Factors Affecting the Efficiency of Pipe Pumped Concrete for Multi-Story Buildings

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Article Info

Page Number:722 - 730

Publication Issue:

Vol 71 No. 2 (2022)

Article History

Article Received: *24 January 2022*

Revised: *26 February 2022*

Accepted: *18 March 2022*

Publication: *20 April 2022*

Abstract

Concrete has been crucial Within the endeavors of planners and engineers who sought out reliable and affordable materials for concrete and high-rise structures. Whether ordinary or RMC, concrete for building of small-height (up to three to five stories) is moved and utilized to move concrete using buckets, wheelbarrows, culverts, and occasionally cranes. It is time consuming to place the concrete in the bucket,crane,etc method since it is not an endless procedure and can impact the concrete productivity as the structure rises and gets better. In this situation, pumping is a practical way to pump concrete. The productivity improvement is just one of several positive features of the concrete pump. Increased productivity is crucial since it results in quicker completion, which enables the owner to return on his investment rapidly. To replace concreting buildings, the variables affecting the productivity and efficiency of pumped concrete resources are explored. Information about the pumped concrete for this study, factors affecting concrete productivity in a high-rise building, and the need for concrete pumps. In the study, additional variables that affect concrete placement will be taken into account and offer many advantages like increase in productivity. The pump offers great performance in areas where humans cannot reach easily.

Keywords: - Productivity, pumped concrete, pumping machinery

1. INTRODUCTION

When it comes to how much texture is used in our world, concrete cement is only slightly behind water. Concrete has evolved from many years into the material choice for residential and public buildings structures, as well as important infrastructure like highways, dams, bridges, channels, and ports. The popularity of cement is due to its affordability, ability to be created almost anywhere, ability to wrap things up, and inherent strength. Countless historical examples of concrete structures speak volumes about their sturdiness and adaptability. Concrete is loaded, emptied or carried for high-rise structures (up to 3 to 5 stories) using wheelbarrows or bolts loaded with RMC, or occasionally lifts are used for concrete transportation. The hoist and wheelbarrow method of putting concrete, however, becomes time-consuming as buildings get taller and better, slowing down the output of concrete operations. Pumped concreting is among the methods that have greatly aided the construction sector. An alternative of employing a concrete pump to place the concrete is pumped concreting. The majority of conventional construction mixes are frequently pumped without any alteration. However, when concreting, a number of operational and Technical factors affecting like pumped concrete productivity must be considered. Concrete pumps and other tools used in the process are primarily used to convey wet concrete into the formwork. Concrete purequire concrete, and are an effective method forpushing cement to where it should be siphoned. Expanding efficiency is fundamental on the grounds that its fast fulfillment permits the proprietor to return rapidly on their speculation.

1.1 **Objectives:**

1. Calculating and comparing productivity rates based on the number of pump strokes applied, pumping time, and required total time (including all operations and delays).
2. Determine the causes of concreting operation delays, make an effort to reduce potential delays and factors, and strive to boost real production.

2. METHODOLOGY

2.1 Literature study on pumped concrete productivity.

2.2 Site Data collection:

1. Access to the construction site to gather statistics and in-depth information.
2. Keep track of the quantity of pump strokes used to discharge concrete and compute productivity.
3. Simply note the amount of time needed for pumping, disregarding any delays.
4. Note the overall pumping timing taking all delays into account.

2.3 Data Analysis :

1. Calculate the productivity rates depending on the number of strokes applied, the amount of time the pump is running for both with and without delays.
2. Make a comparison of the productivities based on all the conditions mentioned in the step above.
3. Find the causes of delays, issues that are slowing down productivity, and really essential factors.
4. Plot the regression equation using all the productivities for the different building heights.

3. LITERATURE REVIEW

1.Early in the 1990s, a research was done on the labor and other resources like equipment used for on-site concrete pouring of structures in Hong Kong. The study covered one hundred and fifty four POS and thirty eight days at building sites with concrete batching equipment and 38 days of combined costs. The various concrete laying techniques are compared as a result of the extensive detailed productivity information that has been obtained. Other variables that affect pour size and type, placing rates, and supply of concrete are produced not only to compare Hong Kong to other major cities but also to track progress towards the standards currently in place.Measure the productivities achieved by RMC plants, truck mixers, and site labor in the concreting of buildings, as well as those achieved by truck mixers and RMC plants, are the study's goals.Additionally, it aims to develop performance metrics that can be applied in the future and compare the resource usage of the various concrete placement techniques.Additionally, to draw comparisons between Hong Kong's performance and that of other locations.

2. In many nations, the placement of ready-mixed concrete is a crucial step in construction projects. This is particularly accurate given the rise in high-rise building in Egypt. The conventional technique of pouring concrete on site is still used to construct many of these structures. Truck mixers must be used to transport concrete that has been remotely dosed.It is clear that in Egypt, the PRMC rate of paving is crucial to raising the overall productivity of the residential construction sector. In order to predict the installation rate of PRMC on tower cranes, the purpose of this study is to develop a substitute regression model using the correlation analysis method.The model is based on a detailed observation of four hundred and eighteen pour cycles for pouring columns, slabs, and beams, each from the beginning to the end of the operation, on ten different job sites. Additionally, the elements influencing the PRMC installation speed on tower cranes were researched. The following are the study's limitations: Only Egyptian construction projects were used to collect the data, so results may not be generalizable to other countries. This study is restricted to concrete pouring-related activities and only makes use of tower cranes.

3 This study provides a description of concrete placement and transportation pumps. Couplings and other accessories are examined together with robust and adaptable pipes. Recommendations for the ratio of pumpable concrete highlight the importance of evaluating test compounds for pumpability, describe the ideal height of the gravel, and describe the water, cement, and entrance requirements. It is emphasized how crucial it is to saturate light aggregates. The layout of the lines, maintaining the same delivery rate and concrete quality at the top of the line, and cleaning pipelines were all suggested.The concrete described in the paper is transported by pipe or pipe in the shape of a pump. In 1933, in Milwaukee, piston pumps were first used to push concrete via metal pipes. This concrete pump was powered by a mechanical connection and is often extended through pipes with a diameter of six inches or more. Since then, the concrete pumping area has undergone numerous recent changes. It includes new and enhanced pumps, truck-mounted and stationary placing booms, higher pumping pressure-resistant pipeline, and hose. Concrete placing by pumps is now one of the most extensively employed techniques in the construction industry as a result of these advancesSiphoning is likewise utilized for the overwhelming majority of substantial designs, however it is particularly helpful where space for development hardware is restricted. Concrete pumps free up cranes and concrete pumping legs, enabling construction-resistant materials to be produced. Also, different crafted works are not impacted by substantial action. For successful pumping, a steady supply of pump-capable concrete is essential. Like conventional concrete, pump-capable concrete needs good internal control, such as uniform, properly graded gravel and well-mixed batch material.

ISSN: 2094-0343
2326-9865

4 This study examines the effect on solids handling and the various contributing factors. The impact of these factors on the effectiveness of concrete pumps is discussed, and a calculation for choosing the best concrete pump for the circumstances at a particular construction site is shown. Pumped concrete has seen a significant rise in use recently, especially for domestic infrastructure projects. Ready Mix Concrete (RMC) suppliers have played an important role in popularizing the concept of concrete pumping in India. Most applications take place in and around metropolitan areas. It is only recently that the concept and application of pumped concrete has entered the Egypt areas, where pumped concrete is often viewed as an unaffordable luxury. This study examines the effect on solids handling and the various contributing factors. The impact of these factors on the effectiveness of concrete pumps is discussed, and a calculation for choosing the best concrete pump for the circumstances at a particular construction site is shown. Pumped concrete has seen a significant rise in use recently, especially for domestic infrastructure projects. The idea of concrete pumping has become very common in India thanks in large part to ready mix concrete (RMC) suppliers. The majority of applications occur in and around urban areas. The idea and use of pumped concrete has only recently spread to Egypt areas, where it is frequently thought of as costly.

5 The article outlines the concrete batching, delivery, pumping, and return cycles of the construction process. The construction industry relies heavily on cyclic processes, some of which don't always deliver performance levels that are satisfactory. The method used to place concrete is one such area. When these processes are thoroughly studied, they do not produce unrealistic system characteristics due to a random distribution of system actions. It is possible to think of the process of mixing, transporting, and finally placing concrete as a random system that is subject to interruptions, manipulations, and fluctuations. It is crucial to effectively manage these uncertainties in order to give contractors high-quality service. In order to study the effectiveness of the method, this paper frequently uses "lean" methods and tracks the flow and transmission of the concrete paving process. Examples from the study are shown using information gathered over a two-year period on a significant construction project in the northwest of England. Over seventy concreting operations' pertinent times make up the information. A fancy queuing system was used in the majority of the concreting operations that were observed to pump concrete into the formwork.

6 One of the worksite factors affecting pouring volume was studied concreting to determine its effect on concreting productivity. A total of one hundred and sixty seven different concrete pours were found at twenty five construction sites in Lagos, Nigeria, of which twenty five joints were placed with cranes and dump trucks; twenty six were placed with dump trucks; fifty eight were added with wheelbarrows; thirty seven were kept with ladles; and eleven were combined with pump, wheelbarrow, and head ladle. Data collected from the daily concrete components were analyzed in accordance with the operational productivity rate. The relationship between increasing quantities and productivity was investigated using regression analysis. The results show that productivity typically increases by 1.1 m3 / h per ten m3 regardless of the paving method.

ISSN: 2094-0343
2326-9865

7 The most recent analytical and experimental research on concrete pump evaluation is reviewed in this paper. The most common approaches for observing the geological characteristics of the sliding (or smearing) layer are first discussed. Second, a model for estimating concrete pumping is described, including delivery rate, pumping pressure, and pump able distance. This model is based on the rheological characteristics of the sliding layer and the initial concrete. Following the test results for various concrete mixes is a discussion of the variables that affect concrete pumping. The suggestion is made to conduct additional research on concrete pumping. Concrete is used in various concrete mixes according to the grading of the coarse and fine gravel and cement types because the sliding layer openings created between the pipeline surface control the performance of the sliding layer concrete in concrete pumping. The sill thickness is proportional to the cement pipe, the cement content of the water, and, as a result, the dosage of the super systemizer. The thickness of the sliding layer is also reduced by better sanding. The diameter and length variations of the pipe's thickness are also taken into account.

8 The main objective of assessing the efficacy and productivity of pumped concrete as well as the efficient use of pumping equipment resources during construction in-place concreting are discussed in this research paper. The study includes observation of a sixty pours on residential building construction sites using pumped concreting in order. Furthermore, data on concrete productivity is obtained, and factors affecting it are investigated. The goal of this study is to investigate the affecting factors of concrete placement rate

9 The wrong pump is chosen for the job at hand, which can lead to high costs, energy and time waste, and project delays. It is not advised to choose a pump based on how well it performs with various heads. As a result, the system that can choose the right kind of pump for various heads needs to be improved. The topic of the essay is choosing the right kind and capacity of pump for concrete and water pumping in construction projects. In order to choose the appropriate and cost-effective pump type for this study, performance and pressure charts for water and concrete pumping systems, respectively, had to be prepared. In order to choose a suitable and affordable pump, the main considerations are the power needed, the pressure head of the applications, and the pressure needed for pumping.

4. DATA COLLECTION

Observation

- 8 meters :Height of Pumping
- Putzmeister 1407 D :Pump type
- 71 m^3/ hr :Theoretical output
- 27 (Theoretical) : Maximum strokes/ minute
- Cylinder Pumping : L = 1400 mm , D = 200 mm

Table 1: Strokes and Durations

Start Time	Duration (minutes)	No. of Strokes	Total Duration (mins.)	Total Strokes(no.)	Remark
11:35 am	0:51	22	5:36	138	-
11:37 am	1:33	38			-
11:40 am	0:36	14			-
11:44 am	0:38	16			-
11:46 am	1:03	25			-
11:52 am	0:55	23			End of 5.5 m3
-					
12:02 pm	0:10	4	5:56	145	Clamp breakdown
12:20 pm	0:58	24			-
12:24 pm	1:01	24			-
12:27 pm	1:44	42			-
12:30 pm	1:03	26			-
12:32 pm	1:00	25			End of 5.5 m3
No Concrete Available					
2:15 pm	1:23	34	5:53	144	-
2:19 pm	1:09	28			-
2:24 pm	0:31	12			-
2:31 pm	0:59	24			-
2:33 pm	2:26 pm	1:05			
2:34 pm	0:40	16			End of 5.5 m3
-					
2:40 pm	0:45	18	5:39	131	-
2:42 pm	0:06	2			-
2:43 pm	1:18	31			-
2:46 pm	0:57	21			-
2:50 pm	0:29	11			-
2:51 pm	0:57	23			-
2:53 pm	0:03	1			-
2:55 pm	1:04	24			End of 5.5 m3

Table 2: Factors Affecting Productivity.

Factors	1	2	3	4	5
Condition of type of Pump	-	-	√	-	-
Condition of Pipelines clamps and bends	-	-	-	√	-
Availability of Transit mixers at site	-	-	-	-	√
Working Space at site	-	√	-		-
Workability of Concrete	√	-	-	-	-
Workmanship at Site	-	√	-	-	-
Supervision at site	-	√	-	-	-
Type of pour	√	-	-	-	-
Weather Condition	√	-	-	-	-
Height/Depth & distance of Pour from pump	√	-	-	-	-
Continuity of work	-	-	-	-	√
Communication at site	-	√	-	-	-

Table 3: Other Data Collected

Arrival Time of TM (minutes.)	10-15	16-30	31-45	46-60	More than 60
	-	-	-	√	-
Time req. to take position (minutes.)	1-3	3-5	5-7	7-10	More than 10
	√	-	-	-	-
Distance of RMC plant from site (kms)	Within 5	5-10	11-15	16-20	More than 20
	-	-	-	-	√
Working conditions for placing concrete	Very Easy	Easy	Average	Difficult	More difficult
	-	√	-	-	-
No. of Choke-up occurs	No choke Up	1-2	3-4	5-6	More than 6
	√	-	-	-	-

5 DATA ANALYSIS

1.Calculations for the number of strokes per minutestrokes number (per min)=Total number of strokes executed / Total time in minutes
For 1st, number of strokes per minute=138/5:36=24.64
For 2nd, number of strokes per minute=145/5:56=24.43
For 3rd, number of strokes per minute=144/5:53=24.47
For 4th, number of beats per minute=131/5:39=23.18
Average number of strokes per minute = (24.64+24.43+24.47+23.18)/4=24.18
2. Calculations of duration
Time needed for pump-down without considering delays (minutes) = 5:36 +5:56+5:53+5:39 = 23:04
The total time needed for pumping down, taking into account delays and all other factors , is the total time between 11:35 and 14:55 = 200 minutes.
3.Productivity Calculation
a)The actual productivity is calculated as follows: a) Considering the number of strokes of the concrete pump:
Vol. of concrete pumped per stroke = Volume of pumping cylinder = π × r2 × h
Vol. of concrete pumped per stroke = π × 0.12 × 1.4= 0.0439 m3
The average maximum stroke of the pump per minute is 24.64
∴ Vol. of pumped concrete (per min) = 0.0439 × 24.18= 1.061 m3
∴ Vol. of pumped concrete (per hour) = 1.061 × 60= 63.66 m3
b) Considering the time needed for pumping without taking into account delays
∴ Average time required to pump out 5.5m3 = (5:36+5:56+5:53+5:39)/4 = 5:46 min
∴ Amount of concrete pumped per hour= (60/5:46) ×5.5= 57.22 m3 /h. c)
4.Consider the time required for pumping, taking into account delays:
It takes 3 hours 20 min to pump 22 m3, i.e.200 minutes
,∴ Amount of concrete pumped per hour = 22 / 3:20= 6.6 m3 /h r
The influencing factors are identified for all sites and their R.I.I. is calculated as follows:
If we consider the factor of condition and type of pump, its RII is calculated as follows:
Total number of respondents (total number of sites) = 6
According to all respondents (sites), 3 respondents gave 3 weights to the factor's total influence weight, 3 respondents gave 1 weight to age.
∴ ∑ W = 3× 3 + 3 × 1 = 12
∴ R. I. I. =12/5× 6=0,40
Similarly, the R. I. I. is calculated for all influencing factors.

6. CONCLUSION

1.The results of this study suggest that there is a sizable discrepancy between the theoretical and practical rates of production of pumped concrete. When the number of pump strokes is taken into account when calculating productivity per hour, it is always higher than when the actual time needed for pumping is taken into account without taking into account delays brought on by other

factors.
2.When considering all task like changing pipe connections, spreading and compacting concrete with vibrators,transit mixer positioning, etc., there is a sizable difference in productivity when only taking the timing required for pumping activities into account.
3.It has been noted that a variety of factors can cause delays, which extends the overall schedule for pumping concrete. Certain measures are taken in the paper to lessen the potential.

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