

CAPEX CONSIDERATIONS

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analyse CAPEX

considerations of various
engineering options when
establishing a modular
grinding plant.

Background and objective

Modular clinker grinding plants are not only to be envisaged as industrial assets, but also as tools of the supply chain, especially in coastal areas, as they are quick and easy to erect, imply a reduced CAPEX, and are close to niche or small markets that do not necessarily need massive industrial facilities to supply them.

This article is aimed at providing a better understanding of modular grinding projects under an EPC approach, as well as benchmarking its advantages against other supply methods, such as EP or package contracting

Modularisation

Modular grinding plants are an ideal tool to supply markets of about 0.25 million tpy with ball mill technology and about 0.3 million tpy with vertical roller mill technology (VRM), depending on the final product composition and grindability of the mix.

Table 1. MMG modular mobile grinding equipment characteristics (Source: CBMI - GlobBULK).

MMG characteristics	Ball mill	Vertical roller mill
Grinding capacity	35 tph @ 3800 Blaine Up to 0.32 million tpy	60 tph @ 4500 Blaine Up to 0.5 million tpy
Power supply	MV 6.3 kV or LV 400v	MV 6.3 kV or LV 400v
Dust emissions	Dust emissions: 30 mg/Nm ³	Dust emissions: 30 mg/Nm ³
Noise emissions	85 dB inside buildings 50 dB outside buildings	85 dB inside buildings 50 dB outside buildings
Raw materials shed	Capacity to be defined	Capacity to be defined
Mill feed bins	3 x 15 m ³ each	3 x 15m ³ each
Cement silos	2 x 1000 t capacity each	2 x 1000 t capacity each
Packing plant	90 tph six-spout rotary packer	90 tph six-spout rotary packer
Bagged cement loading	2 x overhead manual loader	2 x overhead manual loader
Bulk truck loading station	2 x 120 tph	2 x 120 tph
Weighbridge	1 x 80 t (13 x 3 m)	1 x 80 t (13 x 3 m)
Electrical control and drives	Substation, MCC, control, PLC	
Palletising	90 tph (optional)	90 tph (optional)
Utilities system	Cooling and industrial water, compressed air, electricity	Cooling and industrial water, compressed air, electricity
Utilities system	Optional (potable water, fire fighting, HVAC)	Optional (potable water, fire fighting, HVAC)
Buildings	Industrial buildings	Industrial buildings
Buildings	Optional (offices, canteen and changing room, workshop and spare parts, others)	Optional (offices, canteen and changing room, workshop and spare parts, others)
Diesel generator	Optional	Optional
Infrastructure	Optional (roads, dainage, fencing, others)	Optional (roads, dainage, fencing, others)
Laboratory	Optional	Optional

The modular concept for grinding plants consists in the supply of prefabricated equipment, which is installed inside modules. Those modules must fit sea transport handling standards (in size and weight). The different types of modules are as follows:

- Standard containers with the equipment placed inside.
- Container-sized modules with own structure with installed equipment.
- Oversize equipment and parts to be shipped in roll-on roll-off (RORO) sea transport flat racks and devices.

The modularisation for mill sections, as the standard and main equipment supply, is as follows:

- About 14 prefabricated modules.
- About 11 open top or dry 40 ft containers for break bulk, ancillaries, and sundries (containers to be returned after transport).

For raw materials and cement storage, dispatch, buildings, auxiliary equipment, utilities, and other plant sections, the number of additional modules has to be calculated on a case-by-case basis, because it depends on the scope of equipment supply and type of contracting mode.

Modularisation in cement grinding provides the following advantages:

- Low CAPEX.
- A faster payback.
- A quick project implementation with short manufacturing, transport, erection, and commissioning.
- Faster time to market since the project is approved.
- Smaller footprint for construction.
- Flexible plant arrangement and options for dispatch and auxiliary equipment.
- Likelihood of avoiding deep/piling foundations (depending on soil conditions).
- Equipment tested in workshop.

Table 2. MMG ball mill and vertical roller mill performance tables (Source: CBMI).

Ball mill						
Mill size	2.2 m dia. x 6.5 m			3.0 m dia. x 10.5 m		
Product	CEMI	CEMII/A-L	CEMII/B-L	CEMI	CEMII/A-L	CEMII/B-L
Blaine (cm ² /g)	3200	3200 – 4500	4500	3200	3200 – 4500	4500
Grindability (kWh/t)	31	24 – 42	34	31	25 – 43	
Capacity (tph)	11	8 – 14	10	36	26 – 45	34
Approximate annual rate (tpy)	60 000 – 100 000			190 000 – 320 000		
Installed motor power (kW)	380			1250		
Vertical roller mill						
Product	Ordinary portland cement		Portland limestone cement, portland pozzolana cement, and portland slag cement		Ground granulated blastfurnce slag (GGBFS)	
Blaine (cm ² /g)	3500 – 4500		4000 – 5000		4000 – 4500	
Grindability (kWh/t)	19 – 25		15 – 19		24 – 27	
Capacity (tph)	45 – 50		55 – 60		34 – 50	
Approximate annual rate (tpy)	300 000 – 500 000					
Installed motor power (kW)	1200					
Total installed power (kW)	2200					

Note: the final gurantee for specific project will be finalised by material laboratory test.

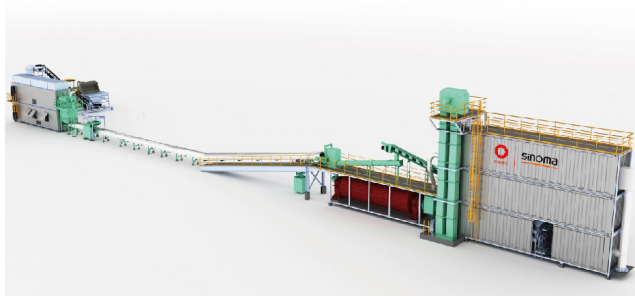


Figure 1. MMG ball mill: 3D views.
Source: CBMI.

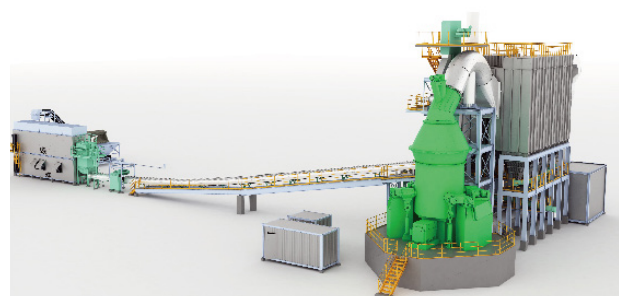


Figure 2. MMG vertical roller mill: 3D views.
Source: CBMI.

Modularisation and pre-assembly design are a proven technology that allows for quick erection and dismantling for re-erection elsewhere, high reliability and operation rate, as well as flexibility for different type of cement.

MMG technical concept

Chinese cement manufacturing equipment supplier and engineering company, CBMI, has developed and designed an innovative modular mobile grinding (MMG) concept. The EPC concept developed by CBMI can reach 35 tph with ball mill technology and 60 tph with VRM technology. Table 1 includes detailed technical specifications; Table 2 includes mill performance data.

The basic EPC MMG modular system includes the following main equipment:

- Raw materials storage in open piles with New Jersey retaining walls.
- Mill feeding hoppers (three units for clinker, gypsum, and additives) and dosing system (three weighfeeders),
- Mill (ball mill or VRM) with separator and auxiliaries, process and nuisance filters.
- Cement transport system to silos.
- 2 x 1000 t cement silos.
- Bulk truck loading and dispatch facilities.
- 90 tph cement packing and bag loading.
- Electrical and control equipment.
- Weighbridge and utilities.
- Civil works, erection, supervision, engineering, and training.

EPC optional supplies includes the following:

Table 3. CAPEX build up, broken-down averages in EPC projects for each project cost (Source: GlobBULK).

	Description	Cost split	Comments
1	Civil works plant layout and infrastructure	17	Including buildings for administration, workshop, changing room...
2	Steel structure supply	8	DAP transport included
3	Mechanical equipment supply	22	DAP transport included
4	Electrical and automation supply	19	Transport included
5	Site facility/temporary water and power for construction	2	For construction purposes
6	Erection and commissioning	7	
7	Engineering	3	Civil, structure, mechanical, electrical and process
8	Project management (CBMI)	5	
Total plant proper for CBMI work		83	Supply, transport, erection, and construction
9	Pre-production expenses:		
	Taxes and duties (civil works, mechanical and electrical)	Client	
	Pre-feasibility study / feasibility study / tender document	Client	
	Topographic /soil investigations	Client	
	Environmental impact	Client	
	Other fees for professional services	Client	
	Insurance premiums (ARI, etc...)	Client	
	Client project administration	Client	
	Site expenses	Client	
	Other miscellaneous expenses	Client	
	Subtotal pre-production expenses	0	
10	Project management (GlobBULK)	7	
11	Escalation	Client	
12	Contingencies	10	
Total project cost		100	
13	Interest / financing charges	Client	
14	Financing charges	Client	
Total project investment		100	

- Storage shed for raw materials.
- Additional feeding bins and weighfeeders to increase product portfolio.
- Palletising equipment and palletised cement storage facilities.
- Diesel generators and tank.
- Laboratory, administration building, changing room and canteen, maintenance workshop, and spare parts room.
- Roads, drainage, and fencing.

Optional services, called EPC PLUS, can be also provided, such as operation and maintenance for an agreed period of time, strategic spare parts for two years operation, and feasibility research for project financing

Project implementation schedule typically comprises a period of 10 – 12 months from effective contract commencement date. Figures 1 and 2 show 3D drawings for the MMG modular system.

CAPEX preparation

CAPEX preparation is a key issue for the project success. A basic CAPEX scheme consists of engineering, supply and transport of mechanical and electrical equipment, steel structure, spare parts, civil works (including concrete, pilling [if needed] and construction works), erection works, commissioning and start-up, project supervision and training (called plant proper). Adding to the above, the pre-operative expenses, contingencies, and financing, the total project cost is obtained.

For the plant proper cost, the following assumptions have to be taken into consideration:

- The type of the mill (ball mill or VRM) shall be selected, depending on the volume and materials to be ground.
- The design of the raw materials storage has to consider the size of the incoming vessels (whether

Table 4. CAPEX build up: cost averages in EP projects for supply of mechanical and electrical (Source: GlobBULK).

Description		Cost split	Comments
3	Mechanical equipment supply	22	DAP transport included
4	Electrical and automation supply	19	DAP transport included
7	Engineering	3	Civil, structural, mechanical, electrical and process
Total supply DAP for mechanical and electrical equipment		44	

Table 5. CAPEX build up: benchmark EP vs EPC cost averages (Source: GlobBULK).

Description	Supplier A: EPC (equipment supply)	Supplier B: EPC (equipment supply + erection)	Supplier C: EPC Plus (CBMI/GlobBULK)	
1	Civil works plant layout and infrastructure	Client	Client	Included
2	Steel structure supply raw materials storage	Client	Client	Included
	Steel structure supply (mill building and other buildings)	Client	Client	Included
	Steel structure supply (mill cement silos)	Client	Client	Included
3	Mechanical equipment supply	Included	Included	Included
4	Electrical and automation supply	Included	Included	Included
5	Transport of equipment	Client	Included	Included
6	Site facility/temporary water and power for construction	Client	Client	Included
7	Erection and commissioning	Client	Included	Included
8	Engineering	Included	Included	Included
9	Project management and training (supplier)	Client	Included	Included
Total plant proper		35%	56%	83%

seaborne supply or the volume of the strategic stock in case of rail or road supply).

- The number of feeding bins shall be decided based on the additives to be used.
- Storage size and number of cement silos shall be decided taking into consideration the current and future product portfolio and seasonality.
- Cement dispatch facilities will be designed depending on the bagged/bulk ratio.

Depending on the contracting mode, several cost items will be included in the scope of supply by the main contractor, such as transport of the equipment and type of delivery (Ex works, FOB, CFR, DAP), civil works, piling, raw materials storage and size, offices, buildings and infrastructure, water and power, erection, supervision, training, and spare parts.

Total project cost also has to consider the following cost items:

- Pre-operational expenses (such as taxes and duties, feasibility study, tender document, soil investigation, environmental impact, insurance professional services, site costs, project management and other costs).
- Escalation.

- Contingencies.
- Interest and financing.

CAPEX analysis

Table 3 shows the breakdown of each project-related cost in terms of percentage versus total cost considered as 100%. The purpose of this analysis is to evaluate the weight on average (%) of each cost item in relative terms. From Table 3, it can be noted that in EPC projects, plant proper accounts for 83% of the total project cost, whereas the project management, preproduction expenses, and contingencies account for the remaining 17%.

Table 4 shows that in EP projects, the supply of mechanical and electrical supply of equipment, transport, and engineering accounts only for 44% of the total project cost. In this case, it must clearly be underlined that there is still a significant 66% of CAPEX costs that have to be borne/contracted separately by the client.

It is the client's responsibility to prepare a clear and comprehensive tender document, including description of the scope of supply and services required to obtain a comprehensive quotation, to be benchmarked and compared with at a later stage during the tender evaluation and procurement process.

CAPEX benchmark

A correct benchmark of supplier's proposals allows the client to establish a like-for-like comparison of all cost items of the project. For this reason, it is recommended to provide to all suppliers in the tender document a detailed list and a table with scope of supply and services to be offered.

Table 5 shows the benchmark made of three different proposals from different suppliers. The breakdown figures from the total plant proper (83% of the total project cost) are as follows:

- 35% accounts for EP contracting (equipment supply FOB, and engineering). Remaining to be contracted by the client stands at 48% of total plant proper.
- 56% accounts for EP + erection contracting (equipment supply, transport, engineering, erection, project management, and training). Remaining to be contracted by the client stands at 27%.
- 83% (100% of the total plant proper) accounts for EPC PLUS contracting. No remaining to be contracted by the client.

The above figures show the advantage of EPC contracting versus other alternatives in such small projects. In addition, EPC contracting


avoids management of interfaces and loss of responsibilities due to contractor overlaps or blind zones between different contracts.

Conclusions

Modular grinding plants enable cement producers to meet low CAPEX and fast project implementation schedule. A price or an offer is not enough to precisely establish a total project cost: it must be clearly understood what is included in a techno-economic proposal and benchmark in like-for-like basis against other potential vendors.

Supply of mechanical and electrical equipment typically accounts for only 44% of the total project cost.

The contracting benchmark of total plant proper shows that: EP FOB accounts for 35%, whereas EP + erection accounts for 56%, and EPC PLUS accounts for 83% (100% of the total plant proper)

EPC contracting enables easier project management for the client. 

About the authors

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