

## Usage of Pre Mixed Dry Mortar (PDM) In the Nigerian Construction Industry: How Far So Far?

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### ABSTRACT

This study assessed the use of pre-mixed dry mortar in the Nigerian Construction Industry. Purposive sampling was adopted where Lagos state, Kaduna state, Plateau State and the Federal Capital Territory (Abuja) were selected. The target population were the professionals and craftsmen (artisans) involve in building production process. Data were collected through structured questionnaires. Out of the 60 structured questionnaires issued 48 were returned. The 4 point - likert scale was used for the study. Results obtained were analysed using simple mean, percentile and frequency. The research revealed a high awareness level of dry mix product amongst professional and artisans. The study found that, actors such as lack of technical knowhow, lack of skilled workers, cost of dry mix product, and lack of availability of raw materials tend to serve as barriers to the acceptance and use of dry mix mortar products. Furthermore, the study found that the benefit of using dry mix mortar is pronounced most in the quality of work increase ( $\chi = 3.41$ ), followed by durability of structures, higher product performance, maintenance reduction and cost effectiveness in the long run.

**Key words:** Additives, Artisans, Dry mix mortar, Durability, Quality

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### I. INTRODUCTION

The construction industry is tending towards new technological developments that can address some of the shortcomings of traditional oriented means of building production. Lime based and gypsum based mortar have been used as bedding materials for laying stones and bricks as well as rendering materials for wall plaster applications for many years until recently in the 1950's when minerals binder within the mortar was gradually changed from lime and gypsum to cement as a result of the availability of Portland cement (Wan, 2008 cited in Green Mortar study, 2011). From that time onwards, the job-sites mortar technology has been introduced and applied in the construction industry worldwide. But due to some deficiencies ranging from the quality of the raw materials, in correct batching problems, the in homogeneity of mixture and lack of consistency of the fresh mortar, the job-site mortar has found limited applications (Plank, 2015). According to Lange and Plank (2016), Some major disadvantages of job-sites mortar includes: the whole process cannot be automated, workers cannot ensure quality due to possible errors during various steps in the production process and liquid additives can only be added wrongly or might not be added at all ending in significant variations from batch to batch. Hence job-site mortar application is limited to unimportant low performance and non-structural work without a concern on quality and durability (Hsueh, 2012).

Michael (2011), Dry mix mortar has been defined as a modern building technology that allow economic and environmental friendly alternative to the traditional mortar. Manufacturing is done in controlled manner which ensures that the quality is consistent across batches adhering to technical specifications. Usually one just needs to add water prior to the use; the process ensures that there is no scope for inconsistency of constituents or binders. Professionals or even beginners that follow the new technologies in construction industry know undoubtedly about dry concrete mixes. Nowadays dry construction mixes having high consumer qualities, have become a separate branch in construction industry (Tatale and Kulkarni., 2013).

According to Jin (2011), dry mix mortars usually form the base material in floor making, waterproofing and repair compositions, glues for ceramic tile and natural stone, cement grouting, plastering mixes of different applications. Modern dry construction mixes is not just simple cement with sand, but advanced technology product. Their application does not only increase working efficiency greatly, but also makes it possible to get perfect quality results, that were not possible to get using the usual sand-cement mixes (Tatale, *et al.*, 2013). Good quality dry mix products are available in markets with improved performance.

Most of the dry mix products can provide outstanding properties to meet the performance requirements of buildings. If properly used, they can be cost effective building materials to minimize some potential construction problems. The use of premixed dry mortars does not only increase product performance significantly but also guarantees high degree of application reliability and consistency. Factory premixed dry mortars ensures binders, fillers and chemical additives of known quality are blended exactly in the required ratio thus ensuring high degree of product performance and consistency (Usman, 2011). Most of the high performance products are usually based on extensive development process and tests in order to achieve designed material properties. Although, dry mortars cannot totally solve all construction problems they can at least provide a proper or more advanced materials approach to minimize the potential failure and enhance durability of structures. According to Huang, Yuan and Wen (2011), the 19th century witnessed the industrial revolution where everything was driven by machines. The next revolution is likely to be an environmental revolution. In the 21st century it will be the environment that drives the way we think and act and sustainability will be the mantra of the century. Sustainability is a broad and complex subject with different components and definitions.

From the literature reviewed, the authors have defined sustainability as meeting the needs of the present without compromising the ability of future generations to meet their own needs. Buildings, infrastructure and the environment are inextricably linked. The building industry is a large producer of waste, and an intensive user of virgin materials and energy. Thus, improvements in construction practice and design stage throughout the building life cycle can lead to significant environmental benefits. Globally, buildings consume 16 % of the water, and 40 % of the energy used annually; close to 70 % of the sulphur oxides produced by fuel combustion are produced through the creation of electricity used to power houses and offices.

Dry mix mortars are one among many different construction materials that used in construction of buildings. The contributions dry mix mortars can make to improving sustainability have been a topic of in-depth discussions and analysis for a long time (Huang, *et al.*, 2011). The primary impact of dry mix mortar on sustainability can be summarized into three main areas: durability, quality and efficiency as opined by Hsueh (2012). The extended durability offered by dry mix mortars can help support long term performance and low maintenance which is a major consideration when aiming for construction of more sustainable buildings. Offering better durability can also have a huge positive impact on cost savings (Huang, *et al.*, 2011). Dry mix products can be designed to meet various end-use requirements such as different climatic conditions, temperature variations, different substrates etc. and can therefore be designed to survive different weather conditions. Quality Dry mix mortars are mostly manufactured in plants which are automated and have good process controls. This helps ensure proper weighing and charging of various raw materials and additives and enables homogeneous mixing (Tatale, *et al.*, 2013). Typically, quality control is done for every batch of dry mortar produced, meaning the quality and consistency of the dry mix mortar can be guaranteed and customers can expect to receive the same quality every time. In addition, since the dry mix mortars are modified with polymers and additives, they offer excellent application properties, helping to ensure trouble free installation and excellent finishes and helping to improve living quality.

One of the most important drivers for the growth of dry mix mortar was its very high efficiency. Using dry mix mortar enables the use of machines for application which can result in huge time savings and more efficient use of material: this in turn supports very high productivity and therefore time and cost savings (Huang, *et al.*, 2011). The importance of dry mix mortars technologies in the achievement of structural design characteristics objectives and productivity of building production processes seems to be increasing daily. This is as a result of numerous problems encountered with the use of traditional mixes of construction processes worldwide which requires stringent solutions because they have far detrimental effect on the building production process. Some of these problems include: poor quality of workmanship, deterioration of building elements, excessive cost overrun, insufficient durability of structures, occupational safety these and other problems have adverse consequences not only on the building production process (Michael, 2011).

However, a prospective option of solving these problems is the use of these dry mortar technologies, which has the potentials to improve building performance in terms of durability and quality. Therefore, the aim of this research work is to appraise the application and acceptability of dry mix mortars in the Nigerian construction industry.

The objectives of the study include:

- i. To ascertain the level of awareness of dry mix mortars in the Nigerian construction industry.

- ii. To identify the reasons for the acceptance of dry mix mortars and where they are mostly applied in the building production process.
- iii. To identify the setbacks facing the acceptability and application of dry mix mortars in the Nigerian construction industry.

## II. RESEARCH METHODOLOGY

The study was conducted in Lagos state, Plateau state, Kaduna state and the Federal Capital Territory (Abuja). Purposive sampling was adopted where 10 construction companies were selected from Abuja and Lagos state each while 5 construction companies each were selected from Plateau and Kaduna states, the number of construction companies selected in each state was based on the proportion of functional construction companies in each of the surveyed states. The target population comprises of project managers which includes civil engineers, builders, and architects. Artisans (craftsmen) were also involved in the study. Two sets of identical structured questionnaires were used for the research, one for the professionals, and the other for non-professionals (craftsmen). Respondents were asked to rank their answers on a 4-point likert scale with 5 being the highest rating. Data obtained were analysed using simple mean score, percentiles and frequency.

The following formulae were used in the analysis of the data collected:

$$1. \quad \text{Percentile} = \frac{n * 100}{N}$$

Where P is the percentage of the factor

n is the size of the factor in consideration and N is total size of the population.

2. Mean was used to analyse the likert-scale data using:

$$\text{Mean} = \frac{\sum n_i k_i}{\sum N_i} = \frac{4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{N_4 + N_3 + N_2 + N_1 + N_0}$$

Where:

N = Total number of respondents

$N_4, n_4$  = the number of respondents that choose 5, etc

0 – 4 = the various marks for the ranking of the factors as applicable in each case

## III. RESULTS AND DISCUSSION

Out of the 60 randomly administered questionnaires 48 were returned, 20 were received from Abuja, 12 were returned from Lagos state, 10 were returned from Kaduna state and 6 were received from Plateau state representing 80% response rate. 14 Architects responded representing 29.1% of the total number of respondents. 10 Builders responded representing 20.8%, 8 Civil engineers representing 16.6% responded and 16 craftsmen representing 33.3% responded. Out of the 32 professionals that responded, 5% have up to 5 years of professional experience, with 25% having 6 - 10 years' experience, 63% having 10-15 years while the remaining 7% have over 15 years' experience in the industry. All 24 respondents are familiar with and use advanced dry mix mortar in construction.

Table 1: Awareness of pre mixed dry mortar technology in the Nigerian Construction Industry

Avenues	Mean Score			Rank
	Professionals	Artisan	$\chi$	
Workshops and Seminar	4.56	4.36	4.46	1
Personal Contact	4.20	4.00	4.10	2
On – Site Constructions	4.10	3.88	3.99	3
Mandatory Development Prog.	4.22	3.70	3.96	4
Bulletins and Leaflets	3.20	2.68	2.94	5
Radio and Television Adverts	2.95	2.55	2.75	6

Source: Field Survey, 2021

Table 1 shows the mean score of the awareness level of respondents about dry mix mortars in the Nigerian construction industry. The analysis of the responses showed a general positive awareness towards a number of suggested awareness option. Those avenues through which the information were gotten with positive responses were through workshops and seminars ( $\chi = 3.46$ ), Personal contacts ( $\chi = 3.10$ ), onsite constructions ( $\chi = 2.99$ ) and Mandatory continuing development programme ( $\chi = 2.96$ ). However, respondents showed

unfavourable attitudes with average mean score of ( $\chi=1.94$ ) and ( $\chi=1.75$ ) awareness level through Bulletins and leaflets and Radio and Television adverts respectively. The results showed that professionals were not positive about onsite construction awareness ( $\chi=2.88$ ) as Craftsmen ( $\chi=3.10$ ) indicating that professionals are mostly aware of such new products in seminars and workshops than onsite construction awareness.

Table 2 shows the mean scores of respondent to the reasons for the acceptance of dry mix mortar technology arranged in descending order of preference. Consistent product quality and reliability ( $\chi=3.54$ ) is the most preferred reason, followed by non-complication in the proportions of aggregates mixtures ( $\chi=3.43$ ), Availability of dry mix products ( $\chi=3.20$ ) and cost of dry mix products ( $\chi=2.90$ ) in descending order. Others are, speed of construction ( $\chi=2.69$ ) and suitability due to weather conditions ( $\chi=2.26$ ). The result shows that while professionals found consistent product quality and reliability as the most preferred reason for the acceptability of the dry mix products, the Artisans did not. However, the average mean score of ( $\chi=3.20$ ) for the preference of dry mix products availability of dry mix products indicates that the products are now familiar with both professionals and Artisans in the construction industry

Table 2: Reason for the acceptability of pre-mix dry mortar in Nigerian Construction Industry.

Reasons	Mean Score			Rank
	Professionals	Artisan	$\chi$	
Consistent product quality	4.86	4.18	4.54	1
Non complication in mix ratio	4.46	4.40	4.43	2
Availability of dry mix products	4.40	4.00	4.20	3
Cost of dry mix products	4.20	3.60	3.90	4
Speed of Construction	4.00	3.38	3.69	5
Suitability due to weather conditions	3.50	3.02	3.26	6

Source: Field Survey, 2021

Table 3 Areas of application of pre mixed dry mortar in the Nigerian Construction Industry

Area of Usage	Mean Score			Rank
	Professionals	Artisan	$\chi$	
Tiling process	4.82	4.64	4.73	1
Concreting	4.69	4.67	4.68	2
Plastering and Rendering	4.67	4.25	4.46	3
Water proofing	4.00	2.88	3.44	4
Finishing	3.30	3.50	3.40	5
Block bonding	3.10	3.50	3.35	6

Source: Field Survey, 2021

Table 3 shows the mean score of respondents rating about areas where dry mix mortar has found applications. Tiling process was rated highest with an average mean score of ( $\chi=3.73$ ) by all the respondents followed by concreting process ( $\chi=3.68$ ). Both professionals and artisans agreed that plastering and rendering is the third ranked area where dry mix mortar technology is applied. With regards to water proofing both professionals and non - professionals shared the view that it has been carried out with a lot of successes ( $\chi=2.44$ ). However, the professionals rating of both finishing process and block bonding with average mean scores of ( $\chi=2.30$ ) and ( $\chi=2.10$ ) respectively were lower than the craftsmen rating of ( $\chi=2.50$ ) each for both block bonding and finishing. The reason for this disparity may be due to the fact that professionals may have alternative means through which these products may be applied than the artisans.

Table 4 shows the mean scores for the rating of barriers to the acceptability and application of the dry mix mortars. The result showed that professional ( $\chi=3.46$ ) agreed to a great extent with craftsmen ( $\chi=3.67$ ) that technical knowhow is the chief barrier to lack of use of dry mix mortar. The result further revealed that professionals ( $\chi=3.44$ ) and the craftsmen ( $\chi=3.40$ ) share the view that shortage of skilful workers with average mean score ( $\chi=3.42$ ) followed. With regards to cost of dry mix mortars and complication in the mix proportions with mean score ( $\chi=3.38$ ) and ( $\chi=3.16$ ) respectively, professionals agreed that the former is a more contributing factor ( $\chi=3.60$ ) while the craftsmen responded that the latter complication in the mix proportions is the most likely barrier to acceptability of dry mix mortar products ( $\chi=3.32$ ). Issue of climatic conditions and availability

of raw materials with mean score of ( $\chi = 2.95$ ) and ( $\chi = 2.53$ ) were the least ranked. All respondents agreed to a great extent that these factors are least barriers to acceptance of dry mix mortars product

Table 4: Hindrance to the use and acceptability of pre mixed dry mortar in the Nigerian Construction Industry.

Barriers	Mean Score			Rank
	Professionals	Artisan	$\chi$	
Technical Knowhow	3.46	3.67	3.46	1
Shortage of skilful workers	3.34	3.40	3.28	2
Cost of dry mix mortars	3.60	3.16	3.38	3
Complication in mix proportions	3.00	3.32	3.16	4
Climatic conditions	3.10	2.80	2.95	5
Availability of raw materials	2.70	2.36	2.53	6

Source: Field Survey, 2021

#### IV. DISCUSSION OF FINDINGS

The Study found that the level of awareness of the use and performance of dry mix mortar is on the increase in the Nigerian construction industry with respondents who attends seminars and workshops gaining more experience and having first-hand information of the new products than respondents restricted to on - site construction processes (this is in agreement with the findings of ----).

Today, modern dry mix mortars have gain more acceptability because they have proved to be consistent products with high qualities and reliabilities, they are easily mix and are available in the construction markets, they are less expensive and requires little maintenance in the long run, they increase the speed of construction and are suitable for use under different kinds of weather conditions as posit by Usman (2011) in a similar study carried out in Adamawa State.

Furthermore, the study found that suitability of dry mix mortars for various applications is the least factor for the acceptance of such products as well as a contributing reason for the use of dry mix products most especially in on – site construction this finding agrees with the opinion of (Huang, *et al.*, 2011) and (Tatale, *et al.*, 2013) who carried out a related study around the globe. Finally, the implications of the use dry mix mortars on construction sites have many benefits which include increase durability of structures, savings in economy in the long run, higher product performance and increase in the quality of the structures as opined by Wan (2010) and supported by Usman (2011).

#### V. CONCLUSION

This study specifically looks at how far and successful has the use of pre-mixed dry mortar gone in the Nigerian Construction Industry. The objectives ascertain the level of awareness of dry mix mortars in the Nigerian construction industry, identified the reasons for the acceptance of dry mix mortars and where they are mostly applied in the building production process as well as identified the setbacks facing the acceptability and application of dry mix mortars in the Nigerian Construction Industry. The study concludes that the use of premixed dry mortars does not only increase product performance significantly but also guarantees high degree of application reliability and consistency. Further the level of awareness of the use and performance of dry mix mortar is on the increase in the Nigerian construction industry also problems such as poor quality of workmanship, deterioration of building elements, excessive cost overrun, non - durability of structures, occupational safety usually encountered with on the job site concrete are greatly reduced with the use of the pre – mixed dry mortars. Finally, the research concludes that the use of pre – mixed dry mortar improves building performance in terms of durability and quality.

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