(3.) Portland-cement Manufacture.

The quarrying of material for the manufacture of Portland cement, together with the mechanical and chemical processes necessary to produce the finished article, is becoming an important industry in New Zealand, quarries and works of considerable magnitude being established at Whangarei (north Auckland), Golden Bay (Nelson), and Milburn (Otago).

At Tarakohe, Golden Bay, the extensive quarries and works of the Golden Bay Portland Cement Company (Limited) are situated. For the purpose of obtaining information regarding the operations at Tarakohe I have inspected the works, the following being a report upon the quarries and process of manufacture, with the result attained :—

Synopsis of Manufacture from Raw Material to Portland Cement.

QUARRIES (MECHANICAL PROCESS).

The limestone and marl quarries are favourably situated in proximity a few chains inland from the wharf, on the northern slope of a hill.

The limestone has been classed by Dr. J. M. Bell as Miocene (Oamaru Series) in Bulletin 3 of the Geological Survey of New Zealand ; the overlying marlstone (calcareous claystone) quarried is of similar geological age.

The quarries are worked in benched faces, the overburden being stripped preparatory to quarrying. At the limestone-quarry the face has a maximum height of about 90 ft. The marl-quarry is of lesser height. This raw material is broken down by blasting, gelignite and blasting-powder being used.

The following are the average valuations of limestone and marl from the quarry as obtained by Mr. Sydney F. Strudwicke, works chemist to the company :—

	Percentage Carbonate of Lime.
Sample No. 1—Quarry-floor	95·4
„ 2—About 5 ft. above floor	93·0
„ 3—Average height from quarry-floor 5 ft. to 15 ft.	89·4
„ 4 „ „ 15 ft. to 25 ft.	90·2
„ 5 „ „ 25 ft. to 45 ft.	91·0
„ 6 „ „ 45 ft. to 70 ft.	94·8
„ 7 „ „ 70 ft. to 80 ft.	96·2
„ 8 „ „ 80 ft. to 90 ft. or more	95·9
„ 9 „ „ over 100 ft.	96·8
„ 10—Average of remainder to extreme top of deposits, say about 125 ft. height	97·8

Various layers of limestone shown above are roughly classified according to their exterior appearance in the various strata of the limestone-deposits. The stone becomes richer as the top of the deposit is approached.

Typical Complete Analysis of Limestone, being Average Value of Stone for 25 ft. above Quarry-floor (Samples 1 to 4 inclusive).

	Per Cent.
Moisture	0·24
Carbonic anhydride	40·10
Silica and insoluble	5·88
Alumina	1·05
Peroxide of iron (estimated as ferric only)	0·32
Lime	51·08
Magnesia	0·85
Sulphuric anhydride	Traces
Alkalis and undetermined	0·48
Total carbonate of lime, 91·20 per cent.	100·00

General Sample of Blue Marl used in Cement-manufacture.

	Per Cent.
Moisture	9·63
CO_2 and combined water	18·25
Silica	36·44
Alumina	8·49
Iron-oxide (as peroxide only)	5·76
Lime	18·44
Magnesia	0·80
Sulphuric anhydride	None
Alkalis and undetermined	2·19
Carbonate of lime, 32·93 per cent.	100·00

It has been laid down* that a Portland-cement mixture when ready for burning should contain about 75 per cent. of lime carbonate ($CaCO_3$), and about 20 per cent. silica (SiO_2), alumina (Al_2O_3), and iron-oxide (Fe_2O_3) together, the remaining 5 per cent. containing only magnesia, sulphur, and alkalies that may be present. Good commercial cement should have the following limits of these ingredients : Silica, 20 to 25 per cent. ; alumina, 4 to 8 per cent. ; oxide of iron, 2 to 5 per cent. ; lime, 60 to 67 per cent. ; magnesia, 0 to 2 per cent. ; sulphuric anhydride, 0 to 2 per cent.

The raw material is carried by gravitation tramway to the factory adjacent to the wharf.

CRUSHING, GRINDING, AND MIXING OF RAW MATERIALS (MECHANICAL PROCESS).

The second step is the thorough crushing, grinding, and mixing of the raw materials to such a fineness that 90 to 95 per cent. of the mixture will pass through a sieve having 32,400 apertures per square inch. The marl is crushed down to about 2 in. by a Hadfield's "Stag" jaw crusher ; limestone is crushed to the same gauge by Newell's No. 8 gyratory crusher, having a capacity of 100 cubic yards

* "The Portland Cement Industry," by W A Brown (Crosby Lockwood), p. 9.