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Research Article

Practice of Concrete Production in Gaindakot Municipality, Nepal

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A B S T R A C T

Concrete is one of the most used construction materials. Quality of concrete depends upon its ingredients and workmanship. The paper aims to assess the practice of concrete production and knowledge among practitioners regarding concreting at Gaidakot municipality which relies on manual concrete production. Only 30 under-construction houses in 10 wards of the Municipality were selected purposively for observation of concrete practice as field-based empirical research. A structured questionnaire was surveyed as scheduled with 30 practitioners (10 mixer operator, 10 ingredients pourer and 10 vibrator operator) and intensive observation by the researcher were recorded to analyze the practice for concrete production.

It was found none of the respondents was aware of concreting code of NBC. They had not attended any training to practice NBC of Nepal. Similarly, the majority of practitioners learned about the method of concreting through experience or coworkers by observing at sites during work. However, 77% of them responded that the process of concreting was good. Similarly, there were a lot of problems in workmanship. Quality in ingredients was not taken in due consideration and dosage of ingredients varies from batch to batch and placement was done in segment wise for slab and beam. Compaction as well as curing was inadequate.

Lack of formal education, inadequate guidance and training, proper skill and knowledge about NBC of Nepal among the workers involved directly in concrete production was making concrete production inconsistent and uncontrolled. The study will be significant for quality resident building construction by ensuring the effective implementation of building code, which is the minimum standard, the skill-oriented training and continuous supervision from the concerned local municipality.

Keywords: National building code, Ingredients, Knowledge, Training, Practice

Introduction

Concrete is an integral part of the construction. "An artificially build up stone resulting from hardening of a mixture of cement, aggregates and water with or without a suitable admixture is concrete"(Gambhir, 2013). As per Alam *et al.* (2016), the quality of the concrete is affected by its constituent materials, its proportion, the equipment used knowledge of person involved and workmanship in the concrete production process. Hence, the perception, practice and knowledge of people towards the concreting determine the quality of concrete. Very few test or assessment has been carried out in production practice of concrete in Nepal so we could not obtain a lot of information about the compliance of concrete quality with minimum standard as required. So it was necessary to assess the real scenario to obtain the adequate confidence that all the produced concrete at site complied with what we expect which could be significant in providing information to the concerned authority of study area about the scenario of concreting to help in policymaking and improving the methods to ensure controlled concrete production process.

Problem Statement

After 2015 earthquake, the Government of Nepal has ruled all municipals to follow the National Building Code (NBC) of Nepal strictly which is available easily to all through various media like internet, booklets etc. NBC was implemented to control the concrete production process, but no specific study has been carried out to confirm the compliance. So, practice need to be assessed.

Research Objectives

The paper aims to assess the practice and perception of people during concreting of the residential building at study sites of Gaindakot Municipality, Nepal.

Literature Review

Theoretical Review

Concrete, as stated by Brunauer and Copeland (1964a), "Man consumes no material except water in such tremendous quantities", may be defined as a solid mass made by the use of a cementing medium with sand, gravel and water. Quality concrete production includes uniformity in sources of materials like sand, aggregates, admixtures, water-cement ratio, workability of concrete and in the application of concrete constituents in the same proportion as stated in design mix (Mishra and Chaudhary, 2018). Quality assurance in construction pastime relates to right design, use of ok substances and additives to be furnished via the manufacturers, proper workmanship in the execution of works by using the contractor and ultimately right care all through using a structure which includes well-timed protection and restores by using the proprietor.

Concreting means mixing its ingredients properly along with transportation, putting, compacting and curing. During these operations, great versions arise partially because of the quality of plant to be had and partially because of differences within the performance of strategies used. To make certain right overall performance, it's far important that every step-in concrete that allows you to be covered by using the subsequent step is inspected because of the work proceeds. The standard process during concreting as described in Bureau of Indian Standards, (2000), are considered as the standard of comparison that can be summarized as NBC 2016.

Batching: In batching concrete, the amount of both cement and mixture shall be determined by using mass; admixture, if solid, by way of mass; liquid admixture by quantity in a calibrated tank. The accuracy of the measuring system will be within +2% of the amount of cement being measured and inside +3% of the quantity of aggregate, admixtures and water being measured. Volume batching can be allowed the simplest wherein weigh-batching isn't practical. It is essential to preserve the water-cement ratio consistent at its accurate price. Similarly, proportion/ kind and grading of aggregates will be made by using trial in the sort of manner to achieve densest viable concrete.

Mixing: Concrete will be mixed in a mechanical mixer. The blending will persevere until there is a uniform distribution of the materials and the mass is uniform in shade and consistency. For guidance, the combination time shall be as a minimum of 2 minutes. If there is segregation after unloading from the mixer, the concrete has to be remixed. Workability ought to be checked at common periods.

Transportation and Handling: After blending, concrete shall be transported to the formwork as swiftly as possible by strategies so that it will save you the segregation or loss of any of the components or ingress of overseas be counted or water and retaining the required workability.

Placing: The concrete will be deposited as almost as conceivable in its final function and compacted before initial setting of concrete commences and ought to not be finally disturbed. Methods of setting should be consisting of to prevent segregation and to keep away from the displacement of reinforcement or movement of formwork. As fashionable steering, the most permissible unfastened fall of concrete may be taken as 1.

Compaction: Concrete ought to be thoroughly compacted and completely worked around the reinforcement; around embedded furnishings and into comers of the formwork the usage of mechanical vibrators complying with (Bureau of Indian Standards, 2000). Over vibration, underneath vibration of concrete and vibration of very moist mixes are harmful and ought to be prevented. Whenever vibration

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has to be applied externally, the layout of formwork and the disposition of vibrators need to get hold of unique consideration to make certain efficient compaction and to avoid surface blemishes.

Curing: Curing is the procedure of preventing the lack of moisture from the concrete whilst keeping a quality temperature regime that's critical if the-water cement ratio is low, if the cement has an excessive rate of power development if the concrete contains granulated blast furnace slag or pulverized gas ash. The curing regime should additionally prevent the improvement of excessive temperature gradients inside the concrete. Super sulphated cement concrete is significantly laid low with inadequate curing and the floor needs to be stored wet for as a minimum seven days.

Supervision: It is incredibly hard and costly to regulate concrete once located. Hence, steady and strict supervision of all of the gadgets of the development is vital in the course of the development of the paintings, which include the proportioning and combining of the concrete. Before any essential operation, along with concreting or stripping of the formwork is started, adequate word will be given to the construction supervisor. Furthermore, the quality concrete production can be studied by knowing how the material handling behaviour is adopted at the site which includes the cement manufacture date, cement storing conditions, storing of aggregates, water use etc. at sites as described in (Mishra and Chaudhary, 2018).

Variation in the quality of constituent materials, variation in mix proportions due to batching process, variation in the quality of batching and mixing equipment available, the quality of overall workmanship and supervision at the site are determinants of quality (Alam e*t al.,* 2016).

Alam et al. (2016) studied the practices for quality control of concrete production in Dhaka city, concluded that no test report for any of the construction materials has been found at any of the project sites visited. The construction materials were not stored properly, and there was no supervisor from the landowner and no concrete technician at project sites. Few of the projects were found to have unskilled labour for concreting and almost all of the construction sites maintain their concrete mix ratio by volume batching. Water cement ratio was decided on experience with the following curing properly.

In most of the project, no care was taken for the waterproofing of formworks for concreting and early removal of formwork especially those of columns have been found in most of the projects.

Okazaki *et al.* (2012) found that many building owners and craftsmen have limited knowledge and they did not consider the earthquake as a potential hazard. Most of the owners put deeper attention to the construction cost rather than building safety. Probably because the workers didn't know how to build earthquake-safe buildings or the workers might have the knowledge but, due to the intervention from the owners to reduce the construction cost, they reduced the quality of works.

It is not practical in Nepal at present to insist that all small buildings be designed for strength by a professional advice as the rule has just made in 2016 as hardly engineers are available at a remote area. Therefore, for classes of buildings not exceeding certain simple criteria as to height, several stories and floor area, mandatory rules-of-thumb are provided. (GoN: Ministry of Physical Planning and Works, 1994).

Bhattarai and Mishra (2017) discussed the need for Building code implementation session as the permits approved through drawings ware not implemented in a case study of Nagarjun Municipality effectively.

Parajuli *et al.* (2000), presented that mandatory rule of thumb gives the explanatory documents such that an experienced overseer or mason might be able to understand them and present sufficient details at the time of permit application to prove to a non-technical appraiser at the local authority that the requirements are being met.

Research Gap

According to Okazaki *et al.* (2012), most countries have code, at least guidance, on earthquake safety construction. In Nepal Building code and Bylaws have been made standard as techno-legal documents through several revisions. Cost implication was also justified. In Nepal, knowledge and awareness found to be focused and questioned in most of the cases where the need for housing is highly focused (Mishra, 2019).

In context to this, in Nepal few researches have been carried out to ensure the proper production process of concrete presenting Nepalese local scenario. Hence, this study was to present the real scenario of production practice of concrete in buildings of Gaindakot Municipality, a municipality of the central part of Nepal.

Methodology

Study Area

This was field-based empirical research to analyze the practice of production of concrete. It was emphasizing on examining the compressive strength of concrete produced on those sites on one hand and evaluating the existing concrete production practice for the improvement of concrete quality on the other hand. The location of the study area is shown in Figure 1. Similarly, population and sampling for research is shown in Figure 2.

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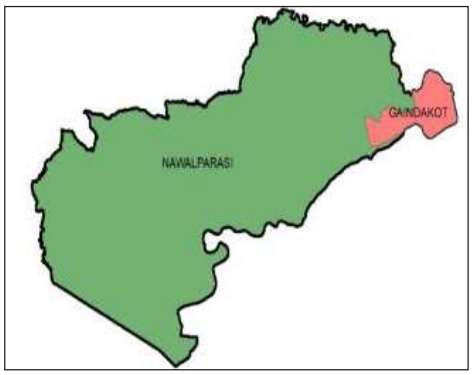

Figure 1.Study area(Gaindakot Municipality)

Population and Sampling

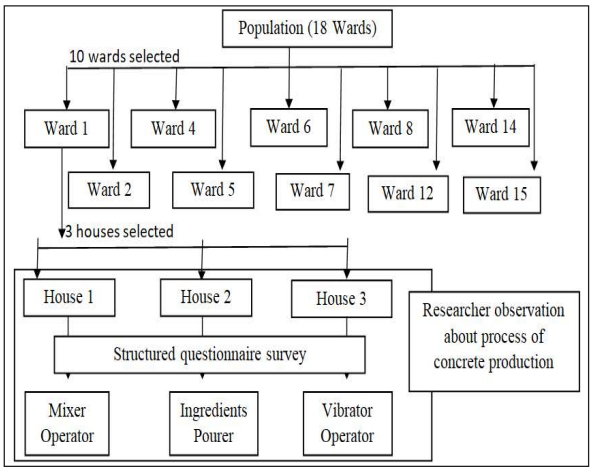

Figure 2.Sampling (Research design) (Only those houses which were conducting concreting have been selected purposively).

Data Collection

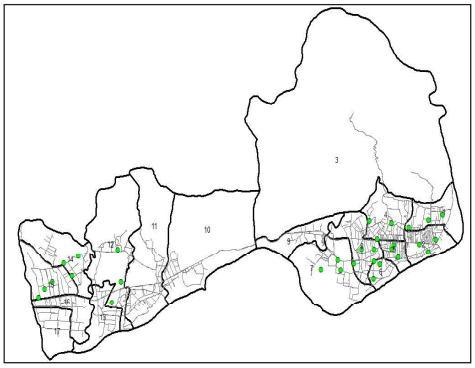

Figure 3.Data collection sites

- A structured questionnaire was prepared and the interview was taken with each practitioner at each site and their response was documented. The practitioners consisted of the person working as a mixer operator (water pourer), ingredient pourer and vibrator operator (compactor).
- The observation of the researcher about the method and practice of concreting was recorded and presented.

The sites for observation and interview are were presented in Figure 3.

Descriptive content analysis was carried out for the response obtained from practitioners on the scheduled questionnaire, to document the perception and practice of people about concreting in selected sites.

Result and Discussion

The practice of concreting and their knowledge about NBC was documented after an interview with practitioners with help of structured questions. The practitioners were the persons involved in the production of concrete i.e. concrete mixer, ingredients pourer and vibrator operator. The response of the structured questionnaire survey was presented in graphical forms.

Knowledge and Practice of Practitioners on Concrete Production

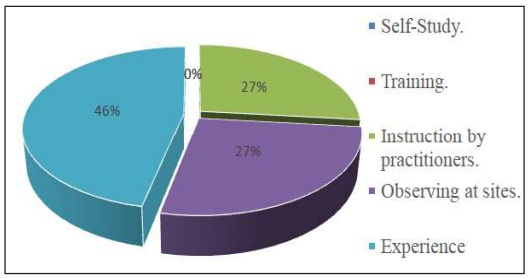

Figure 4.Knowledge gaining method about quantity to mix

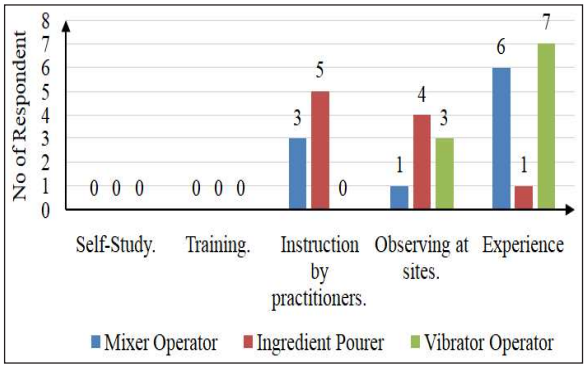

Figure 5.Knowledge gaining method about quantity to mix (Respondent categories)

Figures 4 and 5 refer to the knowledge of practitioners about the number of ingredients to mix during the production of concrete. It was found that 46% of the respondents knew the quantity of mix from experience, whereas 27% of respondents obtained information through observing at sites and the remaining 27% by instruction by mixer owner. None of the respondents had obtained formal education or

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training for quantity to mix. It reveals the need for training for the consistent production process.

In section 2, it was reported that there should be the accuracy of the instrument should be (+/-) 3% of quantity to be measured, but in this study, it was found that none of the practitioners was given any training about the quantity to mix. This led to the use of ingredients in a haphazard way to produce concrete.

The laymen (untrained of NBC) were responsible for producing concrete, but none was attained to get a formal education. So, the production was not in a professional manner to produce the concrete to maintain the standard. It showed the necessity of formal education for low-level laymen.

Figure 6 refers to the knowledge of the respondent about NBC of Nepal. All of 30 respondents were unaware about Nepal NBC. The result showed none of the key informants was aware of NBC of Nepal. Majority of buildings constructed were designed following "Mandatory rule-of-thumb" as given in NBC of Nepal. The practitioners were unknown about the minimum standard to comply. Hence, this study shows, formal knowledge is necessary to maintain the standard.

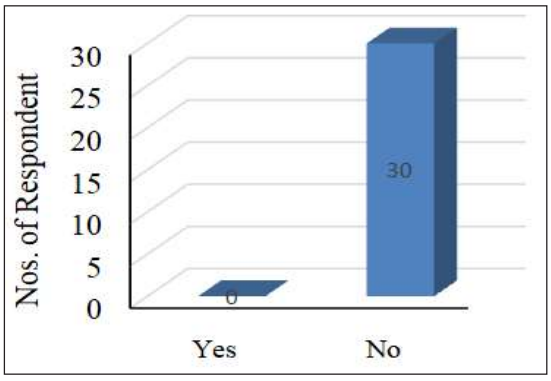

Figure 6.Knowledge about NBC of Nepal

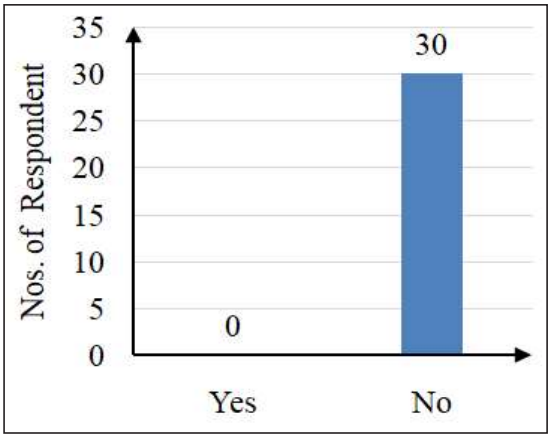

Figure 7.Training acquired by respondent.

Figure 7 refers to the training attended by the respondent about NBC of Nepal. 100% of respondents were unattended in any training about NBC of Nepal. The result showed the practitioners have never attended any training about NBC of Nepal. They were unknown about the standard to produce concrete as reported in section 2.

Bhattarai and Mishra (2017) concluded that the awareness level of contractor about NBC of Nepal is satisfactory in Nagarjun Municipality of Nepal, but this study revealed that none of the workers was aware of NBC of Nepal. Which is good practice. This is due to the training provided were focused on the only leader of worker groups, who never involved directly in construction. They were not providing enough guidance about what they had learned to the low-level worker and laymen as they keep changing in every season. In this study, it was revealed that most of the workers were from the Terai region of the country or northern part of neighbouring country India. No one was serious in their knowledge about the concreting method. Similarly, they were not given any guidance on the minimum standard to comply. So, the implementation of NBC of Nepal was found to be a challenging task.

Figures 8 and 9 referred to the respondent perception about the current practice of concreting and their feeling about concreting method. 77% of respondents revealed that the current practice was good. Similarly, 20% of respondents feel that the practice is satisfactory but needs to improve.

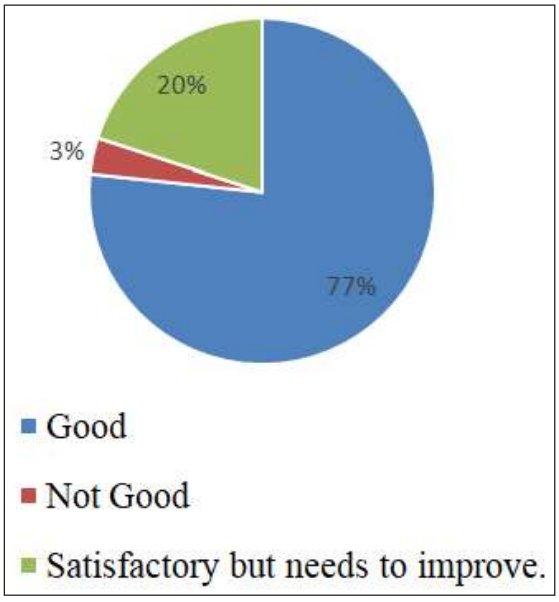

Figure 8.Perception about current concreting practice

The result showed, despite large dispersion in the number of ingredients, the majority of practitioners or workers said that the current practice of concrete is good. It revealed their lack of knowledge of the given sector. The lack of training, lack of instruction, and lack of formal education

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played a major role in the uncontrolled concreting process.

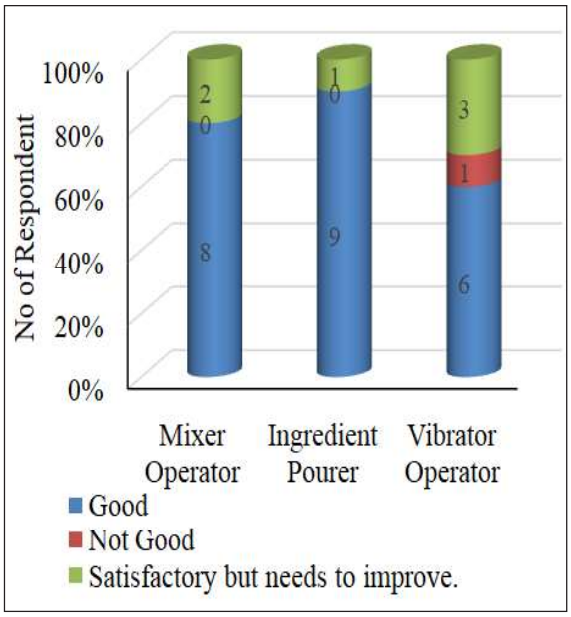

Figure 9.Perception about current concreting practice (Respondent categories)

Similarly, no one was serious on the effect of differed strength in a single building or construction site, which may cause a relative effect in strength during any hazard. It must be considered seriously and adequate guidance and supervision must be considered.

Researcher Observation on Concrete Production

In all sites, the cement was found to be purchased on the day of concreting for a structural component. Time was scheduled however resources were not levelled or scheduled at those sites. Besides the cement required for other purposes like wall construction and plaster was found to stack on the shed of Brick with CGI sheet with plastic for damp proofing (Figure 10).

Figure 10.Stacking of Cement

In all sites, neither house owner nor contractor was aware of the age of cement i.e., the duration of between cement manufactured and used the manufactured date was not indicated on cement bags used in construction sites (Figure 11).

Figure 11.Cement Bags without clear manufacturing date

As per Bureau of Indian Standard (2000), the manufacturer should print the manufacture date in cement sacks. Also, the consumers were promoted to use fresh cement. But in field visit, the manufacture date in the cement sacks was found to be missing whereas though the manufactured date was found in, there was unclear information about the year and manufacture lot number. This unawareness was leading to use cement of old age i.e not fresh cement and it might be affecting the strength of concrete directly.

Quality of ingredients was not taken into due care. The suppliers determine the material to provide to the sites. During concreting, the workmanship regarding quality was found to be poor (Figure 12).

Figure 12.Impurities on Aggregate

As per Bureau of Indian Standard (1996), it was reported that the aggregates should be stored at the site on a hard dry and level patch of ground to prevent contamination with clay, dust, vegetable and other foreign matter. But in field visit, it was found the aggregates were stacked in the muddy ground too, without and preventive measures

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for contamination. In the majority of sites, it was found that the aggregates were contaminated with vegetation, plastics and sacks etc. Similarly, the workers were found neglecting the removable foreign item too. It was a lack of proper guidance and their hurriedness to finish the work.

The ingredients were poured based on the assumption in some sites. The sand was feed in the mixer with the shovel only without using any measurement box, counting several shovels used. It reveals that the dosage of ingredients is not consistent and depends on the mood of the pourer (Figure 13).

Figure 13.Worker feeding sand using shovel only

In section 2, it was reported that there should be the accuracy of the instrument should be (+/) 3% of quantity to be measured and should mix the ingredients measured with the instrument but in field visits, it was found that the workers were neglecting the accuracy in ingredients proportion. They were feeding ingredients in assumption basis to minimize the effort. No professionalism was found in workmanship due to lack of education and guidance.

The placement of concrete was done in segment-wise. First beam portion was concreted with relatively low water content concrete and the slab portion was concreted with higher water content concrete for easy workability (Figure 14).

Figure 14.Concrete pouring segment wise in beam and slab portion

As reported in section 2, no precaution was taken while the placement of concrete. The placement was in hurry with the extra labour force, which was segregating the concrete. There was no continuum in the placement of concrete within the same structure. A serious problem was the remaining portion of concrete of each batch at the end, which was already set and creating a problem for replacement.

During mixing for a structural component like column or tie beam, the concrete was mixed manually. The situation for the tie beam was disastrous as there was a high content of water for high workability. And the volume of concreting was high, with loading time more than the initial setting time of concrete. Similarly, concreting was done during raining too (Figure 15).

Figure 15.High water content for easy workability

Compaction is not proper, in slab most of the concrete was found to be segregated, and in the column, the concrete was found to be placed without proper compaction.

As reported in section 2, no proper curing method was found applying at the site. The concrete was highly vibrated and compacted in some places where easy, but neglected in corners and difficult portions. The base of the column was found improperly compacted in major sites, making them weak and of low strength (Figure 16).

Figure 16.Improper compaction during concreting

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Figure 17.Work starting after 3rd day of concreting

Curing was not properly done. The curing for the column was done by spraying water twice or thrice a day. In slab only 4-5 days curing was done. Normally not more than 10 days was allowed for curing. In some cases, it was found that the work was started from the 3rd day of the casting of slab (Figure 17).

As reported in section 2, the concrete surface should be kept in moisture condition for at least 7 days, such practice was found on the majority of sites for only slabs. In some cases, a minimum of only 3 or 4 days was allowed for moistening with water. But mainly a week was allowed with water curing. This was a good practice found in concreting during a field visit. But in the case of columns, no adequate curing was found. Jute or sacks wrapping was never adopted in any construction practice by workers. The column is kept in moisture condition with spraying the water twice or thrice a day. It was also found that none of the concreting practitioners involves in the curing process. House owner solely is responsible and they were doing what they knew only.

The form works were found to be consists of wooden planks and bamboo props in many sites. The formworks were found to be removed for slabs after 20 days of concreting (Figure 18).

Figure 19.Use of Wooden props and wooden formwork

Conclusion

This study gives an understanding of the existing practices for concrete production in Gaindakot Municipality, Nepal. From the limited scope of the present study, the following conclusion can be drawn:

The knowledge level of workers or people producing concrete was poor. Majority of workers knew about concreting through observing at sites and their self-experience. They were unaware of NBC of Nepal and nobody had attended any formal training regarding building code implementation. However, 77% of them responded that the process of concreting was good.

There were a lot of problems in workmanship. Quality in ingredients was not taken in due consideration. No one is aware of grading or age of cement. There were lots of waste in ingredients like, paper, plastics, shrubs etc. dosage of ingredients varies from batch to batch. Placement in segment wise for slab and beam. Compaction, as well as curing, was inadequate.

The proportion of ingredients was not maintained well. The water was poured based on the judgement of the mixer operator. Aggregates proportion and dosage depends on the mood of the pourer and quantity of work.

Recommendation

Formal training, regular supervision and monitoring from concern authority should be carried out for consistency in the production process. The workers should be educated informal way to improve the systematic mechanism of concreting to ensure controlled production process to give consistent strength as required.

Formal training about NBC of Nepal should be provided to workers for effective implementation and to construct the structure with minimum standard as required.

Acknowledgement

I would like to express my deepest thanks to all the helping hands without which this work would not have been completed. This research is dedicated to all the people affected by COVID 19 and hopes the world is going to come over this problem. Great salutation to medical professionals.

References

1. Alam A, Habib ZS, Hasan AR. A Study on the Quality Control of Concrete Production in Dhaka City. (September). doi: 10.9790/1684-1303038998. 2016,
2. Bhattarai SK, Mishra AK. Existing Scenario of Building Code Implementation in Newly Formed. Nagarjun Municipality. *Asian Journal of Science and Technology* 2017; 8(11): 6751-6762.
3. Bollinger L, Sapkota SN, Tapponnier P et al.. Return

period of great Himalayan earthquakes in Eastern Nepal: evidence from the Patu and Bardibas strands of the Main Frontal Thrust. *Journal of Geophysical Research* 2014; 119(9): 7123-7163. doi:10.1002/2014JB010970.

4. Brunauer S, Copeland LE. The chemistry of Concrete. *Scientific American* 1964a; 210(4).
5. Bureau of Indian Standards. *Stacking and Storage of Construction Materials and Components at Site -Recommendation (Second Revision)* IS: 4082 - 1992. Indian Standard Code, New Delhi: Bureau of Indian Standards. 1996.
6. Bureau of Indian Standards. *Plain and Reinforced Concrete - Code of Practice (4th Revision)* IS: 456 - 2000. Indian Standard Code, New Delhi: Bureau of Indian Standards. 2000.
7. Gambhir ML. Concrete Technology. Fifth edition. New Delhi: McGraw Hill Education (India) Pvt. Ltd. 2013.
8. GoN: Ministry of Physical Planning and Works. Nepal national building code. Department of Urban Development and Building Construction. Kathmandu. 1994.
9. Mishra AK, Chaudhary U. Assessment of Cement Handling Behaviour For Selected Construction Sites of Bhatbhateni Supermarket. *J Adv Res Const Urban Arch* 2018; 3(3): 1-11.
10. Okazaki K, Pribadi KS, Kusumastuti D. Comparison of Current Construction Practices of Non-Engineered Buildings in Developing Countries. 2012. [online] available at www.iitk.ac.in (accessed at 26 july 2019).
11. Parajuli YK, Bothara JK, Dixit AM et al. Nepal Building Code - Need, Development Philosophy and Means of Implementation. 2000; 1–7.

ISSN: 2456-9925
DOI: https://doi.org/10.24321/2456.9925.202001