

Dry Mix Mortar And Its Market Potential In Maharashtra (India) - An Advance Technology Based Material

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Abstract: Dry mix mortar is advance technology widely used in European countries and to a limited extent in India. Indian construction industry still relies on job site technology because cost of dry mix mortar is high as compared to job site mortar. But it is the fact that labour and its cost can be minimized and also overall quality can be achieved along with speed in construction by the use of dry mix mortar. Dry mix mortar manufactured with new technology has one of the biggest advantages that wastage of sand which is one of the major content of dry mix can be avoided in order to sustain Indian construction industry which is facing problem of availability of sand. Based on comparative study of dry mix manufacturing industries in Maharashtra (India), the attempt in this paper work is to study the dry mix manufacturing technology, different standards such as European, British, US, and market potentials. And also to specify the specifications for dry mix mortar as Indian specifications based on experimental study of the samples collected from working plants to attract the Indian engineers and builder community to use dry mix mortar to fulfill the needs of construction industry of executing the work speedily and in quality manner.

Keywords: dry mix mortar, quality standard, construction industry, advance technology, job site, market potential.

1. Introduction:

Mortar is amongst the most versatile materials used in modern construction. It serve to lay bricks and other masonry blocks, coat buildings as renders and skin coats, fix tiles. Now a days with emerging demands of Indian and foreign construction industry for new building materials and technologies more and more factory mixed that is dry mix mortar is conquering the market and replacing the traditional job site mixing mortar by advanced dry mix mortar technology which is widely used in India for last 10 years.

From the literature study and visiting the dry mix manufacturing plants, it is observed that, there is a lot of variation from industry to industry and place to place regarding procurement of material, manufacturing processes and marketability for dry mix mortar in India. The variation may be because of not having the specific uniform standards specified as IS, ASTM, UBC, BRITISH etc. The standards given in ASTM, UBC, and BRITISH may not be applicable to every time everywhere for Indian conditions. Therefore this work includes studying the material management, manufacturing process, quality standards

and market potential of dry mix mortar, also to specify the specifications for dry mix mortar as Indian specifications based on experimental study of the samples collected from working plants.

2. Dry mix mortar technology and its advantages:

Dry mix mortar is produced in specially designed dry mix mortar plants in which binders and aggregate are mixed in the appropriate way and are transported to construction site into the bags or silos and need only be mixed with water prior to use. This factory based process also allows different additives and admixtures to be added to these mortars to improve significantly their technical performance. Based on this technology individual dry mix mortar for specific application can be produced according to formulations developed and pretested in the laboratory.

Dry mix mortar comprises of three ingredients such as cement, sand and admixtures. It is high quality premix used for plastering and masonry work. It is manufactured with cement (Ordinary Portland cement), well graded river sand and some admixtures as per the requirement of dry mix.

Following are the details of ingredients of dry mix mortar

2.1 Cement (Ordinary Portland cement):

Ordinary Portland cement is mainly used in the dry mix mortar. The hydration reaction leads primarily to the formation of calcium silicate hydrates, which retain their strength and stability even under water (Hydraulic binder). While the quality of an OPC is sufficient for brick laying mortar, renders and many different types of plasters.

2.2 River sand:

Sand obtained from river is a naturally occurring granular material composed of finely divided rock and mineral particles. River is the main source of sand, in this majority of sand particles are normal size fractions. Sand of different specified grades (S1- 4 to 3mm, S2-3 to 2mm, S3-2 to 1.5mm, S4- 1.5mm to 0.5mm) is used in the manufacturing of dry mix mortar. Sand is graded into different grades at plant by sand grader according to the requirement.

2.3 Admixtures:

Admixtures are added into the dry mix mortar to get maximum technical properties such as workability, consistency, water retention of mix and also hardened mortar property that is compressive strength and bond strength. Mainly used admixtures are methyl hydroxyethyl cellulose (MHEC), methylhydroxypropyl cellulose (MHPC), methyl cellulose (WALOCCEL), re dispersible polymer powder (DLP: DOW Latex powder).

2.4 Mix proportion:

Indian dry mix manufacture produce plaster and masonry dry mix mortar. Dry mix mortar for plaster is produced with mix proportion 1:4, and sand gradation 3mm. Dry mix mortar for masonry is produced with mix proportion 1:4 and sand gradation 4mm. Use of sand gradation may be changed during manufacturing process as per the requirement of mix quality. Third ingredient that is admixture is added in the dry mix mortar, its content lies between 0.1% to 10% weight of the batch quantity.

2.5 Advantages of dry mix mortar:

1. Reduced shrinkage cracks through better cement hydration
2. No delaminating or pop-out on smooth or concrete surface due to very good bond strength
3. Good workability and sag resistance

4. Very good compressive flexural and tensile strength than ASTM standard values
6. Good water resistance property
7. Better flexibility
8. Consistent quality
9. Easy to mix and apply
10. Better finish and surface appearance
11. Almost nil wastage of the material at site
12. Minimum space required for the storage
14. Inventory cost saving
15. No multiple raw material (sand, cement and additives)
16. Minimum supervision requires

3. Dry mix mortar manufacturing in the Maharashtra (India):

It is essential and important to carry out study of any technology for its acceptance as new technology. Dry mix mortar is manufactured almost in all major states of India and in some cities from Maharashtra. In Maharashtra, cities like Pune, Mumbai, Kurkumbha, Kolhapur, Sangli are having tremendous construction work. Hence study is confined to the three plants from these cities. Data regarding materials, manufacturing processes, different standards collected in terms of questionnaire used for analysis. Experimental work have been conducted in the laboratory for the samples collected from the presently working three plants from the above mentioned cities of Maharashtra (India)

4. Dry mix manufacturing plants in Maharashtra (India):

Three plants from the cities of Maharashtra such as Kurkumbha, Pune, and Mumbai are producing dry mix mortar since last ten years. For comparative study and analysis data is collected from these three plants.

Table No 4.1 Comparative data

Item	Plant1	Plant2	Plant3
Year of plant installation	2000	2006	2010
Total production capacity of plant	720t/day	100t/day	100t/day
Total area of factory in acres	6 acres	4 acres	3 acres
Raw materials and their sources	Cement, Sand(River sand), admixtures-	Cement, Sand(River sand), admixtures	Cement, Sand(River sand), admixtures

	(FIV-51)		
Type of dry mix mortar production	External plaster and Masonry	External plaster	External plaster
Raw material and their specifications	1 part of Fresh Cement, 4 part of River Sand in different gradation such as S1(4 to 3mm)S2(3 to 2mm) S3(2 to 1.5mm)S4(1.5 to .5mm) and Admixture as per requirement of premix	1 part of Fresh Cement, 4 part of River Sand in different sizes such as 0.1mm to 3.45 mm, Admixture as per requirement of premix	1 part of Fresh Cement, 4 part of River Sand in different sizes such as 0.1 to 3.45 mm , Admixture as per requirement of premix
Manufacturing process of adopted standard	Dry mix mortar is manufactured in modern	Dry mix mortar is manufactured in modern	Dry mix mortar is manufactured in modern

	fully automated plant	fully automated plant	fully automated plant
Material quantities requiring for daily targeted production quantity	For 100t 1. sand-60%, 2.cement-15%, 3.2 % fly ash 4.additives-23%	1. sand-60%, 2.cement-15%, 3 .additives-25%	1. sand-60%, 2.cement-15%, 3.additives-25%
Package material and package capacity	Plastic bags 50 kg each	Plastic bags 40 kg each	Plastic bags 50 kg each
Quantity of dry mix mortar produced	48000 tones	30000 tones	15000 tones

5. Dry mix manufacturing process:

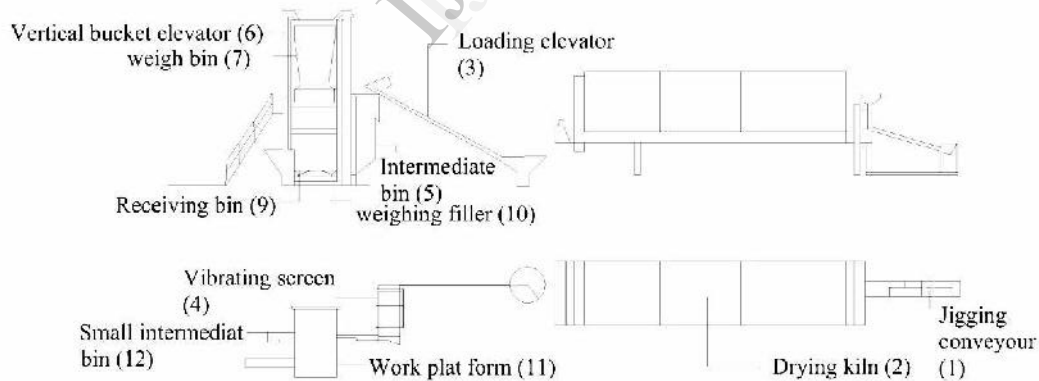


Fig No 1 Manufacturing process flow diagram of the plant 100 t/day capacity

The manufacturing process (Fig No 1) of the dry-mix mortars is based on carefully mixing from two to four main (and some additional) components, which determine the performance characteristics of the mortar. After this, the final product is weighed and packaged. The main component (i.e. sand) is loaded onto the jigging conveyor (1). Then it goes into the drying kiln (2). Currently, the component is cooled by

outside air. After going through the drying kiln, the component is delivered by the loading elevator (3) to the vibrating screen (4). Then it goes into the intermediate bin (5), from where the vertical bucket elevator (6) loads it into the weigh bin (7). Once there, the second component (i.e. cement) is added with a second vertical bucket elevator (6) from the small intermediate bin (12). The additives, which give the mortar its performance characteristics, are added from work platform (11). Then the finished mortar is

automatically delivered into the receiving bin (9) and then into the weighing filler (10), which delivers it into valve bags of a specified weight. The original electronic control system provides accurate measurements of the primary components and weighing of the final product.

6. Experimental work for property specifications of dry mix mortar:

The experimental work for the property specifications of dry mix mortar such as compressive strength, consistency, water retention is carried out in the laboratory. Plant 1 produces two different dry mix mortars for external plaster and masonry, while Plant 2 and Plant 3 produces only external plaster for both the jobs, therefore in the results for Plant 1 two different values are obtained and the results for Plant 2 and Plant 3 are found to be same in the table.no 6.1,6.2and 6.3.We could not get any references from the literature review regarding the experimental studies for property specifications for dry mix mortar in Maharashtra(India).

6.1 Compressive strength test:

Compressive strength testing in accordance with ASTM C 270 is conducted on specimens of dry mix mortar in the testing laboratory. Compressive strength specimens 2 inch (51mm) mortar cubes was casted in nonabsorbent molds and cured in a water tank and tested after 28 days for compressive loading to calculate the value of compressive strength in N/mm^2

Table No 6.1: Average compressive strength after 28 days in N/mm^2

Sr. No.	Type of Dry mix mortar	Average compressive strength after 28 days in N/mm^2		
		Plant 1	Plant 2	Plant 3
01	External plaster	17.05	17.29	31.88
02	Masonry	28.68	17.29	31.88

6.2 Consistency -Cone penetrometer test:

The consistency of dry mix mortars is measured using a cone penetrometer as referenced in ASTM C 780. This device measures the depth of mortar penetration in millimeters.

Table No 6.2: A Consistency in mm

Sr. No.	Type of Dry mix mortar	Consistency in mm		
		Plant 1	Plant 2	Plant 3
01	External plaster	291	175	173
02	Masonry	227	175	173

6.3 Water retention-Flow table test:

Water retention is determined in the laboratory by measuring the dry mix mortars "initial flow" and "flow after suction". Initial flow is the percentage increase in diameter of a dry mix mortar sample when it is placed on flow table and dropped 25 times in 15 seconds. The same procedure is used to determine flow after some of the dry mix mortars mix water has been removed by an applied vacuum. (Bricks were used to absorb the water from dry mix mortar)

Water retention is the ratio of flow after suction to initial flow, expressed as a percentage.

Table No 6.3: Water retention in %

Sr. No.	Type of Dry mix mortar	Water retention in %		
		Plant 1	Plant 2	Plant 3
01	External plaster	61.87	95.89	42.53
02	Masonry plaster	89.82	95.89	42.53

7. Comparison with the dry mix mortar samples collected from the three plants for property specifications:

To specify the IS property specifications for the dry mix mortar ASTM standard values are used (Table No 7.4 and 7.5) for the comparison as ASTM maintains national standards for mortars and materials commonly used in mortars that is masonry cement (ASTM C150), masonry cements are classified as type M, S, or N according to ASTM C270. Type N masonry cement can be combined with Portland cement or blended hydraulic cement to produce type S of M mortars.

7.1 Comparison for compressive strength:

Table No 7.1 Comparison with ASTM standard values

Dry mix mortar	Obtained Values in N/mm^2			ASTM values in N/mm^2
	P1	P2	P3	
External plaster	17.05	17.29	31.88	5.2
Masonry	28.68	17.29	31.88	5.2

Table No 7.1 shows the minimum common obtained value of external plaster dry mix mortar for compressive strength (17.05N/mm^2) is higher by 227.88% than ASTM standard value (5.2N/mm^2) it indicates that external plaster dry mix mortar is far better for its compressive strength property. Also for masonry dry mix mortar (17.29N/mm^2) is higher by 232.50% than ASTM standard value (5.2N/mm^2) it indicates that masonry dry mix mortar is far better for its compressive strength property

7.2 Comparison for consistency:

Table No 7.2 Comparison with ASTM standard values

Dry mix mortar	Obtained Values in mm			ASTM values in mm
	P1	P2	P3	
External plaster	291	175	173	65
Masonry	227	175	173	65

Table No 7.2 shows the minimum common obtained value of external plaster and masonry dry mix mortar for consistency (173mm) is higher by 166.15% than ASTM standard value (65mm) it indicates that external plaster and masonry dry mix mortar is far better for its consistency property.

7.3 Comparison for water retention:

Table No 7.3 Comparison with ASTM standard values

Dry mix mortar	Obtained Values in %			ASTM values in %
	P1	P2	P3	
External plaster	61.87	95.89	42.53	75
Masonry	89.82	95.89	42.53	75

Table No 7.3 shows the minimum common obtained value of external plaster and masonry dry mix mortar for water retention (42.53%) is lower by 43.29% than ASTM standard value (75%). But the lower values of water retention will not affect much more on the strength of dry mix mortar for long term and also on its durability, since water retention is important factor during setting of the mortar, its effect is important from workability point of view during plastic stage of mortar. This factor is not having significance in the hardened stage of dry mix mortar that is the strength and the environment effect on mortar that is durability.

Table No7.4: ASTM C270 Property specification requirements (Ref. 7)

Mortar	Average compressive strength at 28 days minimum psi (MPa)	Water retention minimum %	Air content Maximum %
Type M	2500 (17.2)	75	18
Type S	1800 (12.4)	75	18
Type N	750 (5.2)	75	20
Type O	350 (2.4)	75	20

Table No7.5: ASTM C780 Cone penetration property specification requirements (Ref. 11)

Mortar	Depth of penetration mm
Type N	65

8. Cost comparison of dry mix mortar and conventional mortar:

Dry mix mortar is a new material and it is for replacing the job site mortar, therefore it is essential to know its cost comparison with the job site mortar for the item. This helps to the end users regarding its suitability in replacing the job site mortar. Cost comparison is carried out for 15mm thick plastering work for 1 brass (100sqft) quantity.

Table No8.1 Cost of dry mix mortar

SR.NO.	PARTICULARS	QTY	RATE	COST in RS.
01	Dry mix mortar	5 no of bag	Rs, 315/bag	1575
Total cost of material Rs.				1575
02	Labour			
	1. mason	0.19	400/day	76
	2. Helper.	0.19	300/day	57
Total cost of labour Rs.				133
Total cost of plaster work in brass(100sqft) Rs.				1708

Table No 8.2 Cost of conventional mortar

SR.NO.	PARTICULARS	QTY	RATE	COST in RS.
01	cement	1.5 bags	Rs, 300/bag	450
	sand	8.55 cuft	Rs. 50/cuft	428
Total cost of material				878
02	Labour			
	1. mason	.375	400/day	150
	2 helper.	.375	300/day	113
Total cost of labour				263
Total cost of plaster work per brass				1141

This cost comparison indicates that the total cost of dry mix mortar is more by 49.69 % than conventional mix but cost of labor is less by 49.43 % than conventional mortar.

9. Market potential of dry mix mortar in Maharashtra (India):

Dry mix mortar is modern material for masonry and plasterwork and is in the market since last ten years. Manufacturing units of dry mix mortar are almost in all major Indian states such as Maharashtra, Gujarat, Delhi, Calcutta, Tamilnadu, and Kerala. In Maharashtra the plants have been located in the cities like Mumbai, Pune, Nagpur and Thane.

The growing rate of construction industry is high. The demand of construction industry for dry mix mortar which is considerably very low therefore the manufacturers of dry mix mortar running their plants on order basis. It is not the failure of manufacturers but manufactures are ready to satisfy the needs of construction industry with their full potential. Following data collection (Table No 9.1) details of products so far produced gives an idea that there is very low potential for dry mix mortar for masonry and plaster mortar. And some efforts have to be taken to support the new technology by end users from construction industry.

Table No 9.1 Comparative production data

Dry mix mortar plant	Type of dry mix mortar	Quantity produced in last ten years
Plant 1	Masonry and Plaster	48000 tones
Plant 2	Plaster	30000tones
Plant 3	Plaster	15000 tones

10. Conclusion:

Dry mix mortar is a new material technology which has been introduced by European countries initially and now it is used in Indian from last ten years in various states such as Maharashtra, Gujarat, Tamilnadu, Kerala, Calcutta etc. To study the technology for its materials, manufacturing processes with various different standards, to specify the IS specifications and its market, this comparative study was carried out for the plants selected from Maharashtra(India), based on this study and analysis it is concluded that:

1. Dry mix mortar manufacturing plants provides consistent quality mix, due to proper formulation of its major three constituents such as Ordinary Portland Cement, river sand, additives.
2. Being fully automatic operation, production cost goes high compared to semi-automatic indigenous plants, which is observed during the study
3. It is observed that feasible locations of dry mix mortar plants should be nearer to the source of sand.
4. Plant installation cost varies as per the plant capacity
5. Dry mix mortar plants can be used to produce other powder premixes such as wall putty, tile additives etc. Hence installation of multipurpose plants for production of various premixes is essential.
6. Effective working of plants with less labour may be possible.
7. Plant working and formulations of dry mix mortar should be as per standard.
8. Manufacturers should be supported by end users for better use of this material.
9. Dry mix mortar has strong technical features, but it should be conveyed properly
10. Due to consistent dry mix quality, dry mix mortar is efficient, durable, free from shrinkage cracks formation
11. The common minimum compressive strength test value (17.05N/mm^2) of external plaster is higher by 227.88% than ASTM standard value (5.2N/mm^2). Also for masonry dry mix mortar value (17.29N/mm^2) is higher by 232.50% than ASTM standard value (5.2N/mm^2). It indicates that the external plaster and masonry dry mix mortar is far better for its compressive strength.
12. The common minimum consistency test value (173mm) of external plaster and masonry dry mix mortar is higher by 166.15% than the ASTM standard value (65mm). It indicates that the external plaster and masonry dry mix mortar is far better for its consistency.
13. The common minimum water retention test value (42.53%) of external plaster and masonry dry mix mortar is lower by 43.29% than the ASTM standard value (75%). But this lower value of water retention will not affect much more on the strength since water retention is important than workability point of view during plastic stage of mortar.

14. Dry mix mortar has less demand from end users because its cost is more by 49.69% than traditional job site mortar.

15. Labour cost of dry mix mortar is less by 49.43% as compared with traditional job site mortar.

16. Though the manufacturing cost seems to be high but it is compensated on other side by transportation of materials, labour requirement and quality of work provided to big projects.

17. Due to the feasibility of installation of smaller range capacity dry mix manufacturing plants, this will encourage the entrepreneur. And it may become popular like RMC

18. Lack of appropriate norms and Indian standards for dry mix mortar and also no strong Indian manufacturers association, due to this there is no interaction by end users to accept the material for its other advantages than cost, it observed during the study.

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