Final Report on

Exploring and Testing the Prototype of Plastic-Mixed Bricks

Submitted to:

UNDP Accelerator Lab

Kathmandu, Nepal

Submitted by:

Green Road Waste Management Pvt. Ltd.

Zero K.M, Pokhara,

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Date: 5th August, 2021

Background

Green Road Waste Management Pvt. Ltd. (Nepal) has been continuously working towards solving plastic waste-related problems from the past three years with the support of municipalities, national & international organizations, academia, and the private sectors. Among the various development challenges that the country is facing, the UNDP Accelerator Lab Nepal has also actively taken initiatives on solving the issues related to plastic waste.

With the technical and financial support from the UNDP Accelerator Lab in Nepal, Green Road Waste Management Private Limited together with Pokhara Metropolitan City has been working together to explore and test the prototype to create plastic mixed bricks. The main idea of the project was to replace some components of construction materials with used or discarded plastic products, particularly non-recyclable ones, as raw materials while preparing the prototypes of these plastic mixed bricks. Testing of different types of bricks, cost analysis, selection of bricks, and construction of demonstration model using these bricks within Pokhara Metropolitan City are the major tasks planned for this learning journey.

The duration of the research was for six months from 1st February, 2021 to 20th July 2021, including the no cost extension of two months due to the second wave of the Covid-19 pandemic.

Partners Involved/Partnership

The project has been successfully completed with overwhelming support from key partners like Pokhara Metropolitan City and UNDP Accelerator Lab Nepal. Each partner has their own roles & responsibilities.

UNDP Accelerator Lab Nepal team has curated this project, supported it technically & financially, and directly supervised the Green Road team, helped to tackle hurdles, and to complete the project on time. With their supervision, Green Road Team, procured the construction materials, prepared the testing bricks, conducted lab tests for strength analysis & construct the demonstration model of a "toilet" as per the standards set by Pokhara Metropolitan city.

Pokhara Metropolitan city has shown interested in this research from the beginning. They have provided space for testing the bricks on their material testing facility, supervised the brick's lab test, and approved the bricks for toilet construction. They have also drafted the design, estimation of the demonstration toilet & granted permission for building the unit inside their laboratory compound attached to the material facility building.

Soil Water & Air Testing Lab Pvt. Ltd. conducted the air pollution test & Race Group has done the toilet construction work. Gandaki Innovates has collaborated in making sample interlock bricks for the lab tests.

Objectives

The overall objective of the project was to explore and test the prototype of plastic bricks by using readily available local materials and plastic wastes and check its strength, costeffectiveness, and ability to replace normal interlock bricks. To fulfill the objectives, testing the three different kinds of bricks (solid bricks, interlock bricks & pavement tiles) using hot & cold process were done. After the strength analysis, the prototype with best results as per the government standard was chosen to construct a sample structure 'toilet'.

The specific objectives are:

- Closely coordinate with UNDP Accelerator Lab Nepal and Pokhara Metropolitan City Office for exploring and testing the plastic mixed bricks.
- Compare the compressive strength tests at various levels after mixing different % of processed plastics.
- Finalize the optimal ratio of concrete and processed plastic that blends perfectly for any construction.
- Construct a model toilet out of plastic bricks.
- Receive testimonials from the engineers on the viability of the plastic bricks.
- Organize sessions to incorporate community, engineers and user's experiences, feedbacks and inputs in the prototype of the plastic bricks for further refinement.
- Drawing key insights and learnings during and after testing/experimenting.

Results

Phase I: Lab Test Results and approvals

After the collection and shredding of waste plastics like MLP(Multi-Layer Plastics), PP(Polypropylene), HM (High Molecular carry bags) , the Green Road team started making different composition of interlock bricks, pavement tiles, and solid bricks through both the hot and cold processes. As per the work plan, pavement tiles sample had been made by mixing (0.75%, 1%, 1.25%, 1.5%, 2%) plastics, solid bricks sample bricks had been made by mixing(0.75%, 1%, 1.25%,1.5%, 2%, 3%) plastics, interlock bricks has been made by mixing(0.5%, 0.75, 1%) plastic. After making sample bricks, compressive strength and water absorption test has been done in the material testing laboratory of Pokhara metropolitan city in observation of Lab officers.

Fig: Sample preparation of solid bricks for lab test

Fig: Fire resistant test of Solid bricks

Fig: Picture of Pavement tiles

Fig: Compressive strength testing of pavement tiles and interlock bricks

Fig: Weight variation with & without plastic during weighing of solid brick

Fig: Hot process experimentation

Table: Summarized results of Compressive strength (units in MPa):

Composition	Type of Brick	Process	0.00%	0.25%	0.50%	0.75%	1%	1.25%	1.50 %	2%	3%
Pure MLP	Interlock	Cold	7.0	-	5.4	4.4	4.32	3.11	-	-	-
Pure HM	Interlock	Cold		-	5.2	5.1			-	-	-
Pure PP	Interlock	Cold		-	5.4	4.7	4.46	4.30	-	-	-
MLP + PP	Interlock	Cold		-	5.3	4.8			-	-	-
MLP + HM	Interlock	Cold		-	6.8	5.0			-	-	-
PP + HM	Interlock	Cold		-	5.8	5.2			-	-	-
Pure MLP	Solid	Cold	16.61	-	-	14.51	10.10	8.77	6.21	4.46	1.73
Pure HM	Solid	Cold		-	-	16.34	12.17	11.89	10.01	8.32	4.61
Pure PP	Solid	Cold		-	-	16.17	10.29	8.81	7.32	5.24	2.77
MLP + PP	Solid	Cold		-	-	9.60	7.35	5.95	5.10	4.85	2.02
MLP + HM	Solid	Cold		-	-	11.28	11.26	8.64	6.81	3.98	1.82
PP+ HM	Solid	Cold		-	-	14.30	14.27	11.26	7.50	4.49	2.46
Pure MLP	Pavement	Cold	35.31	-	-	21.58	20.17	19.03	18.04	14.7	-
Pure HM	Pavement	Cold		-	-	24.50	22.13	20.76	19.25	17.14	-
Pure PP	Pavement	Cold		-	-	23.65	21.92	23.00	21.81	15.92	-
MLP + PP	Pavement	Cold		-	-	19.62	17.32	14.87	11.50	7.78	-
MLP + HM	Pavement	Cold		-	-	23.31	21.74	18.39	16.32	15.9	-
PP + HM	Pavement	Cold		-	-	24.80	22.76	17.49	15.21	12.69	-
PP+HM+MLP	Pavement	Cold		-	-	19.75	19.31	18.65	15.88	12.72	-

(Note: "Red box" shows the test which were unsuccessful, "-" shows the test which were not carried out. The higher the compressive strength, the better the products are).

The compressive strength results of solid bricks were better than the interlock bricks. The percentage of plastic bricks was found inversely proportional to compressive strength for solid bricks, interlock bricks, and pavement tiles. It was found that when the plastic proportion was replaced by more than 1%, then the strength of the brick starts to decrease rapidly.

Compressive strength & cost of bricks were key parameters for analysis of bricks selection. After analysis, the Pokhara Metropolitan city engineers have approved 0.75% mixed pure-MLP

based solid mixed bricks made with the cold process for the toilet construction on the basis of standard strength required.

Results on hot processes:

Green Road team conducted the hot process test using the PP, HM and MLP. However, when experiment were conducted, the level of emission observed was quite high and it looked risky for the worker to continue with the experiment. The neighborhood people from the location where experiment were performed, started complaining because of the foul smell and smoke that has been generated. Thus, after informing the Accelerator lab team, Green Road team stopped making the bricks using the hot process and conducted experiment of finding out the emission level from bricks produced using hot process.

Table : Results of Air quality emission test:

S.N	Parameters	Results:S1 (µg/m3) (1.7 hrs)	Results: S2 (µg/m3) (1.7hrs)	Standard for ambient air as per AQMS 2017 report
1	Particulate Matter (PM_{10})	100.85	120.19	120 for 24 hours
2	Particulate Matter ($PM_{2.5}$)	29.49	51.61	40 for 24 hours
3	Total Suspended Particles (TSP)	118.24	149.58	230 for 24 hours
4	Sulphur Dioxide (SO2)	2.73	1.69	70 for 24 hours
5	Nitrogen Dioxide (NO2)	0.17	0.19	80 for 24 hours

(Note: S1: Emission test during heating of cold bricks, S2: Emission test during production of bricks with hot process)

On the basis of the air quality test conducted, it has been observed that PM10 is greater than the standard criteria which means inhalable particles with a diameter of 10 micrometers or less are found to be excessive in the test of the hot process of bricks. While PM 2.5 is less than the standard criteria. PM 2.5 is most hazardous for the health as it's more likely to transfer into and accumulate on the surface of the lung at deeper sections, while PM10 is more likely to deposit on the surfaces of the lung's wider airways in the upper region and total suspended particle

(TSP) is an antiquated regulatory indicator of particulate matter mass concentration in community air. The total suspended particle was found to be greater than standard criteria in the hot process. From the test, the pollutant from the process like sulfur dioxide and nitrogen dioxide were obtained lower than the standard criteria.

Phase II: Cost-benefit Analysis

The cost analysis of approved brick (0.75% mixed pure-MLP based solid bricks made with the cold process) has been done and submitted to the metropolitan city during the project. Based on the cost analysis of approved brick, it was found that plastic-mixed solid bricks (Rs. 35/pcs) cost higher than the normal solid brick (Rs. 31/pcs). As around 600 gms of aggregate material was replaced by 60gm of plastic in the plastic mixed solid brick, the lightweight of building, minimal resource consumption, thermal insulations properties & the solution to manage the plastic waste can certainly justify the over cost of plastic-mixed bricks. The cost of plasticmixed bricks can go down if the waste MLP (multilayer packaging plastic) will be freely available along with ease in collecting it. Detail cost analysis has been attached in annex 11 & 12.

Table: Comparison of Normal Solid Brick and Plastic Mixed Solid Brick

Parameters	**Normal Solid Brick**	**Plastic Mixed Solid Brick**	**Remarks**
Length (cm)	28	28	
Breadth (cm)	15	15	
Height (cm)	9	9	
Volume (cm^3)	3780	3780	
Dry Weight (gm)	8607	8193	Weight reduction due to plastic
Density (gm/cc)	2.28	2.17	
Cement used (gm)	537.94	508.22	
Sand Used (gm)	3227.63	3049.33	
Aggregate used (gm)	4841.44	4574	
Plastic used (gm)	0	61.45	One brick consumes nearly 30 pcs of noodle wrappers
Compressive Strength (N/mm^2)	16.61	14.46	Minimum Standard requirement is 3 N/mm2 as per building design code.
Market Price Per Brick w/o VAT	27	29.95	Considering shredded plastic cost to be Rs 65/kg, this can be reduced with proper policy or support from CSR activities

Phase III: Construction of Demonstration site

Construction of demonstration structure "Toilet" has been built inside the Pokhara metropolitan city's material laboratory facility. The design of the toilet has been drafted by metropolitan city engineers and constructed by Race Construction Group, Pokhara as per metropolitan city standard under closed observation of the Green Road team. The construction period lasted for two months. At the first stage, the mass production of approved solid bricks was done and left for 21 days curing process. At the second stage after the site clearance, the pit was dug for a safety tank hole and the toilet structure was built using plastic mixed bricks. During this construction approximately 100 kgs of non- recyclable plastics have been utilized in the construction.

Fig: Construction of safety tank

Fig: Construction of toilet structure

Fig: Mass production of plastic mixed solid bricks

Fig: Construction of septic tank

Fig: Completion of toilet

Fig: Internal finishing of toilet

Challenges/ Limitations

The Green Road team has faced various challenges and limitations while testing the bricks and constructing the demonstration site which has been listed below:

1) As per the initial plan for the lab test, using a cold process, the mixture of interlocks bricks should be made by replacing up to 3% plastics. But the sample couldn't be made by replacing above 1% plastics as the bonding of aggregate has been decreased exponentially by the plastic. We assumed that the non-recyclable plastics when heated will have a good binding property as that of recyclable plastics, but our experiment showed that there was not good binding and hence the brick didn't become stable while compressing using the interlock machine. If we use recyclable plastics in large quantity and make the plastic and aggregate in a semi liquid form using a densifier machine and put them in a mold then only a stronger brick can be made but the problem with that would be a higher cost of brick. As per kg cost of plastics is higher than the per kg cost of other raw materials.

2) While doing the compressive strength test, initially the value received was very less when tested interlock bricks as it is. Again, after consulting with engineers, interlock bricks have been made plane surfaced & filled with concrete (sand & cement- 1:4 ratio), and water cured for 2 days, and then compressive strength tests were done to get better results. The standard practice to test such bricks was by filling and levelling up all the voids, as during the real construction all the holes and gaps get filled by concrete, the correct result shall be obtained by following the same principle.

3) As per the initial plan for the lab test, the sample bricks have to be made from the hot process as well. The team tried to make bricks using the hot process but couldn't complete it as the smoke/ fumes generated during its heating process was considered unhealthy for the surrounding environment. The experiment has been stopped in the brick factory as the neighbors complained about the plastic smog. Rather than making a sample for the brick test, the team later carried emission-related tests.

4) For the accuracy of the air quality-emission test of SOx, NOx e.t.c, the test should be carried out for more than eight hours. But, heating lots of plastic for so long will be very harmful to the person carrying the test as well as to the neighbors. Realizing that, the team has carried the individual test for an hour only. For comparison the hourly rate of emission shall be multiplied with the total hours as required by the standard practice. The accuracy might be slightly compromised due to this, but for longer hour results this is one of the practices to multiply the hourly emission rate.

5) The construction work was delayed and had to be carried out during the monsoon due to the 2nd wave of the Covid-19 pandemic. So, in between the team has faced difficulties as construction has been stopped due to rain. The team has taken necessary safety precautions for Covid-19 and had covered the plaster structure with G.I sheets & sacks to get the structure safe from the rain.

Learnings

The major learnings from the project are:

1. Solid bricks were found to be stronger than interlock bricks. Even though cement sand aggregate ratio (1:15) of solid bricks was less in comparison to interlock brick mixture ratio of cement and stone dust (1:7). Interlock bricks were found weaker because, in interlock bricks, the bonding between cement and stone dust was weaker comparing to bonding between cement and sand.

2. Filling the hollow surface of interlock bricks gives better compressive strength results than without filling the hollow surface.

3. Out of the three different plastics tested, HM (High molecular, high density) plastics such as normal carrying bags give better compressive strength results of bricks followed by MLP (Multi layered plastic) & PP(Polypropylene).

4. The team learned that the cold process is a more economically viable solution than the hot process while making plastic bricks. Also, if priority is given to use non-recyclable plastics waste material like MLP over recyclable plastic waste materials, the cost of brick production will also be reduced.

5. Making bricks with the hot process consumes lots of energy & materials as well as produces harmful fumes. For making bricks using a hot process, it should be done in separate airtight & pressure-sensitive machines so that harmful fumes do not leak out. After the cost calculations, making bricks with a hot process looks economically unviable even though the plastic collection & processing cost will be reduced drastically because of the high amount of cost in heating.

6. Working with the local government and development organization was of a new experience for us. With the help of the development organization our communication with the local government became clearer and more productive. We realized that local governments work become slow due to the bureaucratic hurdles, but on the other hand weekly follow up and update meeting conducted by UNDP helped to keep the project on track.

7. Since the prototype prepared by this project would be directly beneficial to the laboratory officials of the municipality, we received a great support from them in the execution.
8. The plastic mixed brick and pavement tiles even though have sufficient strength, we can use it initially in the non-load bearing walls, compound walls, partitions, foot path etc. and save a good amount of non- recyclable plastics from ending up in the landfill.

Way Forward

Each day around 600 tons of plastic wastes are being generated out of which a large percentage are non-recyclable plastics. Recycling plastic waste has been a challenge because of its collection inefficiency. As, for the commercialization of plastic bricks, plastic roads, refusederived fuel (RDF), and other recyclables products, it requires a huge amount of plastic waste, market feasibility and demand. For that, at first dedicated plastic collection and processing center has to be established in Pokhara and other major cities. Collaboration with the metropolitan city, NGOs/INGOs, Bank & financial institutions, waste-producing industries will be a great help to commercialize the business at every local level.

Potential Sources of Plastic Supplier	**Potential End Users of plastic bricks**	**Potential Partners**
Noodle, Biscuit Industries	Public buildings tendered by the Government	Meroghar
Informal Waste collectors	Compound walls of house owners	Race Construction & others
Plastic Collection center at Landfill	Temporary constructions	Development Agencies
	Wherever RED bricks are used, they can be replaced	Municipalities

Green Road team in future, will help to aware people of this kind of solution in Pokhara & other areas and will train and orient interested small bricks producers and others to start the business of plastic mixed construction materials production like plastic bricks. Production of plastic mixed bricks can be adopted at zero cost by current solid bricks, pavement tiles, footpath sidebars manufacturers, but they will have insufficient resources to set up the whole plastic collection center. Thus, the business of plastic waste management and bricks production will be economically viable if both entities do business separately, focus on their parts and support each other. For that Green Road team will also focus on producing the plastic raw materials and help in the technology development, technology transfer and product awareness of roads, bricks, and other innovative plastic management solutions.

The immediate steps from Green Road side will be to partner with current brick manufacturers and convince them to use the shredded plastics in their existing process. As the existing bricks are slightly cost effective than plastic bricks (cost difference of Rs 2.91 per brick), we will look for ways to reduce this cost difference by collaborating with different development partners who could help in setting up the plastic collection center so that the cost of plastic processing gets reduced. We will also make plans on how to bring CSR (Corporate Social Responsibility) activities and funds from various organizations to support the plastic free campaign either through plastic donation programs or by allocating certain CSR funds.

Annexures

Annex 1) Testimonials (translated from Nepali into English)

"Management of non-recyclables waste like packaging plastics, wrappers of noodles & biscuits e.t.c is a huge problem in Pokhara as these types of waste can't be brought back into the circular economy or can't be shaped into new products. Dumping this type of plastic waste in landfills has been the practice up to now. Initiation of using such kind of non-recyclable plastic waste along with cement and sand to make bricks has been initiated by Green Road and is highly appreciable. If the quality of bricks can be meeting national standards, then it's good to bring such kinds of bricks in markets." Ms. Kalpana Baral, Officer- Waste Management Department, Pokhara Metropolitan city.

"The rapid urbanization is leading towards rapid waste production in Pokhara. As per the World bank report 2019, plastic contributes around 19% (over 38 Ton/day) of the solid waste of Pokhara. So concepts like plastic bricks, plastic roads e.t.c will really help to manage the plastic waste as well. As per the national building code (NBC 205-1994), the minimum compressive strength of bricks should be 3.5N/mm2, and since most of tested solid bricks & interlock bricks have compressive strength above the NBC standards, so such kinds of bricks can be used in construction work. Seeing the international best practices, the government can adopt the international norms for such kinds of initiations and start pilot projects. Government can play role in quality testing, adopting or making norms, and recommend it further to implement in pilot projects of the government." Er. Laxmi Prasad Gautam, & Sub Er. Netra Prasad Timilsina, Officer of Infrastructure & Planning Department, Pokhara Metropolitan city

"The lab team has supervised all the brick's lab tests like compression test & water absorption test of different types of plastic bricks. On all the various brick types, the compressive strength of pavement tiles was observed to be very high (many of them were above 25 MPa). Interlock bricks' compressive strength was observed low compared with solid bricks. Among the test carried out, it was observed that less than 0.75% plastic replacement in solid bricks results in compressive strength above 10MPa. For making a building structure, it is usually recommended to use bricks above 10MPa (Solid bricks could be used in that case)." Lalit Timsina, Lab Incharge of Pokhara metropolitan city material testing laboratory

Annex 2) Detail work plan:

	Name / Title	Start Date	End Date	Assigned Person
1	**Brick Construction and testing**	1-Feb	20-May	
1.1	**Preparation for Test**	**1-Feb**	**28-Feb**	
1.1.1	Contract Signing with UNDP		1-Feb	Bimal Bastola
1.1.2	Full Work-plan submission	8-Feb	11-Feb	Nirajan Ghimire
1.1.3	Revision of work-plan		14-Feb	Nirajan Ghimire
1.1.5	Arranging Raw Material	15-Feb	19-Feb	Bimal Bastola
1.1.6	Asking confirmation with Metropolitan city for lab test	15-Feb	28-Feb	Bimal Bastola
1.2	**Sample Preparation and Lab Test**	**15-Feb**	**12-Apr**	
1.2.1	MLP,PP & HM material Preparation	15-Feb	19-Feb	Ajay K.C
1.2.2	Preparation of tiles, interlock & solid bricks with cold process	16-Feb	1-Mar	Ajay K.C
1.2.3	Curing of prepared sample	16-Feb	15-Mar	Ajay K.C
1.2.4	Lab Testing of Pavement tiles	19-Mar	23-Mar	Nirajan Ghimire
1.2.5	Sample preparation of bricks with hot process	24-Mar	26-Mar	Nirajan Ghimire
1.2.6	Lab Testing of Solid brick	24-Mar	27-Feb	Nirajan Ghimire
1.2.7	Lab Testing of Interlock bricks	28-Feb	31-Mar	Nirajan Ghimire
1.2.8	Thermal Testing of Solid Bricks	1-Apr	4-Apr	Nirajan Ghimire
1.2.9	Air pollution Test	5-Apr	11-Apr	Nirajan Ghimire
1.2.10	Cost Analysis of Solid Bricks	5-Apr	12-Apr	Bimal Bastola
1.3	**Sample Construction**	**13-Apr**	**13-May**	
1.3.1	Mass Production of bricks	28-Apr	28-Apr	Ajay K.C
1.3.2	Curing of sample bricks	28-Apr	18-May	Nirajan Ghimire
1.3.3	Design & construction cost estimation finalization	20-Apr	27-Apr	Bimal Bastola
1.3.4	Site Selection & Permission approval from metropolitan city	12-Apr	9-May	Bimal Bastola
1.3.5	Contractor appointment	10-May	18-May	Bimal Bastola
1.3.6	Raw Material procurement	19-May	26-May	Bimal Bastola
1.3.7	Site Clearance	27-May	31-May	Bimal Bastola
1.3.8	Video Making	1-Jun	20-Jul	Surat Giri, Onion Flims
1.3.9	Construction of the septic tank & curing	1-Jun	14-Jun	Race Construction
1.3.10	Construction of toilet structure, brick laying & curing	14-Jun	3-Jul	Race Construction
1.3.11	Plaster work, piping & finsihing	4-Jul	13-Jul	Race Construction
1.4	**Reports & Handover**		**20-Jul**	
1.4.1	Final Complete Report Submission		14-Jul	Nirajan Ghimire
1.4.2	Handling over the model to local government		20-Jul	Bimal Bastola

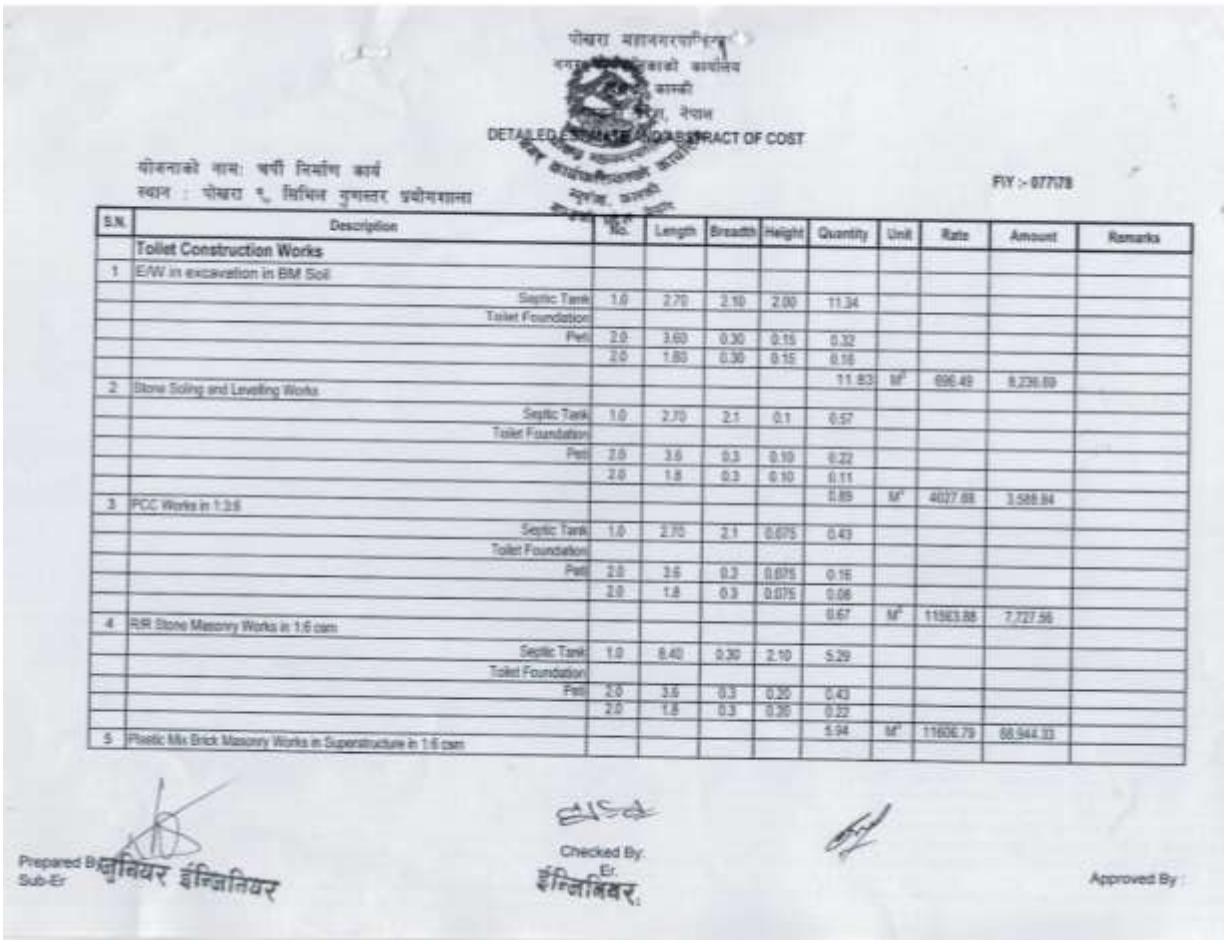
Annex 3: Project Expenses

Net Project Expenses (A)	Quantity	Unit	Amount (With VAT)
Raw Materials Total Cost			
Interlock Bricks	150	Pcs	8475
Pavement Tiles	180	Pcs	7119
Solid Bricks	648	Pcs	22699
Plastic	70	Kg	4900
LPG Gas	1		1500
Cement	200	Kg	3200
Sand	500	Kg	1500
Thermal Sensor Gun	1	Pcs	6500
Safety equipment and other			6000
		SUM 1	**61893**
Lab Test Expenses			
Compressive Strength	279	pcs	27900
Water absorption	6	pcs	600
Fire resistant	18	pcs	1800
Emission Test	2	set	56000
Carbon Test	2	set	24000
		SUM 2	**110300**
Machine Charges			
Hydraulic brick machine and it's unit	10	day	30000
Vibrator machine & solid brick & tile mold	4	day	10000
Mixing pan	2	day	3000
		SUM 3	**43000**
Labor Charge			
Operator	15	day	22500
Helper	30	day	30000
		SUM 4	**52500**
Technical Human Resource Cost			
Technical Human Resource (Cost per hr)	600	hr	120000
Other Overheads			31,197
		Total A	**418890**
Sample Construction (B)			
Estimated Toilet Construction	Municipal Estimate	SUM 6	**337450**
Budget Grand Total (A+B)			**756,340.00**

Annex 3) Team Composition for Project - Exploration & Testing of Plastic-Mixed Bricks

S.N	Name	Project-position	Responsibility
1.	Er. Bimal Bastola (Age: 30)	Principal Investigator (PI)	To investigate the overall project and update to UNDP team
2	Er. Ajay K.C (Age: 32)	In-charge	To lead the lab testing process
3	Mr. Nirajan Ghimire (Age: 25)	Mechanical Engineer / Technical Assistant	To look after lab-testing and reporting activities
4	Miss. Kriti Sharma (Age: 28)	Environmental Officer / Technical Assistant	To look after Environmental aspect & assist to PI

Annex 4) Cost estimates of toilet structure prepared by Pokhara Metropolitan city:



पोखरा महानगरपालिका

DETAILED ESTIMATE AND ABSTRACT OF COST

योजनाको नाम: चर्पी निर्माण कार्य
स्थान : पोखरा ९, सिमित गुणस्तर प्रयोगशाला

FIY :- 077/78

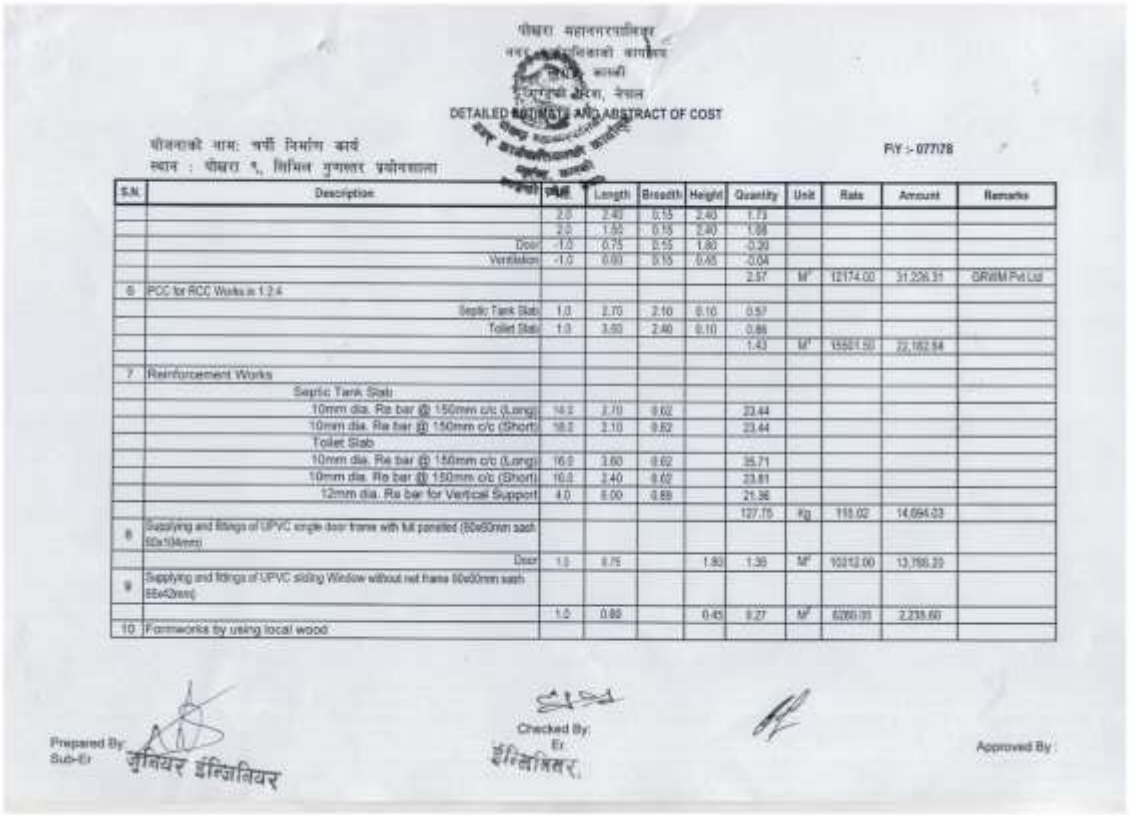
S.N.	Description	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount	Remarks
	Toilet Construction Works									
1	E/W in excavation in BM Soil									
	Septic Tank	1.0	2.70	2.10	2.00	11.34				
	Toilet Foundation									
	Pan	2.0	3.60	0.30	0.15	0.32				
		2.0	1.80	0.30	0.15	0.16				
						11.83	M^3	696.49	8,236.69	
2	Stone Soling and Levelling Works									
	Septic Tank	1.0	2.70	2.1	0.1	0.57				
	Toilet Foundation									
	Pan	2.0	3.6	0.3	0.10	0.22				
		2.0	1.8	0.3	0.10	0.11				
						0.89	M^3	4027.69	3,588.84	
3	PCC Works in 1:3:6									
	Septic Tank	1.0	2.70	2.1	0.075	0.43				
	Toilet Foundation									
	Pan	2.0	3.6	0.3	0.075	0.16				
		2.0	1.8	0.3	0.075	0.08				
						0.67	M^3	11563.88	7,727.56	
4	RR Stone Masonry Works in 1:6 cem									
	Septic Tank	1.0	8.40	0.30	2.10	5.29				
	Toilet Foundation									
	Pan	2.0	3.6	0.3	0.20	0.43				
		2.0	1.8	0.3	0.20	0.22				
						5.94	M^3	11606.79	68,944.33	
5	Plastic Mix Brick Masonry Works in Superstructure in 1:6 cem									

Prepared By: Sub-Er — जुनियर इन्जिनियर

Checked By: Er. — इन्जिनियर

Approved By:

Fig: Cost estimate Page (1 of 3)



पोखरा महानगरपालिका
नगर कार्यपालिकाको कार्यालय
कास्की
पृथ्वी नारायण, नेपाल

DETAILED ESTIMATE AND ABSTRACT OF COST

योजनाको नाम: चर्पी निर्माण कार्य
स्थान : पोखरा ९, तिमिल गुणसार प्रयोगशाला

F/Y :- 077/78

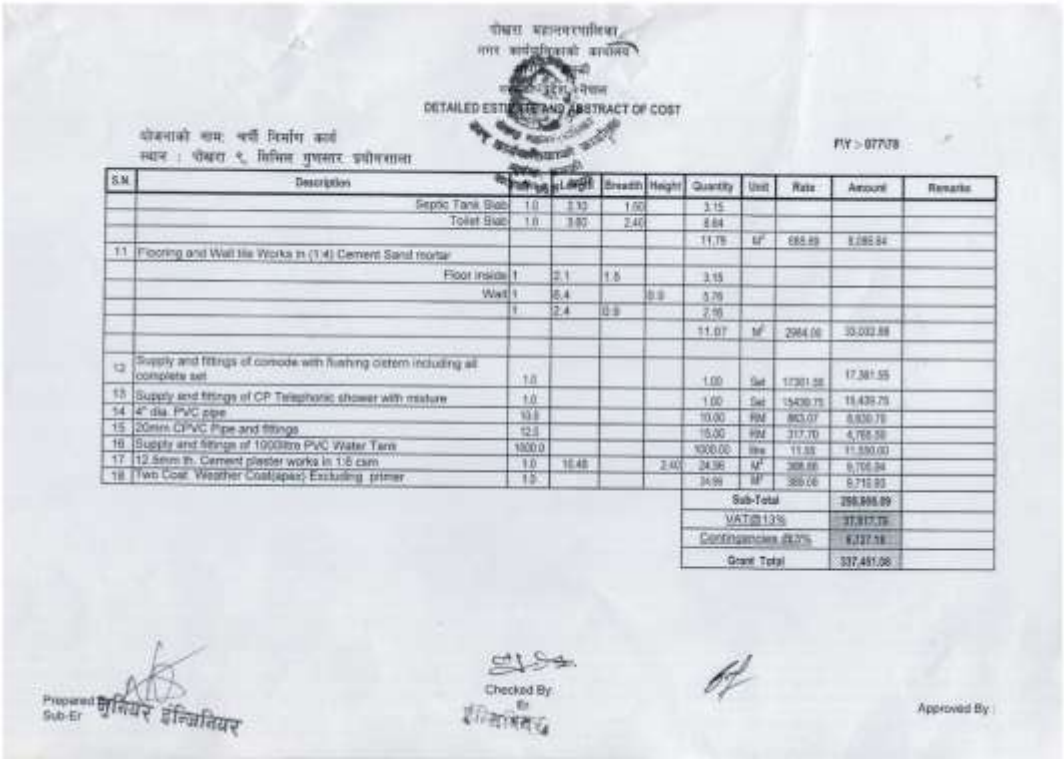
S.N.	Description	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount	Remarks
		2.0	2.40	0.15	2.40	1.73				
		2.0	1.50	0.15	2.40	1.08				
	Door	-1.0	0.75	0.15	1.80	-0.20				
	Ventilation	-1.0	0.60	0.15	0.45	-0.04				
						2.57	M³	12174.00	31,226.31	GRWM Pvt Ltd
6	PCC for RCC Works in 1:2:4									
	Septic Tank Slab	1.0	2.70	2.10	0.10	0.57				
	Toilet Slab	1.0	3.60	2.40	0.10	0.86				
						1.43	M³	15521.50	22,182.54	
7	Reinforcement Works									
	Septic Tank Slab									
	10mm dia. Re bar @ 150mm c/c (Long)	16.0	2.70	0.62		23.44				
	10mm dia. Re bar @ 150mm c/c (Short)	16.0	2.10	0.62		23.44				
	Toilet Slab									
	10mm dia. Re bar @ 150mm c/c (Long)	16.0	3.60	0.62		35.71				
	10mm dia. Re bar @ 150mm c/c (Short)	16.0	2.40	0.62		23.81				
	12mm dia. Re bar for Vertical Support	4.0	6.00	0.89		21.36				
						127.75	Kg	110.02	14,054.03	
8	Supplying and fittings of UPVC single door frame with full panelled (60x50mm sash 60x104mm)									
	Door	1.0	0.75		1.80	1.35	M²	10312.00	13,766.20	
9	Supplying and fittings of UPVC sliding Window without net frame 60x60mm sash 55x42mm)									
		1.0	0.60		0.45	0.27	M²	8266.00	2,235.60	
10	Formworks by using local wood									

Prepared By
Sub-Er
जुनियर इन्जिनियर

Checked By
Er
इन्जिनियर

Approved By

Fig: Cost estimate page (2 of 3)



पोखरा महानगरपालिका
नगर कार्यपालिकाको कार्यालय
कास्की
पृथ्वी नारायण, नेपाल

DETAILED ESTIMATE AND ABSTRACT OF COST

योजनाको नाम: चर्पी निर्माण कार्य
स्थान : पोखरा ९, तिमिल गुणसार प्रयोगशाला

F/Y :- 077/78

S.N.	Description	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount	Remarks
	Septic Tank Slab	1.0	3.10	1.00		3.15				
	Toilet Slab	1.0	3.60	2.40		8.64				
						11.79	M²	688.89	8,080.84	
11	Flooring and Wall tile Works in (1:4) Cement Sand mortar									
	Floor inside	1	2.1	1.5		3.15				
	Wall	1	5.4		0.9	3.78				
		1	2.4	0.9		2.16				
						11.07	M²	2984.00	33,032.88	
12	Supply and fittings of comode with flushing cistern including all complete set	1.0				1.00	Set	17381.55	17,381.55	
13	Supply and fittings of CP Telephonic shower with mixture	1.0				1.00	Set	15439.75	15,439.75	
14	4" dia. PVC pipe	10.0				10.00	RM	863.07	8,630.70	
15	20mm CPVC Pipe and fittings	12.0				15.00	RM	317.70	4,765.50	
16	Supply and fittings of 1000ltre PVC Water Tank	1000.0				1000.00	litre	11.55	11,550.00	
17	12.5mm th. Cement plaster works in 1:6 csm	1.0	10.48		2.40	24.96	M²	388.66	9,705.94	
18	Two Coat Weather Coat(apex) Excluding primer	1.0				24.99	M²	389.08	9,719.93	
						Sub-Total			250,995.09	
						VAT@13%			37,917.76	
						Contingencies @3%			8,737.16	
						Grant Total			337,451.06	

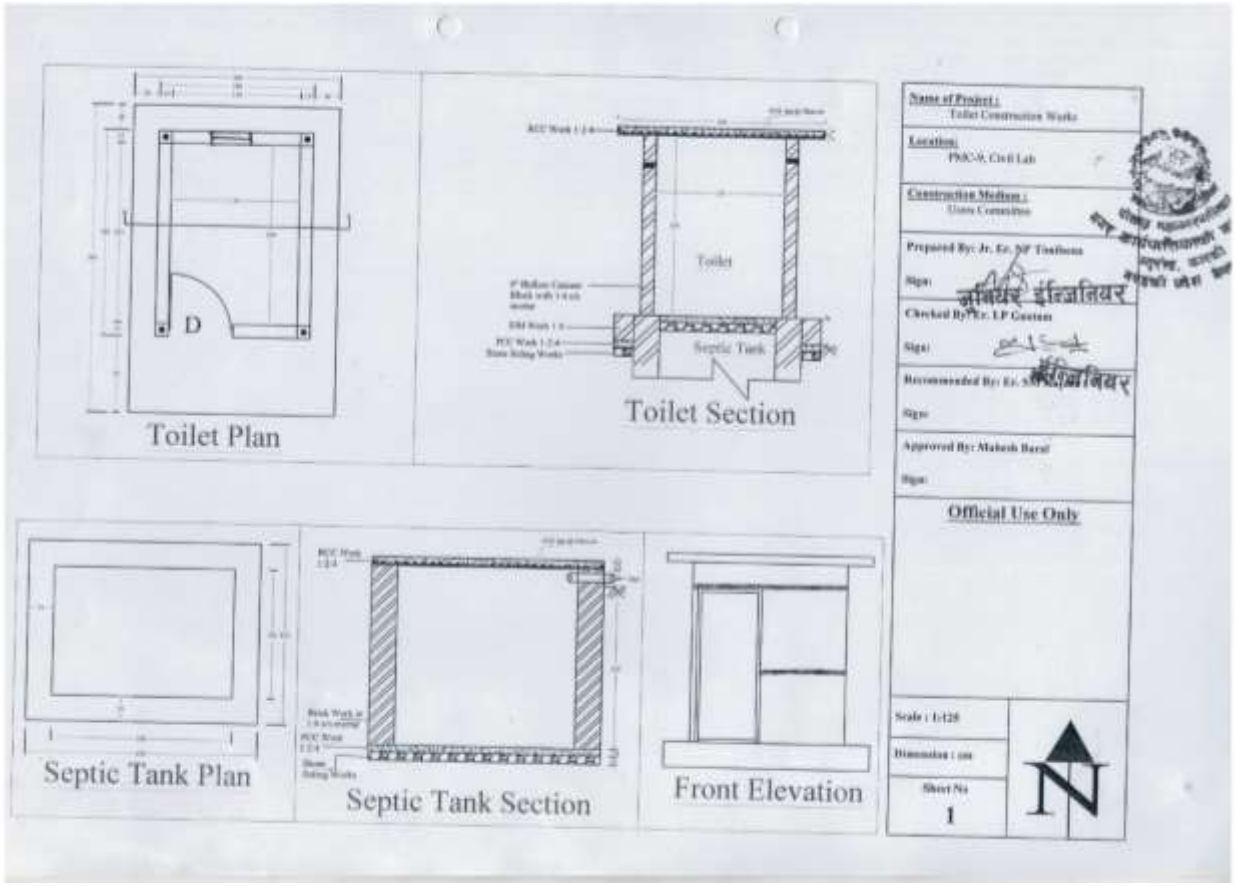
Prepared By
Sub-Er
जुनियर इन्जिनियर

Checked By
Er
इन्जिनियर

Approved By

Fig: Cost estimate page (3 of 3)

Annex 5) Pictures of design of toilet prepared by Pokhara Metropolitan city:



Annex 6) Picture of testimonial of Pokhara Metropolitan city:

मिति: २०७८/०१/०६

श्रीमान प्रमुख ज्यु
पूर्वाधार महाशाखा
पोखरा महानगरपालिका कार्यालय

विषय: राय पेश गरिएको संबन्धमा ।

प्रस्तुत विषयमा ग्रीन रोड वेष्ट म्यानेजमेन्ट प्रा.ली. पोखरा १२,को मिति २०७८/०१/०१ को पत्रानुसार व्यहोरा अवगत भयो । सोही सम्बन्धमा पूर्वाधार महाशाखा प्रमुख ज्युको राय पेश गर्न निर्देश भए बमोजिम पोखरा महानगरपालिकाको सिभिल गुणस्तर परिक्षण प्रयोगशालामा परिक्षण गरिएको प्लाष्टीक मिसिएको ईट्टा प्रयोग गरी पुर्वाधार निर्माण गर्नेको लागी उपयुक्त नतिजा आएको खण्डमा यु.एन.डि.पि.को समेत सहयोगमा नमुना कोठा/चर्पि निर्माणमा सहयोग गर्ने भएकोले सो सम्बन्धमा यो छोटो प्रतिवेदनात्मक राय पेश गर्दछौं ।

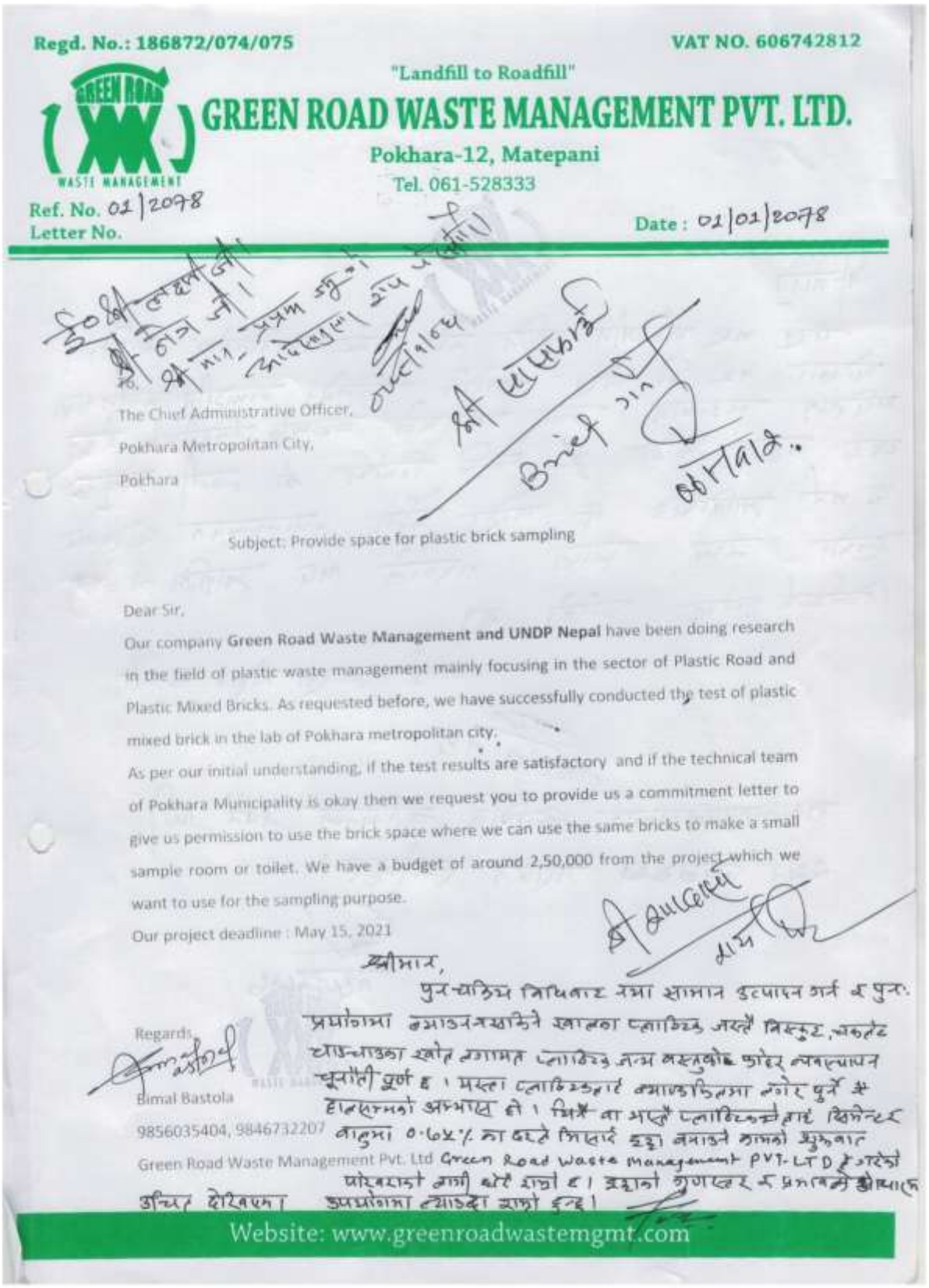
बढ्दो शहरीकरण सगै पोखराको फोहोरमैला अत्यधिक वृद्धि भैरहेको जस अन्तर्गत विश्व बैंकले तयार गरेको सन् २०१९को ड्राफ्ट प्रतिवेदन अनुसार प्लाष्टीक जन्य फोहरमैला मात्र १९ प्रतिशत उत्पादन भैरहेको अवस्थामा प्लाष्टीक जन्य फोहोरलाई पुर्वाधार निर्माणको कच्चा पदार्थको रुपमा प्रयोग गर्न सकेमा फोहोरमैला व्यवस्थापनमा समेत सकरात्मक सहयोग पुग्ने हुँदा निम्न कारणले नमुना संरचनाको लागी स्थान प्रदान गर्न उपयुक्त देखी सोही व्यहोरा अनुरोध गर्दछौं ।

१। पोखरा महानगरपालिका क्षेत्रभित्र प्रतिदिन उत्पादन हुने प्लाष्टीक जन्य फोहोरमैला १९ प्रतिशत अर्थात करिब ३८टन छ । माथी उल्लेखीत प्रविधिको प्रयोग गरी प्लाष्टीक जन्य फोहोरमैलाको समेत व्यवस्थापन गर्न सहयोग मिल्ने ।
२। अन्तराष्ट्रिय अभ्यासको समेत अनुसरण गरी उपयुक्त नर्मस बनाएर सडक तथा अन्य संरचनाहरु समेत निर्माण गर्न सकिने ।
३। प्रयोगशालामा परिक्षण गर्दा राष्ट्रिय भवन निर्माण संहिता (NBC 205-1994) अनुसार ईट्टाको क्रसिड स्ट्रेन्थ कम्तिमा 3.5N/mm² हुन पर्नेमा नतिजा 4.4N/mm² आएकोले सुरक्षीत देखीएको ।
४। सन् २०२१ अप्रील ६मा यु.एन.डि.पि.को टिम समेतको भर्चुअल माध्यमको छलफलमा नमुना संरचनाको लागी आर्थिक सहयोग गर्न तयार रहेको ।
५। अनुसन्धानकै क्रममा रहेको प्रविधि भएकोले सरकारी नर्मस तयार नभैसकेको अवस्थामा सरकारी लगत इष्टिमेट र आर्थिक सहयोग बाहेक आवस्श्यक गुणस्तर परिक्षणको लागी र नमुना संरचनाको लागी सानो स्थान प्रदान गरी सहयोग गर्न सकिने ।

पोखरा महानगरपालिका मेयर कार्यपालिकाको कार्यालय नगरपालिका, कास्की गण्डकी प्रदेश नेपाल

पेश गर्ने
सव इन्जिनियर नेत्र प्रसाद तिमिल्सिना
जुनियर इन्जिनियर
ईन्जिनियर लक्ष्मी प्रसाद गौतम
पो.म.न.पा.कार्यालय
ईन्जिनियर

Annex 7) Picture of Testimonials of Pokhara Metropolitan city:



Regd. No.: 186872/074/075 VAT NO. 606742812

"Landfill to Roadfill"

GREEN ROAD WASTE MANAGEMENT PVT. LTD.

Pokhara-12, Matepani

Tel. 061-528333

Ref. No. 01/2078

Letter No.

Date : 01/01/2078

To,

The Chief Administrative Officer,

Pokhara Metropolitan City,

Pokhara

Subject: Provide space for plastic brick sampling

Dear Sir,

Our company **Green Road Waste Management and UNDP Nepal** have been doing research in the field of plastic waste management mainly focusing in the sector of Plastic Road and Plastic Mixed Bricks. As requested before, we have successfully conducted the test of plastic mixed brick in the lab of Pokhara metropolitan city.

As per our initial understanding, if the test results are satisfactory and if the technical team of Pokhara Municipality is okay then we request you to provide us a commitment letter to give us permission to use the brick space where we can use the same bricks to make a small sample room or toilet. We have a budget of around 2,50,000 from the project which we want to use for the sampling purpose.

Our project deadline : May 15, 2021

Regards,

Bimal Bastola

9856035404, 9846732207

Green Road Waste Management Pvt. Ltd

Website: www.greenroadwastemgmt.com

श्रीमान्,

पेश गर बायोटीभ ग्रीन रोड वेस्ट म्यानेजमेन्ट प्रा.लि. पोखरा-१२ ले पेश गरेको निवेदन बायोटीभ प्रयोगशाला परीक्षण पश्चात तयार पारिएको प्रमाणित नतिजाको ईद्दा बार नमूना जाँदा / मापदण्ड निर्धारण को लागि उपयुक्त देखिन्छ प्राविधिक रु फाइदे जेल्ला व्यवस्थापन लोकप्रिय तिनले स्पष्ट प्राप्त गर्ने कार्य प्राविधिक को लागी निर्णयार्थ पेश गरेको छु।

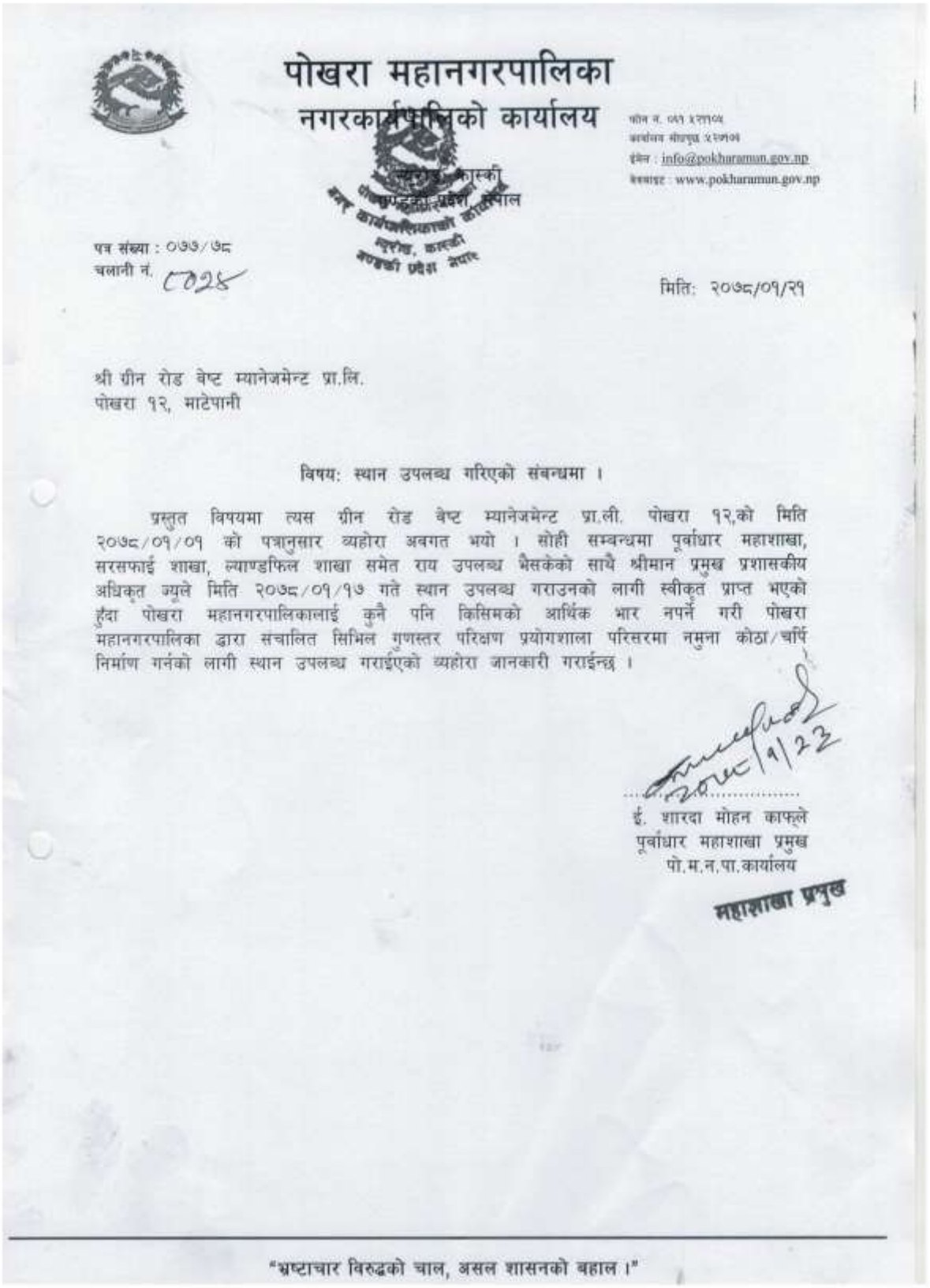
इ. सुभाष मोहन डोटेल

०७८/१/१६

महानगरपालिकालाई आर्थिक दायित्व नपर्ने गरी स्थान उपलब्ध गराउन स्वीकृत।

२०७८/१/१६

Annex 8) Picture for permission approval from Pokhara Metropolitan city



पोखरा महानगरपालिका
नगरकार्यपालिको कार्यालय

फोन नं. ०६१ ५२१०५
कार्यालय मोबाइल ५२७०७
ईमेल : info@pokharamun.gov.np
वेबसाइट : www.pokharamun.gov.np

पत्र संख्या : ०७७/७८
चलानी नं. 0028

मिति: २०७८/०१/२१

श्री ग्रीन रोड वेष्ट म्यानेजमेन्ट प्रा.लि.
पोखरा १२, माटेपानी

विषय: स्थान उपलब्ध गरिएको संबन्धमा ।

प्रस्तुत विषयमा त्यस ग्रीन रोड वेष्ट म्यानेजमेन्ट प्रा.ली. पोखरा १२,को मिति २०७८/०१/०१ को पत्रानुसार व्यहोरा अवगत भयो । सोही सम्बन्धमा पूर्वाधार महाशाखा, सरसफाई शाखा, ल्याण्डफिल शाखा समेत राय उपलब्ध भैसकेको सायै श्रीमान प्रमुख प्रशासकीय अधिकृत ज्युले मिति २०७८/०१/१७ गते स्थान उपलब्ध गराउनको लागी स्वीकृत प्राप्त भएको हुँदा पोखरा महानगरपालिकालाई कुनै पनि किसिमको आर्थिक भार नपर्ने गरी पोखरा महानगरपालिका द्वारा संचालित सिभिल गुणस्तर परिक्षण प्रयोगशाला परिसरमा नमुना कोठा/चर्पि निर्माण गर्नको लागी स्थान उपलब्ध गराईएको व्यहोरा जानकारी गराईन्छ ।

2078/1/22

ई. शारदा मोहन काफ्ले
पूर्वाधार महाशाखा प्रमुख
पो.म.न.पा.कार्यालय

महाशाखा प्रमुख

"भ्रष्टाचार विरुद्धको चाल, असल शासनको बहाल ।"

Annex 9) Cost Analysis of Plastic mixed brick:

Items for Normal Type				Details using Plastic-mixed solid bricks		
	Items	**Unit**	**Data**	**Items**	**Unit**	**Data**
	Type		Solid bricks	Type of Plastic		MLP (100%)
	Grade		M5	Percentage of Plastic	%	0.75
	Ratio (Cement : Sand : Aggregate)		1/6/09	Dry weight of Product	gm	8193.00
	Total ratio parts		16.00	Weight of Plastics Used	gm	61.45
	Length	cm	28.00	Compressive Strength	N/mm2	14.46
	Breadth	cm	15.00	Market Rate		
	Height	cm	9.00			
	Volume	cm3	3780.00			
	Dry Weight	Gm	8607.00			
	Density	gm/cm3	2.28			
	Compressive Strength	N/mm2	16.61			
	Market Rate	NRs.	30-33			

Raw Material Cost Calculation - Normal Type solid bricks

S.N	**Items**	**Percentage (%)**	**Quantity (gm)**	**Unit**	**Rate per Kg**	**Amount (NRs.)**
1	Cement	6.25	537.94	gm	14.000	7.53
2	Sand	37.50	3227.63	gm	1.3542	4.37
3	Aggregate	56.25	4841.44	gm	1.4583	7.06
	Total	100.00	8607.00			18.96

Raw Material Co st Calculation - Pla stic Mixed solid bricks

S.N	**Items**	**Percentage (%)**	**Quantity**	**Unit**	**Rate per Kg**	**Amount (NRs.)**
1	Cement	6.20	508.22	gm	14.000	7.12
2	Sand	37.22	3049.33	gm	1.3542	4.13
3	Aggregate	55.83	4574.00	gm	1.4583	6.67
4	Plastic	0.75	61.45	gm	65.00	3.99
	Total	100.00	8193.00	gm		**21.91**

Comparison- Raw Materials of Normal & Plastic Mixed solid bricks

S.N	**Items**	**Weight (gm)**	**Raw Cost (NRs.)**			
1	Normal	8607.00	18.96			
2	Plastic mixed	8193.00	21.91			
3	Difference (Normal - Plastic)	414.00	-2.95			

Labor Cost

S.N	**Items**	**Quantity**	**Per unit Salary/month**	**Amount (NRs.)**		
1	**Labor charge**					
	Labor	3.00	17000.00	51000.00		

	Incharge	1.00	23000.00	23000.00		
2	**Production**		**Total**	**74000.00**		
	Production per day	800.00				
	Total production per month	20000.00				
3	**Labor cost**					
	Labor cost per bricks			**3.70**		
Fixed Cost						
S.N	**Items**	**Quantity**	**Rate**	**Amount**	Remarks	
1	**Machine Cost**					
	Mixture machine	1.00	70000.00	70000.00		
	Molding Die	1.00	30000.00	30000.00		
	Vibration Machine	1.00	100000.00	100000.00		
	Electricals & Supplies	1.00	100000.00	100000.00		
	Wooden plates	500.00	100.00	50000.00		
	Tools	3 set	10000.00	30000.00		
			Total	380000.00		
2	**Infrastructure Cost**					
	Truss + Other structure	1.00	500000.00	500000.00		
			Total (1+2)	**880000.00**	Life cycle of machine	9.00
			Cost per year	97777.78		
			Cost per month	8148.15		
Operational Cost & Over Heads						
	Items	**Quanity**	**Rate**	**Amount**	Remarks	
	Land lease	1.00	20000/month	20000.00		
	Electricity, logistics		15000/month	15000.00		
	Maintenance & Overhead			5000.00		
			Total/month	**40000.00**		
Cost Calculation of Plastic Mixed Bricks						
S.N		**Unit**	**Spec.**	**Amount**		
	Fixed cost	per month		8148.15		
	Operational & over head	per month		40000.00		
	Total	**per month**		**48148.15**	Labor cost/brick	3.70
	Production of sellable bricks	Per month		20000.00		
	Fixed & operational cost	per brick		2.41		
	Raw material cost	Per bricks		21.91		
	Labor cost	per brick		3.70		
	Total cost of production	Per brick		**28.02**		
	Profit	per brick	10 percentage	2.80		
	Selling price excluding VAT	Per brick		**30.02**		
	VAT	per brick		**4.01**		
	MRP (Including VAT)	per brick		**35**		

Annex 10) Cost Analysis of bricks using different kind of plastics:

Production cost of different types of plastics (minimum cost to maximum cost):

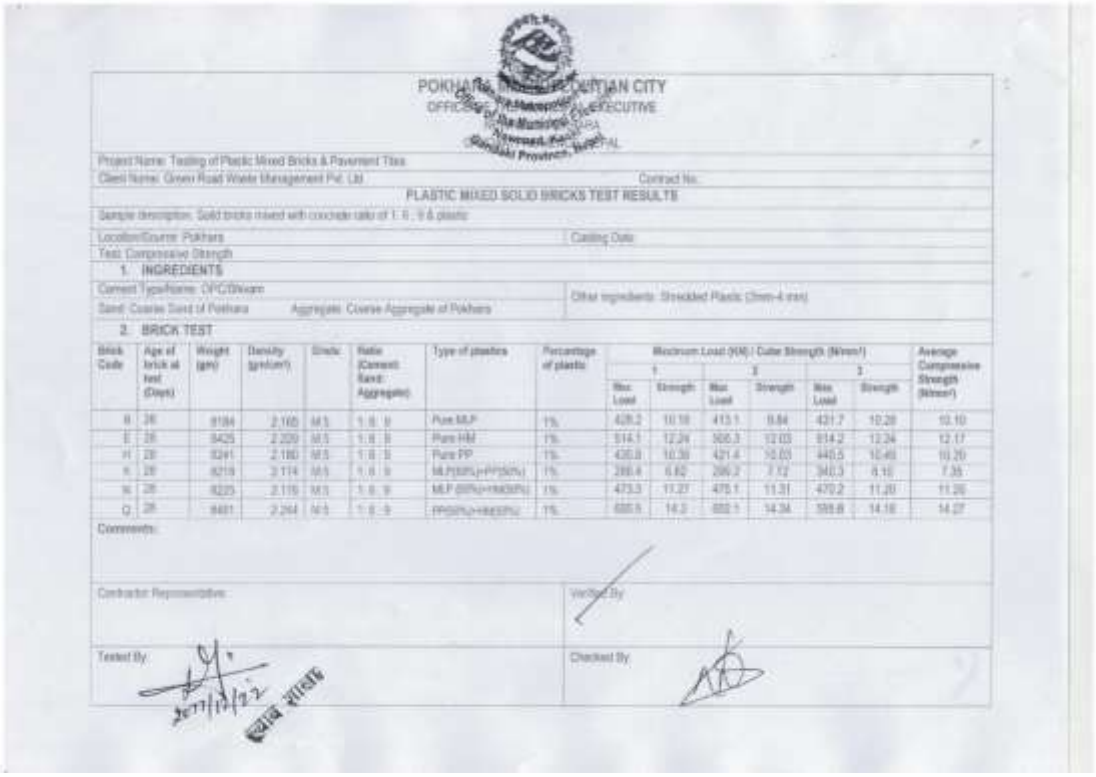
Type of plastic	Rate/Kg	Remark
MLP	30-65	(MLP plastic has no reusable value so it can be freely available with organizational support but most cost are required for its collection and processing. MLP cost can be bring to 30/Kg if there is support from industrial producers and if there is no purchasing cost & if collection process is easy.
HM	60-75	HM plastic can be recycled to make pipes & other accessories. So, purchasing cost of HM plastic is high.
PP	50-70	PP plastic can also be recycled into making other producsts like pp flower vase, safety euipments like road blocker e.t.c

Bricks cost using different types of plastic (minimum rate):

Items	**Material**	**Weight**	**Unit**	**Rate/Kg**	**Amount**
1	Cement	508.22	gm	14.000	7.12
2	Sand	3049.33	gm	1.3542	4.13
3	Aggregate	4574.00	gm	1.4583	6.67
4	Plastic (Using MLP)	61.45	gm	30.00	1.84
	Plastic (Using HM)			60.00	3.68
	Plastic Using PP)			50.00	3.07
5	Total material (Using MLP)	8193	gm		**19.76**
	Total material (Using HM)	8193	gm		**21.6**
	Total material (Using PP)	8193	gm		**20.99**

Annex 11) Pictures of Lab test reports of bricks :

Pictures of Lab test reports of bricks



POKHARA METROPOLITAN CITY

OFFICE OF THE MUNICIPAL EXECUTIVE

Project Name: Testing of Plastic Mixed Bricks & Pavement Tiles

Client Name: Green Road Waste Management Pvt. Ltd. Contract No:

PLASTIC MIXED SOLID BRICKS TEST RESULTS

Sample description: Solid bricks mixed with concrete ratio of 1 : 6 : 9 & plastic

Location/Source: Pokhara Casting Date:

Test: Compressive Strength

1. INGREDIENTS

Cement Type/Name: OPC/Shivam

Sand: Coarse Sand of Pokhara Aggregate: Coarse Aggregate of Pokhara Other ingredients: Shredded Plastic (2mm-4 mm)

2. BRICK TEST

Brick Code	Age of brick at test (Days)	Weight (gm)	Density (gm/cm³)	Grade	Ratio (Cement: Sand: Aggregate)	Type of plastics	Percentage of plastic	Maximum Load (KN) / Cube Strength (N/mm²) 1 Max Load	1 Strength	2 Max Load	2 Strength	3 Max Load	3 Strength	Average Compressive Strength (N/mm²)
B	28	8184	2.160	M 5	1 : 6 : 9	Pure MLP	1%	428.2	10.18	413.1	9.84	431.7	10.28	10.10
E	28	8425	2.220	M 5	1 : 6 : 9	Pure HM	1%	514.1	12.24	506.3	12.03	514.2	12.24	12.17
H	28	8241	2.180	M 5	1 : 6 : 9	Pure PP	1%	430.8	10.30	421.4	10.03	440.5	10.49	10.20
K	28	8219	2.114	M 5	1 : 6 : 9	MLP(50%)+PP(50%)	1%	286.4	6.82	286.2	7.12	340.3	8.10	7.35
N	28	8225	2.176	M 5	1 : 6 : 9	MLP (50%)+HM(50%)	1%	473.3	11.27	475.1	11.31	470.2	11.20	11.26
Q	28	8481	2.264	M 5	1 : 6 : 9	PP(50%)+HM(50%)	1%	600.5	14.3	602.1	14.34	599.8	14.18	14.27

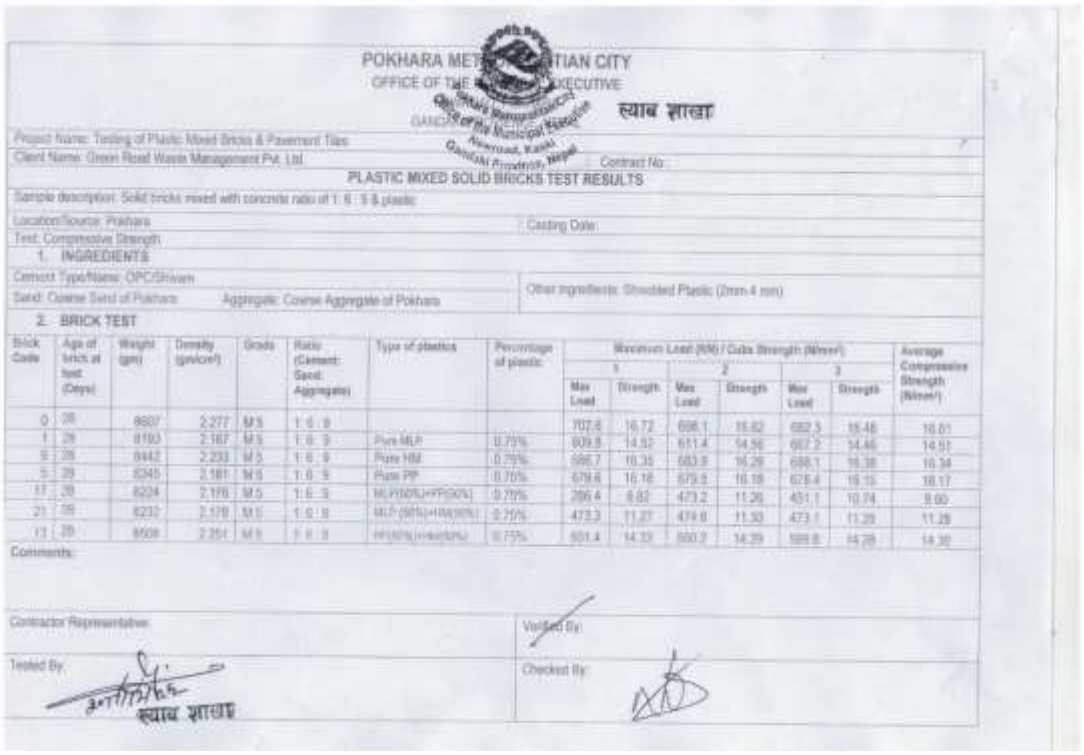
Comments:

Contractor Representative: Verified By:

Tested By: Checked By:

स्याब शाखा

Fig: Lab test report of Solid bricks



POKHARA METROPOLITAN CITY

OFFICE OF THE MUNICIPAL EXECUTIVE

स्याब शाखा

Project Name: Testing of Plastic Mixed Bricks & Pavement Tiles

Client Name: Green Road Waste Management Pvt. Ltd. Contract No:

PLASTIC MIXED SOLID BRICKS TEST RESULTS

Sample description: Solid bricks mixed with concrete ratio of 1 : 6 : 9 & plastic

Location/Source: Pokhara Casting Date:

Test: Compressive Strength

1. INGREDIENTS

Cement Type/Name: OPC/Shivam

Sand: Coarse Sand of Pokhara Aggregate: Coarse Aggregate of Pokhara Other ingredients: Shredded Plastic (2mm-4 mm)

2. BRICK TEST

Brick Code	Age of brick at test (Days)	Weight (gm)	Density (gm/cm³)	Grade	Ratio (Cement: Sand: Aggregate)	Type of plastics	Percentage of plastic	Maximum Load (KN) / Cube Strength (N/mm²) 1 Max Load	1 Strength	2 Max Load	2 Strength	3 Max Load	3 Strength	Average Compressive Strength (N/mm²)
0	28	8607	2.277	M 5	1 : 6 : 9			707.6	16.72	696.1	16.62	692.3	16.46	16.61
1	28	8193	2.167	M 5	1 : 6 : 9	Pure MLP	0.75%	609.8	14.52	611.4	14.56	607.2	14.46	14.51
9	28	8442	2.233	M 5	1 : 6 : 9	Pure HM	0.75%	686.7	16.35	683.8	16.28	686.1	16.38	16.34
5	28	8345	2.181	M 5	1 : 6 : 9	Pure PP	0.75%	679.6	16.18	679.3	16.18	678.4	16.15	16.17
17	28	8224	2.176	M 5	1 : 6 : 9	MLP(50%)+PP(50%)	0.75%	286.4	6.82	473.2	11.26	451.1	10.74	9.00
21	28	8232	2.178	M 5	1 : 6 : 9	MLP (50%)+HM(50%)	0.75%	473.3	11.27	474.6	11.30	473.1	11.26	11.28
13	28	8508	2.251	M 5	1 : 6 : 9	PP(50%)+HM(50%)	0.75%	601.4	14.33	600.2	14.29	599.8	14.28	14.30

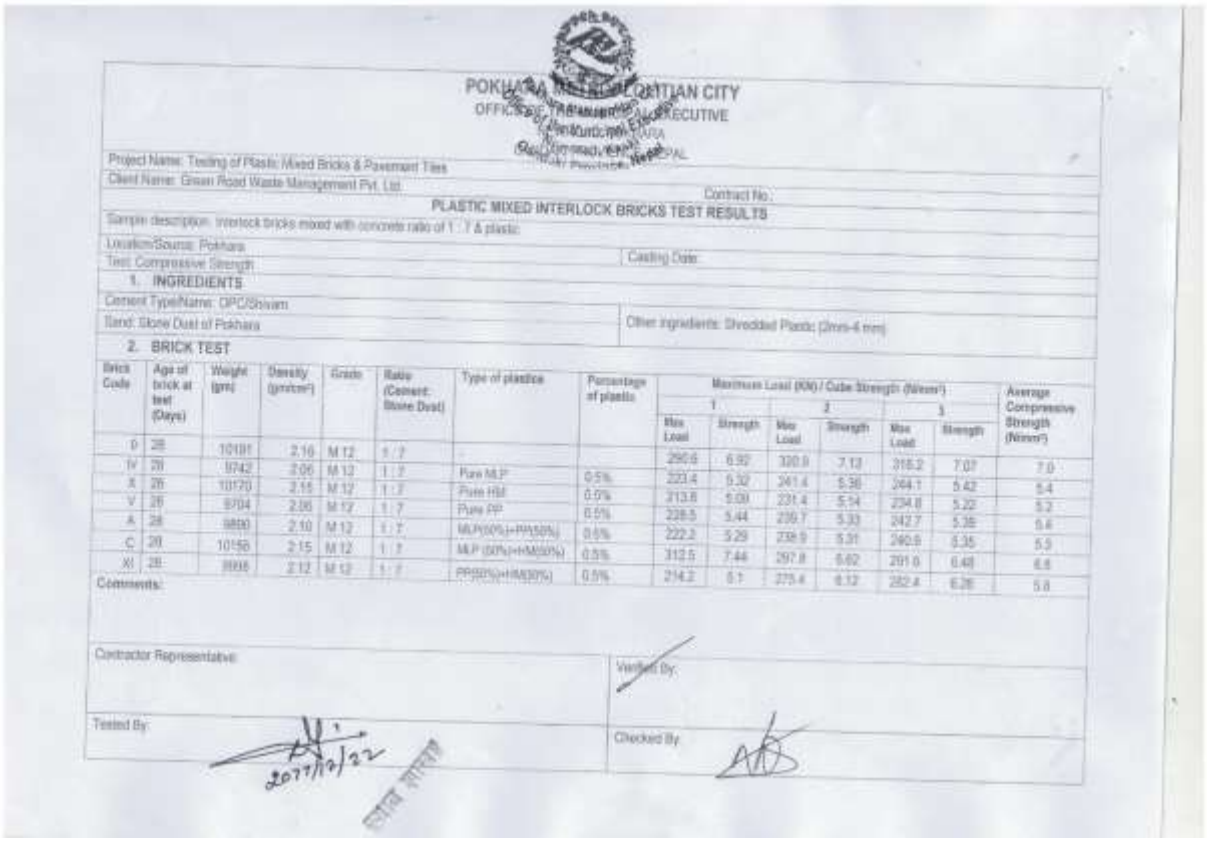
Comments:

Contractor Representative: Verified By:

Tested By: Checked By:

स्याब शाखा

Fig: Lab test report of Solid bricks



POKHARA METROPOLITAN CITY
OFFICE OF THE MUNICIPAL EXECUTIVE

Project Name: Testing of Plastic Mixed Bricks & Pavement Tiles
Client Name: Green Road Waste Management Pvt. Ltd. Contract No.:

PLASTIC MIXED INTERLOCK BRICKS TEST RESULTS

Sample description: Interlock bricks mixed with concrete ratio of 1 : 7 & plastic
Location/Source: Pokhara Casting Date:
Test: Compressive Strength

1. INGREDIENTS

Cement Type/Name: OPC/Shivam
Sand: Stone Dust of Pokhara
Other ingredients: Shredded Plastic (2mm-4 mm)

2. BRICK TEST

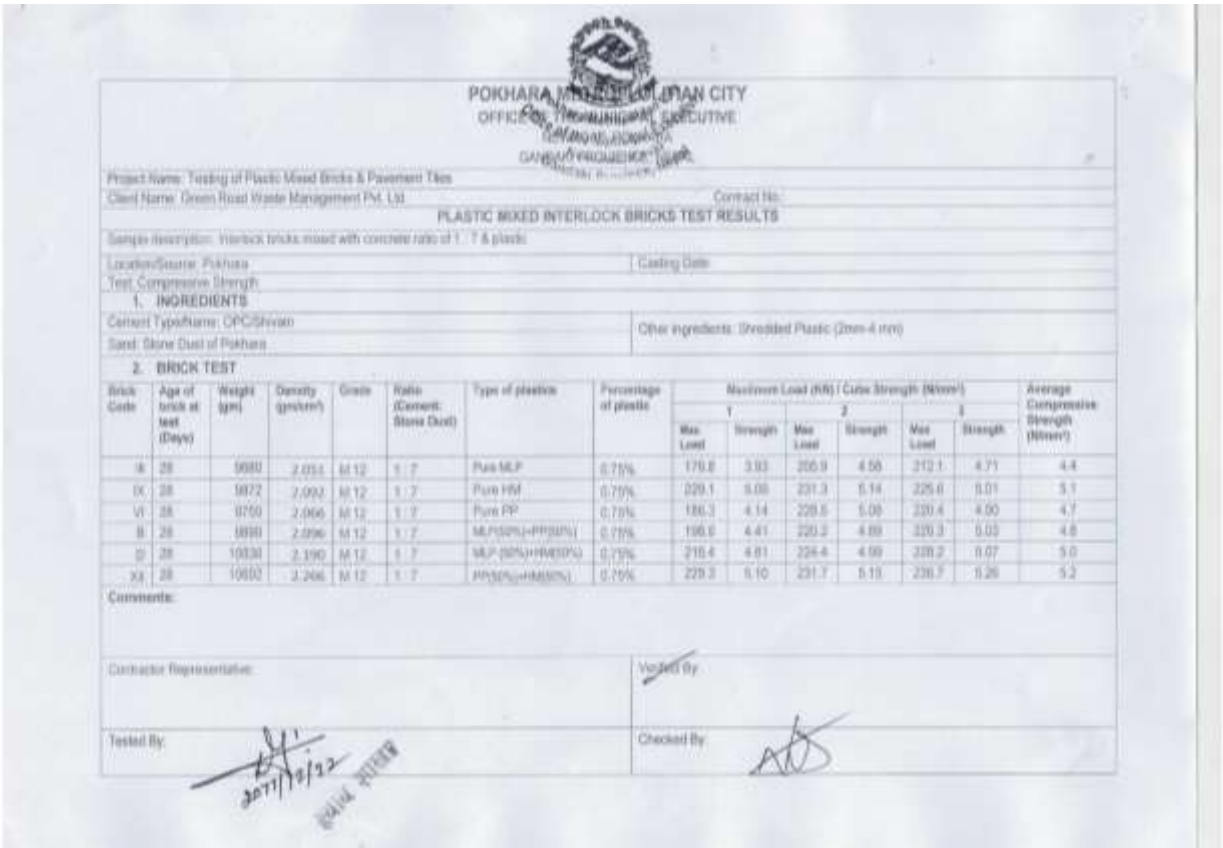
Brick Code	Age of brick at test (Days)	Weight (gm)	Density (gm/cm³)	Grade	Ratio (Cement: Stone Dust)	Type of plastics	Percentage of plastic	Maximum Load (KN) / Cube Strength (N/mm²) 1 Max Load	1 Strength	2 Max Load	2 Strength	3 Max Load	3 Strength	Average Compressive Strength (N/mm²)
0	28	10191	2.16	M 12	1 : 7	-		290.6	6.92	320.9	7.13	316.2	7.07	7.0
IV	28	9742	2.06	M 12	1 : 7	Pure MLP	0.5%	223.4	5.32	241.4	5.36	244.1	5.42	5.4
X	28	10170	2.15	M 12	1 : 7	Pure HM	0.5%	213.8	5.09	231.4	5.14	234.8	5.22	5.2
V	28	9704	2.06	M 12	1 : 7	Pure PP	0.5%	228.5	5.44	239.7	5.33	242.7	5.39	5.4
A	28	9890	2.10	M 12	1 : 7	MLP(50%)+PP(50%)	0.5%	222.2	5.29	238.9	5.31	240.6	5.35	5.5
C	28	10156	2.15	M 12	1 : 7	MLP (50%)+HM(50%)	0.5%	312.5	7.44	297.8	6.62	291.6	6.48	6.8
XI	28	9868	2.12	M 12	1 : 7	PP(50%)+HM(50%)	0.5%	214.2	5.1	275.4	6.12	282.4	6.28	5.8

Comments:

Contractor Representative: Verified By:

Tested By: 2077/12/22 Checked By:

Fig: Lab test report of Interlock bricks



POKHARA METROPOLITAN CITY
OFFICE OF THE MUNICIPAL EXECUTIVE

Project Name: Testing of Plastic Mixed Bricks & Pavement Tiles
Client Name: Green Road Waste Management Pvt. Ltd. Contract No.:

PLASTIC MIXED INTERLOCK BRICKS TEST RESULTS

Sample description: Interlock bricks mixed with concrete ratio of 1 : 7 & plastic
Location/Source: Pokhara Casting Date:
Test: Compressive Strength

1. INGREDIENTS

Cement Type/Name: OPC/Shivam
Sand: Stone Dust of Pokhara
Other ingredients: Shredded Plastic (2mm-4 mm)

2. BRICK TEST

Brick Code	Age of brick at test (Days)	Weight (gm)	Density (gm/cm³)	Grade	Ratio (Cement: Stone Dust)	Type of plastics	Percentage of plastic	Maximum Load (KN) / Cube Strength (N/mm²) 1 Max Load	1 Strength	2 Max Load	2 Strength	3 Max Load	3 Strength	Average Compressive Strength (N/mm²)
III	28	9680	2.051	M 12	1 : 7	Pure MLP	0.75%	179.8	3.93	205.9	4.56	212.1	4.71	4.4
IX	28	9872	2.092	M 12	1 : 7	Pure HM	0.75%	229.1	5.05	231.3	5.14	225.6	5.01	5.1
VI	28	9755	2.066	M 12	1 : 7	Pure PP	0.75%	186.3	4.14	228.5	5.08	220.4	4.90	4.7
B	28	9898	2.096	M 12	1 : 7	MLP(50%)+PP(50%)	0.75%	198.6	4.41	220.2	4.89	220.3	5.03	4.8
D	28	10038	2.190	M 12	1 : 7	MLP (50%)+HM(50%)	0.75%	216.4	4.81	224.4	4.99	228.2	5.07	5.0
XII	28	10602	2.246	M 12	1 : 7	PP(50%)+HM(50%)	0.75%	229.3	5.10	231.7	5.15	236.7	5.26	5.2

Comments:

Contractor Representative: Verified By:

Tested By: 2077/12/22 Checked By:

Fig: Lab test report of Interlock bricks

Annex 13: Pictures of Completed Constructions

Fig: Use of plastic-mix pavement tiles

Fig: Use of basin in internal part of toilet

Fig: Internal pluming and fitting in toilet