Accessing the Compliance Standards of Selected Projects of Thabang Rural Municipality, Nepal

Mina Yogi*, A. K. Mishra, & P. S. Aithal*****
*Master's Scholar, Construction Management, Madan Bhandari Memorial Academy Nepal, Urlabari – 3, Morang, Nepal. E-mail: meenayogi33@gmail.com
**Post-Doctoral Research Scholar, Srinivas University, India and Associate Professor, Madan Bhandari Memorial Academy Nepal, Urlabari3, Morang, Nepal
OrcidID: 0000-0003-2803-4918; Email: anjaymishra2000@gmail.com
*** Professor, College of Management & Commerce, Srinivas University, Mangalore, India
OrcidID: 0000-0002-4691-8736; E-mail: psaithal@gmail.com

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Mina Yogi*, A. K. Mishra, & P. S. Aithal*****

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**Post-Doctoral Research Scholar, Srinivas University, India and Associate Professor, Madan Bhandari Memorial Academy Nepal, Urlabari3, Morang, Nepal
OrcidID: 0000-0003-2803-4918; Email: anjaymishra2000@gmail.com

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OrcidID: 0000-0002-4691-8736; E-mail: psaithal@gmail.com

ABSTRACT

Purpose: *A project is assumed to be sold before construction based on its accepted quality standards conformed through specification. Standards and specifications are used as benchmarks, and compliance checks are used to ensure that they are met. Accessing standard compliance based on chosen case projects is an attempt to learn about the status of Thabang Rural Municipality construction projects.*

Design/Methodology/Approach: *The compliance status of RCC and masonry building and the motorable road was checked by field observation with help of a checklist and their result are shown through bar graphs. For water supply projects water demand compliance was checked by field observation and water tariff calculation was done based on the possible yearly expenses of water supply management along with effective analysis of Detail Project Reports, Design, and Drawings.*

Findings/Result: *Compliance status 20 RCC and 12 masonry building shows major non-compliance in the spacing of stirrups, lap length in column and beam, chair bars of the slab, provision of the crossing of reinforcement in the staircase. In masonry building, major non-compliance was observed in band/through stone, vertical bars at corners, and corner stretching by dowel bars. Roadway width was checked in two selected road projects and Tutu Praja Bhitrivan motorable road found non-compliance in the major portion of the road. Water demand compliance, water tariff calculations were done in Yebang Chabang Water Supply project.*

Originality/Value: *This study helps policymakers and local level government to assure construction with compliance of standards. It makes it easier for policymakers to incorporate the development needs without compromising quality through regulatory provision.*

Paper Type: *Action and Policy Research*

Keywords: Compliance, National Building Codes, Nepal Rural Road Standard, Water tariff, Water Demand

1. INTRODUCTION :

In all areas of Nepal for the construction of buildings, National Building Code provides regulations and guidelines (National Building Code, 1994) [1-4]. For the construction of a seismic-resistant building, National Building Code (NBC) gives the set of regulations and guidance that specifies the standards. The local government bodies only provide permits for the construction of a building if it satisfies the NBC and Byelaws. For safer construction, NBC is the only legal document that fulfills the requirements [5].

The guidance related to water and sanitation service provision in rural areas using community-led participatory approaches is provided by Nepal's National Policy on Rural Drinking Water Supply and Sanitation (2004) [6]. The policy has recognized community management as a key concept.

Nepal Rural road standards published by DOLIDAR in 2055 BS (1999) [7] for classification and geometric design standard of Local Road Network (LRN) to be followed by all involved in road development (Nepal Rural Road Standard, 2055). The NRRS was applicable for the Local Road Network comprising two categories of the road; District Road Core Network and Village Roads covering 2 subdivisions of terrain and 3 of projected traffic volume.

The Constitution of Nepal adopted in 2015 ended the unitary and centralized system of governance and established a federal structure that distributed legislative and executive powers among three governmental levels: local, provincial, and federal. The local level of government municipalities is categorized into three categories: Metropolitan municipality Sub-metropolitan municipality, Municipality, and Rural Municipality. The local government is provided with larger territories greater responsibility (Diagnostics study of Local Governance in Federal 2017) [8].

Thabang Rural Municipality lies in Rolpa district of Lumbini Province, Nepal. It was established in 2073 B.S. The original demarcation included three existing VDCs viz. Thabang VDC, Mirul VDC, and Uwa VDC were later merged in Thabang Rural municipality on 10 March 2017. The rural municipality spans 191.07 square kilometers (73.77 sq. mi) of area, with a household of 2399 and a total population of 10,881 according to a 2011 Nepal census.

2. PROBLEM STATEMENT :

Mishra & Regmi (2019) [9] recommended tracking through Electronic Building Permit System for effective implementation of BPS and NBC compliance. Frequent field inspection and supervision is one of the key components to ensure earthquake safer construction. Community awareness camps need to be organized frequently and the capacity-building programs to concerned stakeholders are to be provided regularly for the effective implementation of NBC and Byelaws. Training of Trainers (TOT), on-the-job training, mason training, and orientation on NBC are to be conducted frequently for the skill enhancement of masons/contractors and engineers. Timely review and update of NBC are of utmost importance.

Nepal is rich in water resources through the financial performance of Mangadh Water Supply Scheme, the financial performance of Dhankuta 7, 8, 9 water supply systems, and Salayankot water supply seems just satisfactory even after good infrastructure condition of the system [10, 11 & 12].

"Nepal Road Sector Assessment Study" directed together by World Bank and GoN in a joint effort with ADB, DFID, and SDC for far-reaching street area appraisal covering both the Strategic Road Network (SRN) and the Local Road Network (LRN). According to the review, in many regions gear was promptly accessible bringing about a shift towards hardware-based execution because of the much lower execution costs for specific exercises (particularly earth development). Nonetheless, in light of an absence of work standards for gear used in the LRN, work-based standards were being applied, bringing about cost reserve funds and possibly high overall revenues for project workers if hardware were utilized. MTMP is one of the most effective transportation planning tools for the municipality. It has many opportunities. Hence, the municipality should give Municipal Transport Master Plan (MTMP) high priority followed by District Transport Master Plan (DTMP) (Mishra and Magar, 2017) [13]. The operational performance of public transportation in the capital city along with many other major cities is under question (Mishra et al, 2020) [14]. This shows an urgency to conduct research of infrastructure construction based on the rural setting of a remote area like Thabang Rural Municipality of Rolpa district, Lumbini Province, of Nepal.

3. OBJECTIVES :

To access the compliance of standards based on selected case projects representing building, water supply, and the road of Thabang Rural Municipality.

4. LITERATURE REVIEW :

An attempt is made to summarize the work that has been carried out and needs to be carried out during the research ultimately to clarify the concepts and to draw related inferences. Relevant books and journals have been studied in the process. Related literature, Indian Standards, National Building Code (NBC), National Water Laws and Policies, NRRS, and other relevant codes and norms were also reviewed.

4.1 Nepal Rural Road Standard 2071:

The Nepal Rural Standard (NRRS) were introduced in 2055 [7 & 14] to set the classification and geometric design standards for the Local Road Network (LRN) to be followed by all those involved in the development of the network including Users, User Committees, three-level of governments and its development partners.

Various design parameters for district roads and village roads in hilly region as per NRRS 2071 includes,

Design Speed: - District Road - 50 kmph
Village Road - 30 kmph

Roadway Width: - District Road – 6 m
Village Road – 4.5 m

Carriageway: - District Road – 3 m
Village Road – 3 m

Shoulder Width: - District Road – 1.5 m
Village Road – 0.75 m

Total ROW: - District Road – 20 m
Village Road – 15 m

Setback Distance: - District Road – 6 m
Village Road – 3 m

Stopping Sight Distance: - District Road – 45 m
Village Road – 30 m

Ruling Gradient: - 5% (for both district and village roads)

Limiting Gradient: - 6% (for both district and village roads)

Exceptional Gradient: - 7% (for both district and village roads)

Constructability assessment and compliance of road construction at TRM will be checked based on the above-mentioned criteria of NRRS 2071.

4.2 National Building Code:

The apartment building construction is a formal housing process regulated by the government of Nepal in the overall process of approval, supervision, and monitoring. The High-rise apartment buildings in Kathmandu valley are safe enough in an earthquake, Fire other natural disasters since the compliance of building codes and Bylaws is satisfactory. There is no option to go for High-rise Apartment buildings in the cities like Kathmandu where the land is very limited and techno legal provisions are found effective whereas in remote areas capacity of implementing agency is under question? Many more studies are in the area focused on major cities but not much focus on the rural area where capacity needs regarding code DUDBC seem to have well-equipped norms under four Category such as International State-of-the-Art, Professionally Engineered Structures, Mandatory Rule of Thumb-MRT, and Guidelines for Rural Buildings [15 & 16].

4.3 Water Supply :

Mekonnen (2020) [17] showed the different problems of aged pipes, oversized and undersized pipes, low and high pressures and shortage of water from the source based on the Jijiga City of Ethiopia and most of our system shows similar problems that is why the functional system in Nepal is very less around 25% only. The government of Nepal (2004) guided water and sanitation service provision in rural areas using community-led participatory approaches.

5. METHODOLOGY :

In this research, the concept is only supported by action and research questions which are the most important feature of Pragmatism. This research also integrates the use of multiple research methods such as qualitative, quantitative, and action research methods so the philosophy of this research is Pragmatism.

5.1 Study Area:

Thabang Rural Municipality of Rolpa district, Lumbini Province, of Nepal, was established in 2073 B.S. The original demarcation included three existing VDCs viz. Thabang VDC, Mirul VDC, and Uwa VDC were later merged in Thabang Rural municipality on 10 March 2017. The rural municipality spans 191.07 square kilometers (73.77 sq. mi) of area, with a household of 2399 and a total population of 10,881 according to a 2011 Nepal census. The coordinates of Thabang Rural municipality is 28.48°N 82.72°E.

As this municipality is one of the remote rural municipalities of Lumbini province, till now in this rural municipality building permit has not been established yet, no lab for quality of materials check, the new track has opened haphazardly, and graveled, pitched road is not constructed yet. To manage the water supply system user's committees are not formed also any system of the water meter and water tariff. Thus, this scenario of construction status and geographical obstructions in the construction of this area attracted me to research compliance of selected construction projects of TRM with standards.

To check compliance of standards following are selected projects: -

- To access the compliance of NBC code 12 masonry buildings and 20 RCC buildings were selected.
- To check compliance of NRRS "Construction of Telkhola Bhangrang Gramin Sadak on Ward 4 (TRM-06/2076-077/NCB)". The Employer is Thabang Rural Municipality, Office of Rural Municipal Executive and the Contractor is Jalaki Nirman Shewa. The total length of roadway construction is 7 KM, the estimated amount is NRs 1,52,92,757.3 and the quoted amount is NRs 1,51,56,100.48, and "Tutu Bhitrivan motorable road" onward 3 of 1.280 km.

5.2 Collection of Data:

(a) Key Informant Interview: To find out the managerial aspects, planning aspects, construction procedure adopted, project in-charge and project manager was interviewed, for technical queries technicians were asked and to find the functionality of project Users Committee, stakeholders, representatives, public were interviewed.

(b) Questionnaire Survey: A simple set of questions was prepared regarding the compliance of standards of the selected project representing building, water supply, and local road.

(c) Field Observation: A field visit was done carrying a checklist for visual assessment.

(d) Detailed engineering project design report followed by literature review and standards were highly referred to as secondary data.

5.3 Analysis of Data:

The descriptive data analysis was done. Compliance with Code, Bylaws, and standards was assessed through measurement and observation. To make it more objective content analysis followed by picture and observation review has been focused on. The grounded theory process has been applied for particular case projects and narratives were developed from interviews.

6. RESULTS AND DISCUSSION :

6.1 Compliance status of Building with NBC at Thabang Rural Municipality:

As Thabang Rural Municipality is in the developing phase, building construction is at a peak point so it is very important to trace the compliance status of the National Building Code (NBC) on the buildings constructed in the municipality. In this municipality building permit system has not been started yet so site-only observation was conducted for NBC compliance. NBC compliance check was carried out among both masonry and RCC houses constructed after the destruction led by the recent earthquake. To access the status of building constructed in Thabang Rural Municipality 12 masonry buildings, 20 RCC buildings were selected.

6.1.1 Shape of the Building

Building under consideration both RCC and masonry building 100% compliance with the shape of building criteria of the checklist. Thus, all buildings of Thabang Rural Municipality are of either rectangular or square

6.1.2 Column Bays

Column bays are the center to center distance of two columns. No RCC buildings are constructed more than 4.5m apart as checklist data shows 100% compliance in column bays criteria of the RCC building checklist.

6.1.3 Footing

Footing is the substructure of a building whose minimum base width is recommended for both RCC and masonry building in NBC 202-2015 and NBC 205-2015 respectively.

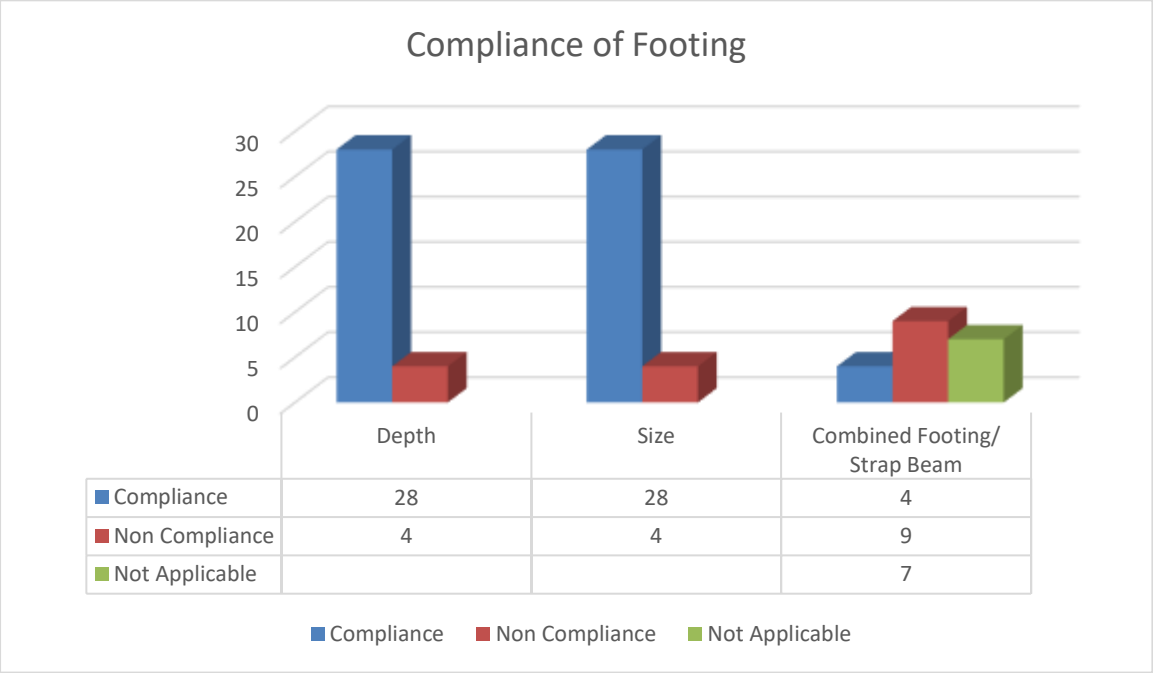


Fig. 1: Compliance of Footing

A study at Thabang Rural Municipality shows compliance of footing by analyzing the depth of footing, Size of footing, and Combined footing/Strap beam parameters. It is seen that out of 32, 28 buildings comply, and 4 buildings are noncompliant with depth and size criteria which indicates most of the buildings are constructed following NBC code criteria for the foundation. A combined footing or Strap beam is provided when footing has to be placed at the boundary. The above bar chart shows in 7 buildings combined footing is not applicable, 9 buildings are constructed at the boundary without providing combined footing and 4 buildings are constructed at edged providing combined footing/Strap beam. Local people of Thabang Rural Municipality say that in past there was the concept of building houses attaching to the neighboring house for safety.

6.1.4 Column:

The column is the vertical member of the RCC building which transfers load from superstructure to substructure and finally to soil.

Compliance Study of Column of Thabang Rural Municipality's buildings was done by observing column size, reinforcement in the column, spacing of stirrups, lap length, and column in grid lines. The above bar chart shows that all sampled buildings comply in column size and column in grid line. Similarly, 17 building compliance and 3 building non-compliance in reinforcement in the column, 11 building compliance and 9 building non-compliance in the spacing of stirrups, 5 building compliance and 15 building non-compliance in lap length. This observation shows that after the earthquake of 2072, NBC standards regarding column size, the column in reinforcement, the column in the grid have been followed more sincerely but lap length criteria were not followed in most of the buildings and case of

spacing of stirrups field observation shows that 6" or more than 6" spacing was provided through the entire height of the column.

6.1.5 Beam:

A beam is usually a horizontal structural element that carries loads perpendicular to their longitudinal direction). Reinforcement details (Min 4 no of 16 mm dia.), Spacing of Stirrups (4" at edges and 6" at center) Lap length (60Ø) is specified in NBC 205-2015 for Category III building as Mandatory Rules of Thumb to make design fast, earthquake resistant, economical and safe.

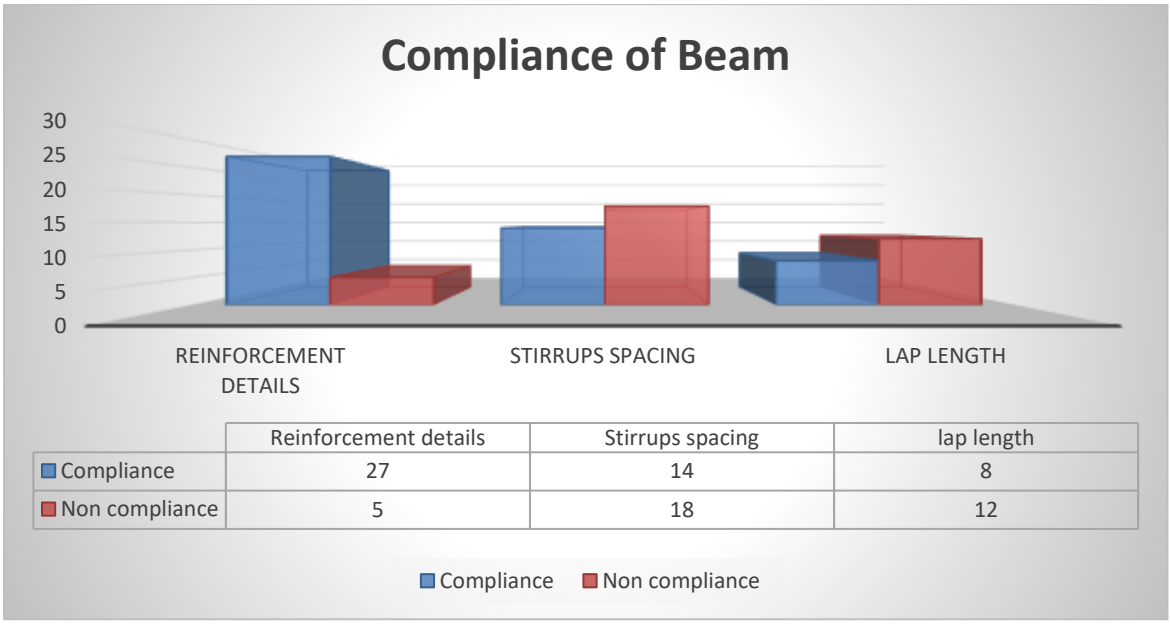


Fig. 2: Compliance of Beam

A study at Thabang Rural Municipality shows compliance of beam by analyzing the depth of reinforcement details, Stirrups spacing, and lap length parameters. It is seen that out of 32 samples, 27 buildings compliance and 5 building non-compliance with reinforcement details, 14 building compliance, 18 building non-compliance in stirrups spacing criteria. Lap length criteria were only checked in RCC buildings and it shows 8 building compliance, 12 building non-compliance in lap length criteria which indicates most of the buildings are constructed following NBC code criteria for reinforcement details specification. But in the case of spacing of stirrups field observation shows that 6" or more than 6" spacing was provided through the entire length of the beam.

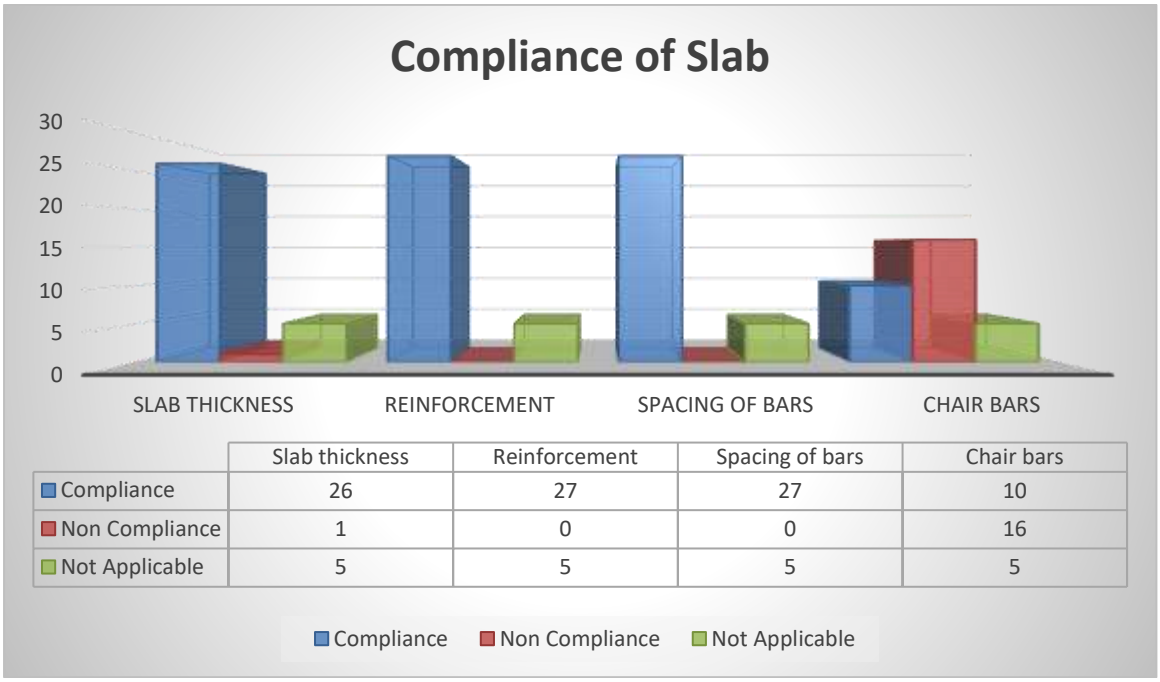
6.1.6 Sill and Lintel bands:

Sill and Lintel provide ductility and crack-proof masonry building, as masonry buildings areas such brittle structure. During an earthquake, bands sustain the shaking and hence minimize damage to load-bearing masonry buildings. As per NBC 205- 2015 minimum thickness is 75 mm or 3" and in masonry, building lintel is provided 150 mm as per NBC 205-2015.

A study of compliance of sill and lintel band shows that out of 32 buildings of Thabang Rural Municipality, 27 buildings are constructed with sill and lintel band, and among them, 24 buildings are fulfilling thickness specification and 3 buildings had not provided 3" thickness and 5 buildings are constructed without sill and lintel band. For masonry building sill and lintel band is very determining criteria for earthquake resistance since these band combines nonstructural element with structural element also prevent diagonal crack. Thus 5 buildings of Thabang Rural Municipality are more vulnerable to earthquakes than other buildings.

6.1.7 Slab:

Slabs are constructed to provide flat surfaces, usually horizontal in building floors, roofs, bridges, and other types of structures and they may be supported by walls or by reinforced concrete beams usually cast monolithically with the slab or by structural steel beams or by columns, or by the ground. The minimum thickness for the slab is 115 mm and the maximum thickness is 125mm, reinforcement detailing of the slab is a minimum of 8 mm with a maximum spacing of 6" along with chair bars to maintain top and bottom reinforcement as per NBC 205-2015.



	Slab thickness	Reinforcement	Spacing of bars	Chair bars
Compliance	26	27	27	10
Non Compliance	1	0	0	16
Not Applicable	5	5	5	5

Fig. 3: Compliance of Slab

Compliance of slab of 32 buildings of Thabang Rural Municipality was studied by observing slab thickness, reinforcement bars, spacing of bars, and chair bars criteria. The above bar chart shows among 20 RCC buildings all comply with slab thickness specification but in masonry out of 12 buildings, 6 buildings comply, 1 noncompliance, and 5 buildings have the flexible roof of either CGI sheet or slate stone. Similarly, all buildings with RCC slab compliance diameter of reinforcement bar and spacing of bars in the slab. Chairs bars are only provided in 10 buildings and in 16 buildings there were no chair bars. This study shows that almost all RCC buildings with concrete slabs are fulfilling their minimum criteria like slab thickness, spacing of reinforcement. It is also seen that chair bars placing has not taken more importance in the slab as only 10 buildings have concreted slab by placing chair bars.

6.1.8 Staircase:

A set of steps leading from one floor to another floor is termed as the staircase. Minimum specifications like thickness (minimum 5"), provision for the crossing of reinforcement, the extra bar at the crossing is recommended for staircase design in NBC 205-2015. Compliance of staircase of 32 buildings of Thabang Rural Municipality was studied by observing waste slab thickness, provision of crossing for reinforcement, and extra bar criteria. The above bar chart shows among 20 RCC buildings all compliance with waist slab thickness specification but in masonry out of 12 buildings, 1 buildings compliance, 6 noncompliance, and in 5 buildings all three parameters are not applicable. Similarly, only 5 buildings complied with the provision of crossing for reinforcement, and 22 buildings were noncompliant in the provision of crossing for reinforcement. Extra bars are provided at the critical crossing section for additional support in a staircase and this study shows that only 5 buildings' staircase was constructed by providing extra bars. This study shows that almost all RCC buildings with staircases are fulfilling their minimum criteria of waist slab thickness. It is also observed that the provision of a crossing bar for reinforcement and extra bar at the crossing has not taken more importance in staircase construction because of the lack of knowledge of masons of TRM about the provision of crossing for reinforcement and extra bars.

6.1.9 Concrete grade:

A study at Thabang Rural Municipality regarding the compliance of concrete by field observation shows that 24 buildings were constructed by using M20 grade concrete and 8 buildings were not fulfilling the minimum criteria for the concrete grade. Most buildings in Thabang Rural Municipality are being constructed by using sand of Thabang Khola without maintaining concrete grade which means the quality of concrete has not been achieved in those 8 buildings.

At Thabang Rural Municipality, there was no system of concrete cube testing to check the strength of concrete. This result was obtained by questionnaire survey, till now cube test was done only for one Administrative building of Thabang Rural Municipality. But only one cube test cannot show compliance of the whole building of Thabang Rural Municipality. Since no cube test has been except for one building it's difficult to say about the compliance of concrete grade. It is recommended to make the concrete strength testing system compulsory before giving any bills from the technical department of Thabang Rural Municipality.

6.1.10 Masonry parameters only:

The integrity (coherence) between structural elements such as walls and ceilings is reached through horizontal and vertical ties in masonry buildings and these buildings are also considered as building with ties.

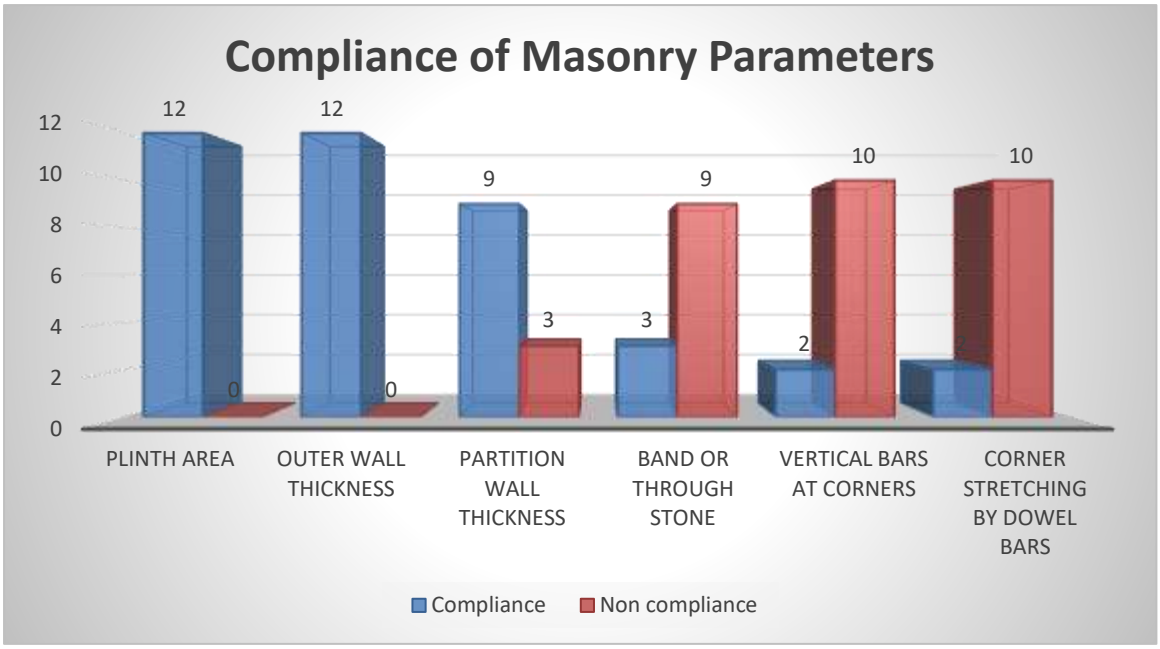


Fig. 4: Compliance of Masonry Parameters

Compliance of masonry building was checked by analyzing plinth area, outer wall thickness partition wall thickness, band or through stone, vertical bars at corners, corner stretching by dowel bars along with other above parameters. The above parameters show that out of 12 buildings all compliance in plinth area, outer wall thickness. Similarly, 9 buildings comply, 3 buildings are noncompliant in partition wall thickness. Band stone and corner stretching by dowel bars are very essential in masonry as it provides a box effect, strengthen the corners, and also avoid the propagation of the crack. But this criterion was only fulfilled by 2 buildings out of 12 buildings. This observation proves that most of the masonry buildings were built avoiding the NBC-2012, specification.

Analysis

Mishra and Thing (2019) [18] found poor institutional and technical capacity within local authorities for strength-related provision. The research concluded that the earthquake-resistant features are plinth band, sill band, lintel band, and vertical core stitch and gable band in 17 models which are based on National Building Code (NBC). It was recommended to promote awareness on earthquake and its possible effects on building structure to house owners, local contractors, and related stakeholders also the provision of soil test should be made from the government side in localities for effective construction of houses.

6.2 Compliance status of roads with NRS-2071 at Thabang Rural Municipality:

Thabang Rural Municipality is at the developing phase since only a new track of village road has been opened by TRM. District road and federal road are constructed by the Provincial government and Federal government [19]. No road in TRM is graveled or pitched. Thus, out of 26 design parameters of NRS 2071 only roadway width was measured and its compliance was checked. To check the compliance of roadway width, the following two roads were taken as samples.

Table 1: Projects selected for compliance check of roads

S. N.	Name of road	Total length	Road type	Compliance parameter
A	Tutu Praja Bhitivan Motorable road	1.280 km	Earthen road	Road way width
B	Telkhola Bhangrang Gramin Sadak	1.660 km	Earthen road	Road way width

6.2.1 Tutu Praja Bhitivan Motorable road:

Standard roadway width as per NRS-2071 = 4.5m (For hilly region)
Observed roadway width,

Roadway width compliance length = 500m (39.06%)
Roadway width Noncompliance length= 780m (60.94%)

It was observed that 500m i.e., 39% of the road of Thabang Rural Municipality compliance and 780m i.e., 61% noncompliance with roadway width standard of NRS 2071. This study shows that a major portion of Tutu Praja Bhitrivan road is non-compliant with the standard.

6.2.2 Telkhola Bhangrang Gramin Sadak:

Standard roadway width as per NRS-2071 = 4.5m (For hilly region)
Observed roadway width,

Roadway width compliance length = 1560m (93.97%)
Roadway width Noncompliance length= 100m (6.03%)

The observed checklist shows that 1560m i.e., 94% of the road of Thabang Rural Municipality compliance and 100m i.e., 6% noncompliance with roadway width standard of NRS 2071. This study shows that a major portion of Telkhola Bhangrang Gramin Sadak road complies with the standard.

6.3 Compliance status of water supply project at Thabang Rural Municipality:

Thabang Rural Municipality has been succeeded till Fiscal Year 2077/078 to construct one tap per house with help of different non-governmental organizations. In this municipality, WUSC has not been formed for management after construction till now, but TRM has planned to form WUSC from FY 2078/079. So, the compliance of the water supply project was checked only in terms of demand fulfillment and water tariff calculation has been done to compensate for its design period expenditure. To check compliance Yebang Chabang water supply project was selected.

6.3.1 Water Demand compliance:

Water demand is the total sum of domestic demand, institutional demand, livestock demand, fire demand, and other demands of the locality. In Yebang Chabang Water Supply Project total demand is calculated only by taking domestic demand for the design period, 20 years. To fulfill that demand design tap flow was calculated during the design phase. To check whether the demand is fulfilled or not as per design, tap flow is observed to each household, and data was taken. A study of Water Demand Fulfillment of Yebang Chabang water supply shows that the observed tap flow of 3 households (7%) did not compliance and 40 households (93%) compliance with design tap flow.

6.3.2 Water Tariff:

A water tariff is a price assigned to water supplied by a public utility through a piped network to its customers. Under the Water tariff fixation commission act 2063 (2006), Water Tariff Fixation Commission is formed for the protection of the interests of consumers by providing qualitative and reliable water supply and sanitation service to the consumers at a reasonable price, by fixing the tariff of water supply and sanitation service. In Thabang Rural Municipality Water Tariff Commission has not been formed yet, construction of the building for water supply has finished in FY 2077/078 so TRM has planned to form Water Tariff Commission and WUSC from FY 2078/079.

6.3.3 Water Tariff Calculation of Yebang Chabang Water Supply Project:

Water tariff calculation was done both considering and not considering construction recovery cost and operation and maintenance cost of Yebang Chabang Water Supply project. Yebang Chabang Water Supply project was constructed for 21 years design period considering a 1-year construction period. To recover construction cost along with yearly expenses of water system management, the total cost of construction was divided by design period and other yearly expenses are added for the total expenditure of the first year. Then consecutive year's expenses were calculated considering inflation. water tariff was calculated by taking 52 base households, 242 base population, 8.33% inflation rate, 20 years' design period, Rs42,26,178.5 cost estimate, and 8000 l/day/per house parameters in AP.

Table 2: Water Tariff calculation

	Flat Rate		Water Tariff	
Years	**Considering const. recovery cost**	**Considering only operation and maintenance cost.**	**Considering const. recovery cost**	**Considering only operation and maintenance cost.**
1	106.92	142.01	468.64	133.76
2	113.48	148.14	497.44	142
3	120.4	154.75	528.16	150.72
4	120.49	161.86	528.16	159.52
5	120.71	169.49	529.12	168.88
6	121.17	177.69	531.12	178.88
7	121.86	186.48	534.16	189.52
8	122.79	195.89	538.24	200.96
9	123.97	205.97	543.44	213.2
10	125.41	216.75	549.76	226.24
11	127.11	228.28	557.2	240.16
12	129.1	240.61	565.92	255.04
13	130.95	253.8	574	270.16
14	133.1	267.89	583.44	286.24
15	135.58	282.95	594.32	303.44
16	138.38	299.04	606.64	321.84
17	141.53	316.24	620.4	341.52
18	145.04	334.61	635.84	362.48
19	148.94	354.25	652.88	384.96
20	152.81	375.23	669.84	407.84

Analysis

While observing the table of Water Tariff calculation considering construction recovery cost, it shows that its rate ranges from Rs400 to Rs700 from the first year to the 20th year which is very high and it would be high for an average person and while only considering operation and maintenance cost water tariff rate ranges from Rs. (100-400) which seems reasonable.

6.3.4 Affordability of water tariff:

The maximum price a consumer can pay for buying something is termed affordability. Water affordability is the basic criterion for economical and healthy life because when water becomes unaffordable it directly affects the health of people. Water affordability is measured by the annual cost of water bills as a percentage of average household income. Some developed organization has developed affordability threshold for water bills based on median household.

In Yebang Chabang Water Supply Project, water tariff considering construction recovery cost Rs 400.3 in an average of 20 years. By key informant interview average yearly income of beneficiaries of the Yebang Chabang Water Supply Project is approximately 1.5 lakhs so water tariff is 0.26% of income taking water tariff with construction recovery cost. Considering only operation and maintenance cost not considering construction recovery cost water tariff is Rs 247.87 which is 0.16% of income. Many agencies in the USA has developed threshold based on median household income like 1.5% by the California Department of Public, 2%-2.5 % as per the U.S Environmental Protection Agency (USEPA), and 3% as per the United Nations Development Program. Providing water supply and sanitation services to 100% of the population is the aim of Rural Water Supply and Sanitation National Policy 2004. Relating to these thresholds, knowing that clean water is a fundamental right of every person and also water tariff fixation is also important for the management of water supply, the water tariff of Yebang Chabang Water Supply can be said affordable.

7. CONCLUSION :

The compliance status of building with NBC of 12 masonry buildings and 20 RCC buildings was studied through checklist observation. All 32 buildings complied in the shape of the building and column bays and major non-compliance was observed in the spacing of stirrups in column and beam, lap length in column and beam, chair bars of the slab, provision of reinforcement at the crossing. All 12 masonry buildings compliance in plinth area and outer wall thickness and noncompliance was observed in band/through stone, vertical bars at corners, and corner stretching by dowel bars.

The compliance status of roads with NRS-2071 was observed in two road projects Tutu Praja Bhitrivan Motorable road and Telkhola Bhangrang Gramin Sadak. Since only new tracks are opened at TRM, only the roadway width parameter was checked. The result shows in Tutu Praja Bhitrivan Motorable road 500m i.e. (39.06%) compliance and 780m i.e. (60.94%) noncompliance with standard and for Telkhola Bhangrang Gramin Sadak 1560m (94%) compliance and 100m i.e., 6% noncompliance with roadway width.

Water Demand Compliance was checked and water tariff was calculated in selected Yebang Chabang Water Supply Projects. Among 43 households, in only 3 households (7%), water demand was not fulfilled according to design but that demand is fulfilled by storing water. Water tariff was calculated considering and not considering construction recovery cost. The calculation was done taking design parameters like 20 years' design period, cost estimate, and 8000 l/day/household. The result shows water tariff Rs (469-670) in 20 years while considering construction recovery cost and Rs (133-407) without considering construction recovery cost. water tariff is 0.26% of income taking water tariff with construction recovery cost. Considering only operation and maintenance cost not considering construction recovery cost water tariff is Rs 247.87 which is 0.16% of income. Relating to various thresholds developed by different organizations and knowing that water tariff fixation is important for the management of water supply, the water tariff of Yebang Chabang Water Supply can be said affordable.

8. RECOMMENDATION :

In the construction of RCC buildings at TRM, spacing of stirrups and lap length in beam and column, chair bars of the slab, provision of crossing in the staircase, extra bars at the crossing are the major parameters that should be supervised regularly. For masonry buildings, placing of band/through stone, vertical bars at corners, corner stretching by dowels are major non-compliance which should be checked properly since these features are earthquake-resistant parameters. Minimum roadway width should be constructed as per NRS-2070 at every point and upgrading should be started as soon as possible for stability and easy transportation. A broad study on water affordability for water supply projects of Thabang Rural Municipality should be done to optimize water price. Water meter system, Water Users Service Committee should be established for effective control and management of water supply system of TRM.

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