$267,000	M$267,000
Mining quantity	7,300 t/y	31,000 t/y
Annual cost		
Maintenance	M$ 21,100	M$ 38,100
Consumable	12,500	22,600
Labor	8,400	8,400
Depreciation	37,400	37,400
Interest	20,900	20,900
(total)	(100,300)	(127,400)
Mining cost	13.74 M$/t	4.11 M$/t
Royalty (*1)	0.56	0.56
Freight (*2)	6.27	20.69
Unit price	20.57	25.36

Notes: *1 Quarry royalty

M$1.50/cu. yard = M$1.96 /m³ = M$0.56/m³
(specific weight 3.5 t/m³)

*2 Freight

Tanah Merah

Freight from Bukit Lata to Tanah Merah
28.5 miles x 0.22 M$/t. mile = 6.27 M$/t

Gua Musang

Freight from Bukit Lata to Rantan Pajang
7 miles x 0.35 M$/t. mile = 2.45 M$/t
Charge for unloading and loading at the station: 6.0 M$/t

Freight from Rantan Panjang to Gua Musang is based on tariff of Malaysian Railway
Distance: 200.1 Km
Freight: 12.24 M$/t
Total freight: 20.69 M$/t

e) Gypsum
Unit price of gypsum (at delivered) consists of imported cost on F.O.R. at Sungai Golok station and freight.

Unit price of gypsum is shown below.

	Case A	Case B
F.O.R. price	37.20 M$/t	37.20 M$/t
Freight (*1)	10.00	12.00
Unit Price	47.20	49.20

Note: *1 Freight is estimated based on the tariff of Malayan Railway
Tanah Merah:
Sungai Golock to Tanah Merah
Distance: 47.1 Km
Freight: 10.0 M$/t

Gua Musang:
Sungai Golock to Gua Musang
Distance: 201.8 Km
Freight: 12.0 M$/t

f) Fuel (imported coal from Australia)
Unit price of fuel (at delivered) consists of imported cost, port charge and inland transportation.

Unit price of fuel is shown below.

	Case A	Case B
C.I.F. Price	165.00 M$/t	165.00 M$/t
Port Charges	10.00	10.00
Inland transportation (*1)	25.32	21.24
Unit Price	200.32	196.24

Note: (*1) Freight is estimated based on the tariff of Malayan Railway.
Tanah Merah:
Port Kelang to Tanah Merah
Distance: 694 Km
Freight: 25.32 M$/t

Gua Musang
Port Kelang to Gua Musang
Distance: 539.3 Km
Freight: 21.24 M$/t

g) Electric Power
The price including demand charge is estimated at M$0.20/KWH, based on the running charge of M$0.17/KWH and the maximum demand charge of M$12.00/KW month indicated by National Electricity Board.

h) Paper bag
The cost of paper bag at Tanah Merah and Gua Musang is estimated at M$8.30/ton and M$8.70/ton respectively which is based on the condition that 3 ply bags and 4 ply bags are mixedly used on the following manner:

	3 ply bag	4 ply bag
Piece of bag (50 Kg)	M$0.40	M$0.45
Tanah Merah	70%	30%
Gua Musang	30%	70%

(3) Fixed Cost

a) Consumables
Annual cost of consumables such as fire brick, castables and steel balls are assumed at 3% of capital cost for machinery and equipment.

b) Maintenance Cost
Annual maintenance costs for the plant are estimated as follows:

Tanah Merah : 3% of capital cost for machinery and equipment
Gua Musang : 3.6% of capital cost for machinery and equipment

c) Labor
It is assumed that the number of employees will be 308 in Tanah Merah and 351 in Gua Musang. Annual labor cost for the plant in Tanah Merah is estimated at M$3,075,400 and in Gua Musang will be at M$4,116,000.
The details of labor cost are shown in Table V-7-4.

d) Overheads
The overhead costs are estimated at 35% of labor cost.

e) Land Cost
The cost of land rent is estimated as follows:

Plant Site, Railway : M$250/acre.
Quarry : M$100/acre.

f) Depreciation and Amortization
The following periods of depreciation and amortization will be applied:

Building and structures	: 35 years
Machinery and equipment including erection cost	: 15 years
Railway siding	: 15 years
Pre-operating expenses	: 15 years
Interest during construction	: 15 years

(4) Sales Expenses

a) Transportation Cost
The transportation cost varies with the distance from the plant site to each market.
The transportation cost in Case A is estimated at average M$15/ton. Regarding Case B, an average transportation cost in both Kelantan and Trengganu will be M$23/ton and the cost up to Pahang is assumed to be M$40/ton.

b) Agent Fee
The sales commission paid to agent is estimated at M$10/ton for the domestic sales and M$5/ton for the exports.

c) Excise duty

Excise duty which was lifted in October 1981 is excluded from the cost calculation.

V-9-3 Profitability

Profitability is assessed for each of the four different tax incentives.

- No Tax Incentives
- Investment Tax Credit (I.T.C.)

Investment tax credit will be applied for machinery and equipment, building and structure. In case that the amount deducted exceeds the taxable income, its excessive amount is assumed to be carried over for subsequent years.

The break down of the I.T.C. is as follows.

	Case 1	Case 2
Investment Tax Credit	25%	50%
Malaysian Material Content	5%	5%
Development Area	5%	5%
Total	35%	60%

- Tax Holidays

Tax holidays will be applied for a period of 7 years after the commencement of commercial operation.

The break-down of the tax holiday period is as follows.

Local Incentives	5 years
Malaysian Material Content	1 year
Development Area	1 year
Total	7 years

(1) Summary of Income Statement

The detales of income statement is shown in the attached sheets.

The details of income statement is shown in the attached sheets.

	Case A	Case B
Capacity	740,000 ton/year	1,200,000 ton/year
Location	Tanah Merah	Gua Musang
Sales Volume	9,762,450 ton	15,831,000 ton
	Million M$	Million M$
Sales Revenue	1,874 (M$192/ton, 100%)	3,021 (M$191/ton, 100%)
Production Cost	1,413 (M$145/ton, 75%)	2,122 (M$134/ton, 70%)
Profit before tax	461 (M$ 47/ton, 25%)	899 (M$ 57/ton, 30%)
Income Tax	Million M$	Million M$
No incentive	251	468
ITC 35%	228 (Saving tax 23)	436 (Saving tax 32)
ITC 60%	212 (Saving tax 39)	413 (Saving tax 55)
Tax holiday 7 years	105 (Saving tax 146)	215 (Saving tax 253)
Profit after tax	Million M$	Million M$
No incentive	210 (M$21/ton 11%)	431 (M$27/ton 14%)
ITC 35%	233 (M$24/ton 11%)	463 (M$29/ton 15%)
ITC 60%	249 (M$25/ton 13%)	486 (M$31/ton 16%)
Tax holiday 7 years	356 (M$36/ton 19%)	684 (M$43/ton 23%)

(2) Cash Flow.

Summarized from the attached detail cash flow sheets, cash flow curves are given below in fig. V-9-1 and fig. V-9-2 assuming that 60% incentives are granted as ITC.

In case A shown in fig. V-9-1, initial capital cost of 240 million M$ is required. During 15 years of operation period over-all cash inflows are 775 million M$ before tax and 563 million M$ after tax. These amounts offset initial capital cost and remain 535 million M$ cash inflows before tax, and 323 million M$ after tax.
In case of applying 10% of discount rate, Net Present Value (NPV) are 97 million M$ before tax and 33 million M$ after tax.

In case B as shown in fig. V-9-2, cumulative cash inflows are 999 million M$ before tax and 586 million M$ after tax. NPV are 228 million M$ before tax and 96 million after tax at 10% discount rate.

Cash Payment Periods are 5.3 years after tax cash flow curves in Case A and 4.7 years in Case B.

Fig. V-9-1 Cumulative DCF Curve (Case A)

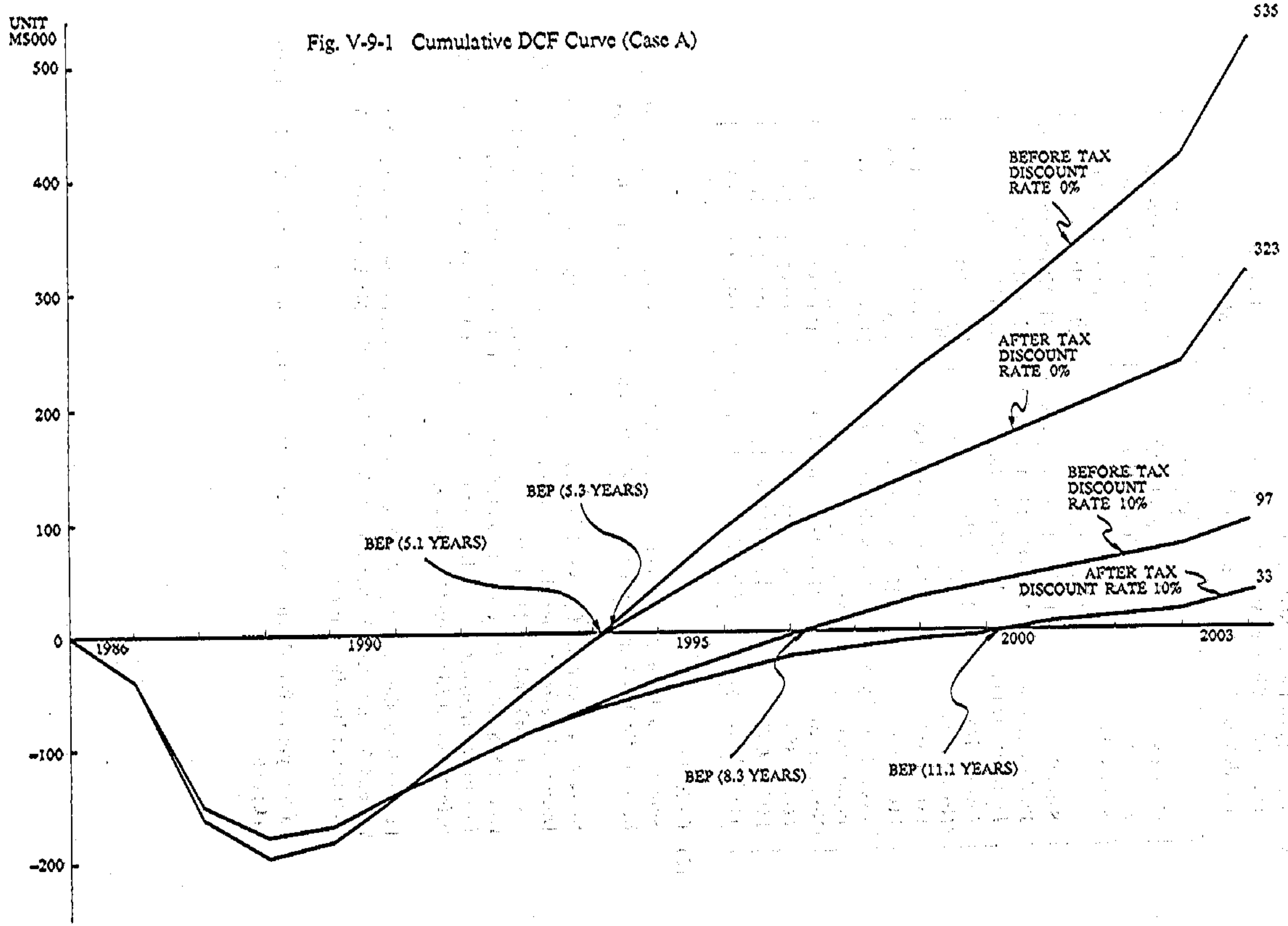
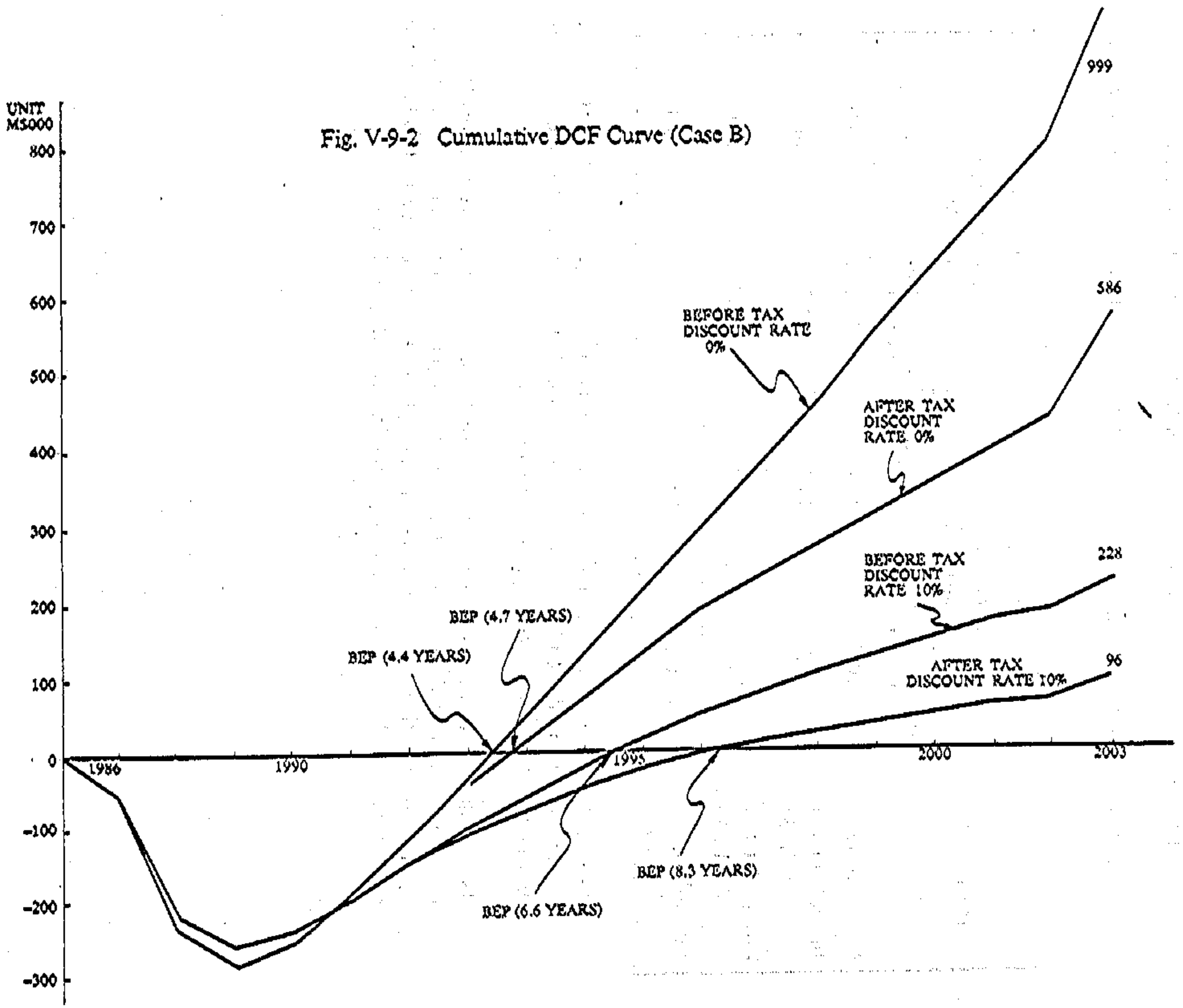


Fig. V-9-2 Cumulative DCF Curve (Case B)



(3) Financial Rate of Return

The financial rate of return on investment and equity for the project are assessed in terms of the internal rate of return (IRR).

The IRR on investment (before tax) will be 16.1% in Case A, 19.4 in Case B.

The IRR (after tax) computed for each of the four different tax incentives is as shown below.

Tax Incentives	Case A 740,000 ton/year Tanah Merah		Case B 1,200,000 ton/year Gua Musang	
	on investment (after tax)	on equity	on investment (after tax)	on equity
No Incentive	10.8 %	12.0 %	13.1 %	16.0 %
Investment Tax Credit 35%	11.9	14.1	14.2	18.2
Investment Tax Credit 60%	12.5	15.3	14.9	19.6
Tax Holiday 7 years	14.8	19.1	17.9	24.5

As seen from the above, a cement plant of 1,200,000 tons per year in Gua Musang is higher than that of 740,000 tons per year in Tanah Merah from the view point of profitability on investment and profitability on equity.

As a result of further analysis, a cement plant of 1,200,000 tons per year in Gua Musang can be said to be in the range of promising level from the view point of profitability on equity assuming that 60% incentives are granted as ITC and can be said to be in the range of acceptable level from the view point of profitability on investment.

While the case study on 740,000 tons per year cement plant has been made assuming that the plant is located at Tanah Merah and limestone quarry is at Gua Panjang. However, if limestone is obtainable from Dabong, the transportation cost will be reduced by about M$5/t and thus the price of limestone will be M$11.66/t with the result that the IRR on investment (after tax) will be increased by about 1%.

In case that the plant is located at Gua Musang, the plant cost will increase by about 8% and thus the IRR will slightly decrease in comparison to Case A, because transportation cost of cement will be increased due to the longer distance between plant site and market although the price of limestone will be decreased by means of the limestone transportation by a belt conveyor.

The comparison between the case where limestone at Dabong is utilized and the case where the plant is located at Gua Musang is as shown below:

Capacity	666,000 ton/year			
Plant site	Tanah Merah		Gua Musang	
Limeston quarry (Limestone price)	Dabong (M$11.66/t)		Gua Panjang (M$5.36/t)	
	on investment	on equity	on investment	on equity
Before tax	17.4%	–	15.6%	–
After tax				
No incentive	11.6%	13.5%	10.4%	11.3%
ITC 35%	12.8	15.7	11.5	13.5
ITC 60%	13.5	17.0	12.2	14.8
Tax holiday 7 years	16.0	21.4	14.3	18.2

In summarizing the above, IRRs on investment (after tax) on four cases are shown below together with limestone cost per ton of cement, plant cost and capital requirements.

Capacity	740,000 ton/year			1,200,000 ton/year
Plant Site	Tanah Merah (Case A)	Tanah Merah	Gua Musang	Gua Musang (Case B)
Limestone Quarry Unit Price Cost per ton of cement	Gua Pajang M$16.27/t M$19.69/t-cement	Dabong M$11.66/t M$14.11/t-cement	Gua Pajang M$5.36/t M$6.74/t-cement	Gua Pajang M$4.39/t M$5.52/t-cement
(M$'000) Plant Cost	170,500	170,500	185,300	244,900
(M$'000) Capital Requirements	239.706	239.596	253.249	341.594
IRR on Investment (after tax)				
No Incentive	10.8%	11.6%	10.4%	13.1%
ITC 35%	11.9	12.8	11.5	14.2
ITC 60%	12.5	13.5	12.2	14.9
Tax Holiday 7 years	14.8	16.0	14.3	17.9

As seen from the above, a cement plant of 740,000 tons per year cannot be said to be profitable unless 7 years tax holiday would be applied.

(4) Sensitivity Analysis

Analysis of sensitivity to changes of interest rate and sales price etc. was made for the two cases, in Tanah Merah and Gua Musang in which 60% of investment tax credit is applied respectively.

a) Interest rate on long term loan

As stated in V-8-2, interest rate is set at 8% p.a. as Base Case. And further, in this section, analysis of sensitivity in case of interest rate of 10% p.a. is made taking into consideration the O.E.C.D. guideline which was recently revised.

(In M$'000)

	Case A		Case B	
Capacity Location	740,000 ton/year Tanah Merah		1,200,000 ton/year Gua Musang	
	8% p.a. (base case)	10% p.a.	8% p.a. (base case)	10% p.a.
Total Capital Requirements	239,706	244,586	341,594	348,486
Equity (30%)	71,912	73,376	102,478	104,546
Debt (70%)	167,794	171,210	239,116	243,940
(Long term loan	148,614	152,030	208,599	213,423
(Short term loan	19,180	19,180	30,517	30,517
Production Cost	158.60 M$/t	163.91 M$/t	145.95 M$/t	150.55 M$/t
(Capacity utilization: 100%				
(Interest: first year base				
Break-even Point				
(First year	62.1%	68.9%	50.9%	56.5%
(Average for 15 years	44.9%	47.3%	37.3%	39.2%
IRR on Investment				
Before Tax	16.1%	16.1%	19.4%	19.4%
After Tax	12.5%	12.8%	14.9%	15.2%
IRR on Equity	15.3%	14.0%	19.6%	18.3%

As seen from the above, if the interest of longterm loan is 10% p.a., total capital requirements increase 5 million M$ in Case A and 7 million M$ in Case B by increasing of interest during construction. Production cost will also increase M$5/ton and IRR on equity will decrease 1% for both cases.

b) Sales price, coal price and investment cost
The sensitivity of the IRR to changes of sales price, coal price and investment cost is shown below.

Case A (Tanah Merah 740,000 ton/year)

	IRR on Investment		IRR on equity
	before tax	after tax	
Base Case (Sales price: M$192/t; Coal price: M$200.32/t; Investment cost: 240 million M$)	16.1%	12.5%	15.3%
Sales price			
10% up: M$211.2/t	20.2%	15.5%	20.9%
10% down: M$172.8/t	11.5%	9.2%	9.2%
Coal price			
10% up: M$220.35/t	15.5%	12.1%	14.5%
10% down: M$180.29/t	16.7%	12.9%	16.1%
Investment cost			
10% up: 264 million M$	14.7%	11.5%	13.4%
10% down: 216 million M$	17.8%	13.7%	17.5%

Case B (Gua Musang 1,200,000 ton/year)

	IRR on Investment		IRR on equity
	before tax	after tax	
Base Case (Sales price: M$192/t, Coal price: M$196.24/t, Investment cost: 342 million M$)	19.4%	14.9%	19.6%
Sales price			
10% up: M$211.2/t	23.3%	17.9%	25.1%
10% down: M$172.8/t	15.0%	11.8%	13.8%
Coal price			
10% up: M$215.86/t	18.8%	14.5%	18.8%
10% down: M$176.62/t	19.9%	15.4%	20.4%
Investment cost			
10% up: 376 million M$	17.8%	13.8%	17.6%
10% down: 307 million M$	21.2%	16.2%	22.0%
Without Discount of Domestic Sales Price	19.6%	15.1%	19.8%
All Products can be sold in Kelantan and Trengganu	20.2%	15.5%	20.7%

If the sales price of cement changes 10%, IRR on investment (after tax) changes 3%, but if coal price and investment cost change 10%. IRR on investment (after tax) changes only 0.4% and 1% respectively for both cases.

Regarding Case B, further study of sensitivity to change of marketing was carried out. IRR on investment (after tax) will be 15.1% unless a discount of M$5/ton for domestic sales is considered, furthermore IRR will be 15.5% if the total volume can all be sold at M$192/ton in both Kelantan and Trengganu since there will be a possibility that the demand in both Kelantan and Trengganu will grow considerably larger than anticipate at present.

V-10 Economic Analysis

The economic analysis is carried out on the following two aspects.

(1) Economic Benefits of this Project, which analyzes the effect of the Project to be given to national and regional economics.

(2) Economic Internal Rate of Return, which analyzes the profitability of the Project.

The details of the economic analysis are explained in V-10-1 and V-10-2.

V-10-1 Economic Benefits of This Project

(1) Creation of employment opportunities

The Project will create considerable employment opportunities in Kelantan with the employment of labours for plant construction and operation.

When this Project will start, 310 – 350 personnel are to be employed for plant operation and about 70 personnel are newly employed for limestone and clay quarry operation.

Furthermore, additional personnel for related industries are to be required.

(2) Maximum utilization of natural resources

Gua Panjang limestone deposit is one of the huge deposit of high quality in Kelantan.

This deposit is developed as a quarry for raw material for cement manufacturing while limestone to be developed in this area can be adopted for other uses such as limestone filler, agricultural liming materials, aggregate for concrete and quicklime, etc.

(3) Improvement of technological level

Substantial improvement in the technological level of Kelantan can be made since the latest technology in worldwide use for cement manufacturing is introduced for this Project.

With an establishment of cement industry in this area, various related industries will also be required for all of these industries would help to improve the industrial technology in this area.

Labour effectiveness will also be improved because training for labours is to be carried out.

(4) Linkage effects on related industries

The inter-industry relations centering on the cement plant will make it possible to facilitate the development and growth of related industries including machinery, foundry and transportation.

(5) Advanced regional development

The exploitation of the limestone deposit for use in this Project will stimulate the development of the Kelantan State and reduce the regional differences, thus, leading to a well balanced national economy throughout the country.

V-10-2 Economic Internal Rate of Return

In order to estimate the national profitability, the economic internal rate of return was computed under the following conditions.

(1) Economic Price of Cement
The economic internal rate of return was computed in two cases of M$190 /ton and M$180/ton as an economic price of cement with due regard to cement price and imported cement price in Malaysia.

CASE 1		CASE 2	
Sales price used for financial projections	M$192/ton	Import price (1981)	M$150/ton (C&F)
		Add:	
Less:	M$ 2/ton	Transportation	
Excise duty		Cost	M$ 20/ton
		Agent fee	M$ 10/ton
Economic price	M$190/ton	Economic price	M$180/ton

(2) Capital Costs
Capital costs incurred in the implementation of this Project consist of the construction cost and pre-operating expenses.

Such costs were estimated by deducting initial working capital and taxes from the capital costs used for the computation of the financial internal rate of return, that is, the capital requirements of the Project less the interest during construction.

Although the costs of mining equipment were excluded in the financial projections, such costs were added to the above capital costs in the computation of the economic internal rate of return.

(3) Operating Cost
Operating costs were estimated by deducting the taxes to be imposed under the Malaysian tax laws and quarry royalty from the cost items, since these are regarded as transferable costs from the point of Malaysian nation.

Depreciation and interest on mining equipment were also excluded from the operating costs used for financial projections, because the costs of mining equipment were newly added to the capital requirements used for financial projections for the purpose of economic internal rate of return.

(4) Economic Internal Rate of Return
On the basis of the above-mentioned economic benefits and costs of this Project, the economic internal rate of return was computed for an economic life of 15 years. The results, of which details are shown in Table V-10-1 and V-10-2, are as follows:

	Case A	Case B
Plant Capacity	740,000 ton/year	1,200,000 ton/year
Location	Tanah Merah	Gua Musang
Economic Price		
M$190/ton cement	17.5%	21.8%
M$180/ton cement	14.9%	19.2%

The above shows that the both Projects will bring sufficient profit in case the economic price is higher than M$190/ton cement, but the profitability of Case A will be lower if the price is M$180/ton cement.

Table V-10-1 Project Economic Result (Case A)

(M$'000)

Year	Economic Cost			Economic Benefit		Net Benefit (M$190/ton)			Net Benefit (M$180/ton)		
	Capital Cost	Operating Cost	Total(A)	M$190/ton (B)	M$180/ton (C)	(B–A)	Discount Rate (17%)	Discount Rate (18%)	(C–A)	Discount Rate (14%)	Discount Rate (15%)
1986	41,410		41,410			(41,410)	(41,410)	(41,410)	(41,410)	(41,410)	(41,410)
1987	117,783		117,783			(117,783)	(100,669)	(99,816)	(117,783)	(103,318)	(102,420)
1988	43,904		43,904			(43,904)	(32,072)	(31,531)	(43,904)	(33,783)	(33,198)
1989		56,458	56,458	84,887	80,419	28,429	17,750	17,303	23,961	16,173	15,755
1990		76,476	76,476	124,958	118,382	48,482	25,872	25,006	41,906	24,812	23,960
1991		76,476	76,476	126,540	119,880	50,064	22,835	21,883	43,404	22,543	21,579
1992		76,476	76,476	126,540	119,880	50,064	19,517	18,545	43,404	19,774	18,765
1993		76,476	76,476	126,540	119,880	50,064	16,681	15,716	43,404	17,346	16,317
1994		76,476	76,476	126,540	119,880	50,064	14,257	13,319	43,404	15,216	14,189
1995	1,260	76,476	77,736	126,540	119,880	48,804	11,879	11,003	42,144	12,960	11,980
1996		76,476	76,476	126,540	119,880	50,064	10,415	9,565	43,404	11,708	10,729
1997		76,476	76,476	126,540	119,880	50,064	8,902	8,106	43,404	10,270	9,329
1998	8,185	76,476	84,661	126,540	119,880	41,879	6,365	5,747	35,219	7,310	6,583
1999		76,476	76,476	126,540	119,880	50,064	6,503	5,822	43,404	7,903	7,054
2000		76,476	76,476	126,540	119,880	50,064	5,558	4,934	43,404	6,932	6,134
2001		76,476	76,476	126,540	119,880	50,064	4,750	4,181	43,404	6,081	5,334
2002		76,476	76,476	126,540	119,880	50,064	4,060	3,543	43,404	5,334	4,638
2003		76,476	76,476	126,540	119,880	50,064	3,470	3,003	43,404	4,679	4,033
Total	212,542	1,127,122	1,339,664	1,854,865	1,757,241	515,201	+4,663	–5,081	417,577	+10,530	–649
							17.48%			14.94%	

Note 1: Breakdown of capital cost is shown in Table V-10-3

Note 2: Breakdown of operating cost is shown in Table V-10-4

Table V-10-2 Project Economic Result (Case B)

(M$'000)

Year	Economic Cost: Capital Cost	Economic Cost: Operating Cost	Economic Cost: Total(A)	Economic Benefit: M$190/ton (B)	Economic Benefit: M$180/ton (C)	Net Benefit (M$190/ton): (B−A)	Net Benefit (M$190/ton): Discount Rate (21%)	Net Benefit (M$190/ton): Discount Rate (22%)	Net Benefit (M$180/ton): (C−A)	Net Benefit (M$180/ton): Discount Rate (19%)	Net Benefit (M$180/ton): Discount Rate (20%)
1986	58,530		58,530			(58,530)	(58,530)	(58,530)	(58,530)	(58,530)	(58,530)
1987	168,088		168,088			(168,088)	(138,916)	(137,777)	(168,088)	(141,250)	(140,073)
1988	60,012		60,012			(60,012)	(40,989)	(40,320)	(60,012)	(42,378)	(41,675)
1989		85,849	85,849	137,655	130,410	51,806	29,243	28,530	44,561	26,443	25,788
1990		116,558	116,558	202,635	191,970	86,077	40,156	38,855	75,412	37,606	36,368
1991		116,558	116,558	205,200	194,400	88,642	34,175	32,797	77,842	32,620	31,283
1992		116,558	116,558	205,200	194,400	88,642	28,244	26,883	77,842	27,411	26,069
1993		116,558	116,558	205,200	194,400	88,642	23,342	22,035	77,842	23,035	21,724
1994		116,558	116,558	205,200	194,400	88,642	19,291	18,062	77,842	19,357	18,108
1995	973	116,558	117,531	205,200	194,400	87,669	15,768	14,642	76,869	16,063	14,898
1996		116,558	116,558	205,200	194,400	88,642	13,176	12,135	77,842	13,669	12,572
1997		116,558	116,558	205,200	194,400	88,642	10,889	9,947	77,842	11,487	10,477
1998	12,414	116,558	128,972	205,200	194,400	76,228	7,739	7,011	65,428	8,113	7,338
1999		116,558	116,558	205,200	194,400	88,642	7,438	6,683	77,842	8,112	7,275
2000		116,558	116,558	205,200	194,400	88,642	6,147	5,478	77,842	6,816	6,063
2001		116,558	116,558	205,200	194,400	88,642	5,080	4,490	77,842	5,728	5,052
2002		116,558	116,558	205,200	194,400	88,642	4,198	3,680	77,842	4,814	4,210
2003		116,558	116,558	205,200	194,400	88,642	3,470	3,017	77,842	4,045	3,509
Total	300,017	1,717,661	2,017,678	3,007,890	2,849,580	990,212	+9,921	−2,382	831,902	+3,161	−9,548
							21.81%			19.25%	

Note 1: Breakdown of capital cost is shown in Table V-10-3

Note 2: Breakdown of operating cost is shown in Table V-10-4

Table V-10-3 Economic Capital Cost

	Case A (M$'000)	Case B (M$'000)
1. Cement Plant		
Total Project Cost (Financial) excluding Interest during Construction	221,263	313,427
Less: Initial Working Capital	19,216	28,450
Sales Tax (5%) and Surtax (5%)	8,395	11,734
Economic Cost of Cement Plant	193,652	273,243
2. Mining Equipment		
Initial Cost	9,445	13,387
Replacement Cost 1995	1,260	973
Replacement Cost 1998	8,185	12,414
Total	18,890	26,774
Total Economic Capital Cost	212,542	300,017

Note 1 : It is assumed that 90% of machinery and equipment including spares for cement plant is imported.
Sales tax and surtax to be deducted from the financial capital cost are calculated as follows:

Case A (Cost of financial Projection) (Amount of sales tax Plus surtax)

Machinery and equipment: M$96,800,000 x 0.9 x 0.1/1.1 = M$7,920,000
Store and spares : M$ 5,808,000 x 0.9 x 0.1/1.1 = M$ 475,200

Case B

Machinery and equipment: M$135,300,000 x 0.9 x 0.1/1.1= M$11,070,000
Store and spares : M$ 8,118,000 x 0.9 x 0.1/1.1= M$ 664,200

Note 2 : Cost of mining equipment: see
Equipment for clay and iron ore: replaced in 7th gear after operation
Equipment for limestone: replaced in 10th year after operation

Table V-10-4 Estimated Operating Cost

(Net Capacity Utilization: 100%)

Variable Cost	Case A (Consumption)	Case A (Price)	Case A (M$/ton cement)	Case B (Consumption)	Case B (Price)	Case B (M$/ton cement)
Limestone	1.210 ton	M$ 13.95/ton	16.88	1.258 ton	M$ 2.25/ton	2.83
Clay	0.312	1.66	0.52	0.216	1.29	0.28
Silica sand	0.036	1.66	0.06	0.057	23.93	1.36
Iron ore	0.011	12.02	0.13	0.029	22.92	0.67
Gypsum	0.05	45.43	2.27	0.05	47.43	2.37
Fuel (coal)	0.122	192.07	23.43	0.119	187.99	22.37
Electric power	118 KWH	0.20/KWH	23.60	116 KWH	0.20/KWH	23.20
Paper bag			8.30			8.70
Transportation cost			15.00			23.00
Agent fee			10.00			10.00
Sub-total			100.19			94.78
Fixed Cost	(Annual Cost)			(Annual Cost)		
Consumables	M$2,666,400		4.00	M$3,726,900		3.45
Maintenance Cost	M$2,904,000		4.36	M$4,871,000		4.51
Labor	M$3,075,000		4.62	M$4,116,000		3.81
Overheads	M$1,076,000		1.62	M$1,441,000		1.33
Land cost	M$ 27,800		0.04	M$ 40,200		0.04
Sub-total	M$9,749,200		14.64	M$14,195,100		13.14
Total			114.83			107.92

Note 1 : Prices of limestone, clay, silica sand and iron ore are to be estimated by deducting quarry royalty, depreciation and interest from the prices used for financial projections.

Note 2 : Prices of gypsum and coal are to be estimated by deducting surtax (5% of CIF price) from the prices used for financial projections.

Note 3 : Consumables are exclusive of sales tax and surtax of imported materials.

Note 4 : Other costs are as per costs for financial projections.