Greywater Recycling Systems

Economic Implications and Environmental Analysis of Residential and Commercial Building **Greywater Recycling Systems**

For rapidly increasing per capita water consumption in an emerging economy like India, Grey Water Recycling (GWR) systems appear to become in future a mandatory and inevitable component in residential and commercial facilities. Though such technologies are quite successful in Western nations but apparently high initial and investment costs tend to reduce the feasibility of such systems in India. This paper aims in analyzing the affordability of such systems considering the life cycle costs of such technologies which is a firm base for evaluating economic feasibility of such technologies.

Dr. Debasis Sarkar Associate Professor **Mitul S. Shah** M. Tech Student, Dept. of Construction & Project Management, Faculty of Technology, CEPT University. Ahmedabad.

Introduction

India faces serious water supply problems in many cities and hence measures have to be taken to conserve water or recycle the existing water. Greywater recycling is a very good technology through which the problems of water supply can be eased. Greywater means the household wastewater which has not been contaminated by toilet discharge water and thus includes wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, sinks and laundry tubs.

Affordability of such technologies has always been a contentious issue during feasibility and implementation studies. India is a developing country and every household still does not have enough financial capability to implement such systems. Thus an attempt has been made here to analyze the affordability of such systems considering the lifecycle of such technologies which is a sounder base for the feasibility judgment of such technologies.

Literature Review

Schneider (2005) defines "Greywater" as "wastewater having the consistency and strength of residential domestic type wastewater. Greywater includes wastewater from sinks, showers, and laundry fixtures, but does not include toilet or urinal waters. He also states that if intended for applications other than subsurface irrigation (e.g. toilet flushing), greywater should not be stored unless biologically treated and disinfected. Left untreated, stored greywater can quickly become septic and develop a population of anaerobic bacteria that will proliferate and create noxious odours. Odours generated by storage prior to subsurface irrigation (i.e. within a septic tank) should be properly managed and ventilated in such a way as to not become a nuisance or result in accelerated corrosion of concrete structures (e.g. concrete septic tank, pipe, or distribution boxes).

Jarque et.al. (2008) recommends the direct reuse without storage as it minimizes the problems of microorganism growth and odor. However, even if storage is not required, each greywater system should be capable of handling sudden foreseeable inputs of greywater (for example from a bath being let out, or a washing machine rinse cycle) without overloading or saturating the soil

The potential economic benefit of supplementing water supply resources with the use of greywater is making it an issue of great interest to water authorities. Greywater reuse in gardens has the potential to replace about 18% of the current domestic water demand. In the Melbourne Urban System, this translates to overall savings of roughly 60 giga litres a year according to Shipton (2003). It has been estimated (Lechte, 1992) that water savings in the range of 18–29% for an average household could be achieved by reusing greywater.

Greywater Recycling Systems Methodology

Greywater is relatively clean but does contain significant quantities of food particles, grease, hair and detergents which can be difficult to filter and can clog membranes. Grey water can be used for flushing the toilet and garden irrigation, or for washing cars etc. It makes sense to use the cleanest source of grey water first, i.e. bath and shower water, followed by water from the bathroom sink. However, the main problem with grey water is how to deal with its storage. Within 24 hours of being stored without treatment, grey water goes "black" i.e. septic, but the technologies have developed in western countries which treat this grey water and convert it to usable form.

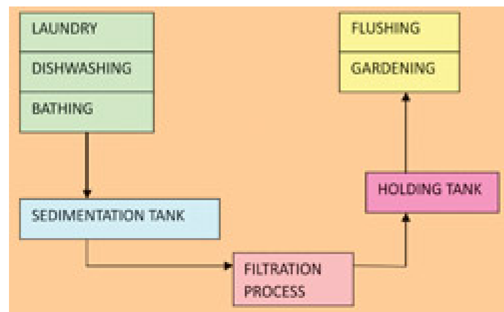


Figure 1: Typical Grey Water Recycle Process

In India, people use water carelessly in washing clothes, bathing etc due to which per capita per day consumption has increased to more than 250 liters which is comparatively very high in comparison to per capita per day consumption in countries like Australia (85 liters) and this major difference is generally because of careless use by people. If such technologies are used in our country of reusing water in flushes or for irrigation a large quantity of water can be saved and per capita per day consumption can be decreased to a greater extent. If proper care is taken at construction stage of building and proper plumbing is done, then the cost of having dual pumping system will not exceed more than few percentage of project cost.

Data for the analysis of the economic feasibility of such systems was collected from two sites which are located in Mumbai and Ahmedabad respectively. Both sites have employed different versions and capacities of the greywater recycling systems. As the market for such systems in India is still at a nascent stage, they are not available readily in the Indian market. Thus foreign systems are used at both locations and the data for the same is given in Table 1. Case 1 is 3-BHK green building apartments which are being developed by a private developer and are nearby the developing Bhandup (Mumbai) area. There are in total 4 blocks which contains highrise apartments of 20 floors each and each floor has 2 flats. This makes a total of 40 flats per block. Grey Water Recycling system was installed for every such block and the details of the following are as follows.

Table 1: Grey Water Recycling System Data (Case 1)			
S. No.	**Data Type**	**Value (Capacity / Cost / Dimensions)**	**Remarks**
1.	GWR System Type	3-Stage Filtration and Disinfection System	Steel Based System
2.	Size	2.5ft diameter x 5 ft long	One Module Size
3.	Capacity of the GWR System	5000 litres	Design Handling Rate for GWR System
4.	Filtration Rate	500 litres/ hr	Capacity wont be fully achieved
5.	Capacity of Adjoining Tank	5000 litres	Tank for only Block B
6.	Sedimentation Tank Capacity	350 litres	GW Held at this tank before filter
7.	Cost of Pipes	Rs. 45000. per Block	All Pipes for the System
8.	Submersible Pump Provided	15 HP	-
9.	Maintenance Costs	Rs. 25000. / Module	Approximate
10.	Maintenance Period	1 Year	-
11.	Cost	Rs. 1,50,000. / System	Total System minus Pipes
12.	Water Amount Generated for GWR	9600 litres / day	-

Case II is a green commercial complex cum hotel building which is being developed by a private developer in Ahmedabad. The building is divided in two sections and for both the buildings, it is proposed that a common grey water recycling system would be installed. This grey water recycling system is to be imported from a German manufacturer. The details for such system are mentioned in Table-2.

Table 2: GWR Systems Details for Case II			
S. No.	**Data Type**	**Value (Capacity / Cost / Dimensions)**	**Remarks**
1.	GWR System Type	2-Stage Filtration and Disinfection System	HDPE Polymer Based System
2.	Size	2ft diameter x 5 ft long	One Module Size
3.	Capacity of the GWR System	300 litres equivalent to 6000 litres	Design Handling Rate for GWR System
4.	Filtration Rate	75 litres / hr	Capacity wont fully be achieved
5.	Capacity of Adjoining Tank	7500 litres	Storage Tank
6.	Sedimentation Tank Capacity	NA	-
7.	Cost of Pipes	Included	All Pipes for the System
8.	Submersible Pump Provided	30 HP	-
9.	Maintenance Costs	Rs. 40000. / System	Approximate

10.	Maintenance Period	2 Year	NA
11.	Cost	Rs. 3,50,000 / System	Total System minus Pipes
12.	Water Amount Generated for GWR	15000 litres / day	-

Calculation of Economic Feasibility

Life Cycle Cost (LCC) of such systems will prove as a very good tool for actually measuring the economic feasibility of such systems as it would overcome the initial bias regarding such systems on the basis of initial costs and would also incorporate all costs associated with such systems during its lifetime which is a more realistic scenario. Components to be considered or the factors that are needed to be calculated for the particular LCC for the GWR System are given below. It is assumed that the economic life of the project is 20 years and the interest rate would be on an average 10%. Salvage value would be zero for this case as the systems would not be usable and cannot be salvaged. Costs to be considered while calculating the life cycle costing for the Case I and II are mentioned in Table 3 and Table 4 respectively. The corresponding case flow diagrams are presented in Figures 2 and 3 respectively.

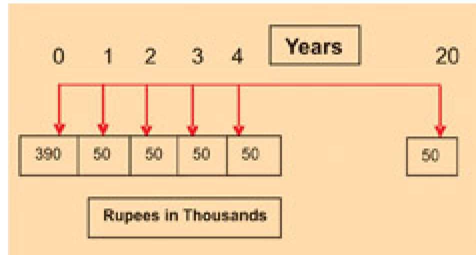


Figure 2: Cash Flow Diagram of GWR System for Case I

Table 3: Life Cycle Cost of Proposed GWR System for Case I

Sr. No	Cost Component	Cost
1.	Initial Cost	Rs. 1,50,000.
2.	Allied Construction Costs	Rs. 40,000.
3.	Maintenance Costs	Rs. 25000. / year
4.	Operation Cost	Rs. 4500. / year
5.	Replacement Cost	Rs. 1,50,000 / 20 Years

Table-4: Life Cycle Cost of proposed GWR system for Case II

S. No	Cost Component	Cost
1.	Initial Cost	Rs. 3,50,000.
2.	Allied Construction Costs	Rs. 40,000.
3.	Maintenance Costs	Rs. 40,000. / year
4.	Operation Cost	Rs. 10,000. / year
5.	Replacement Cost	Rs. 1,50,000. / 20 Years

Similarly, the LCC for the second system which is proposed for Case II is calculated and the assumptions are the same where the interest rate is taken as 10% and the economic life of the equipment is taken as 20 years. Additionally, no salvage value is considered as the equipment will not be of any use after the economic life period.

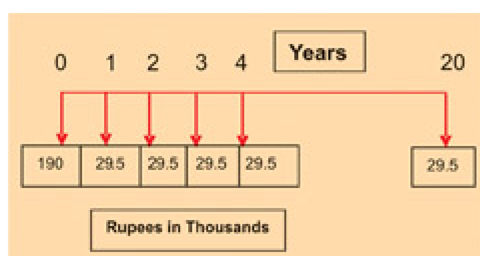


Figure 3: Cash Flow Diagram of GWR System for Case II

Results and Discussion

Thus from the above data we can apply the LCC formulas and find out the total cost of the implementation and maintenance of such systems which will help us in deciding whether the systems are actually feasible or not. The calculations are done as shown in the Table 5. The final costing is calculated in terms of cost / year / m2 of area which will be a helpful data in calculating the costs incurred by the residents according to the built up areas of their own houses.

Table 5: LCC of the Two Systems for Case I and II

Data	Case I GWR System	Case II GWR System	Remarks
NPV (Rs.)	6,50,00	7,50,000	P/A, interest (i)= 10%, years (n)=20 is 8.5136.
Total area considered for analysis (m^2)	140	140	
LC C / m^2 (Rs.)	4645	5350	
Owning and Operating cost / year / m^2 (Rs.)	390	447	

There is a considerable difference in the initial cost, as well as in the maintenance costs of the two systems. But the initial cost which is the most important parameter in our study is quite high for Case II and hence this system appears to be less feasible. The LCC of GWR system of Case I is observed to be Rs. 4645 / m2. and for Case II it is Rs. 5350 / m2. The owning and operating cost of the system for Case I is computed to be Rs. 390 / year / m2 and for Case II it is about Rs. 447. Considering a coverage area of about 80 m2 apartment for Middle Income Group (MIG) family the owning and operating cost would be Rs. 31,200./year which will amount to Rs. 2600. /month.

Conclusion

Considering the analysis of the above study, it is observed that the application of the Grey Water Recycling System is quite feasible in HIG housing schemes, but in affordable housing schemes the system seems to be less feasible. This is due to the higher initial costs and adequately high costs of operations and maintenance. Trends show that these models are quite successful in Western countries. With advancement of technology coupled with the increase in per capita income of urban households, the technology has tremendous potential and applicability in an emerging economy like India. Considering the rapidly increasing demand in per capita consumption of water in India, such systems would be inevitable in the future and hence extensive research is very important in this area. The systems could be made more economic and affordable by studying in details the system components and applying value engineering studies.

References

- Brennan, J.A. and Patterson, R.A. (2004), "Economic Analysis of Grey Water Recycling," Proceedings of 1st International Conference: Wastewater treatment technologies, Tehran, pp 1-9.
- Chung K. and White P. (2008), "Grey Water Recycling: Understanding grey water recycling systems in present and future urban contexts," Green Cities, Vol. CRP 3840, pp 1-20.
- Christoph-Boal, D., Lechte, P., Shipton, R.(1999), "Installation and Evaluation of Domestic Grey Water Recycling Systems," Dept. of Civil Engineering Victoria University Journals, Vol. 25, pp 25-57.
- Friedler, E., Kovalio, R. and Galil, N.I. (2005), "On-Site Grey Water Recycling in Multistory Building," Water Science and Technology Journal, Vol. 15, pp 187-194
- Patterson, R.A. (2005), "Greywater Reuse: Impact of Chemicals on Households," Proceedings of Innovation and Technology for On-site Systems Conference, New South Wales, pp 1- 9
- Schneider, L. (2009), "Greywater Reuse in Washington State," Rule Development Committee Research Issue, Vol. 5, pp 1-16.
- Weissenbacher, P., Müllegger, T. (2006), "Combined greywater reuse and rainwater harvesting in an office building in Austria: analyses of practical operation," NASPA Research Journals, Vol. 3, pp 25-31.

NBMCW October 2011

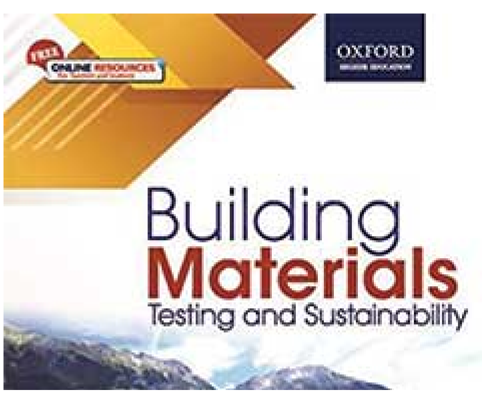
Prev (/tech-articles/others-article/25797-reuse-of-textile-etp-sludge-as-construction-material.html)

Next (/tech-articles/others-article/25787-infrastructure-construction-with-recycled-materials.html)

Brick Kilns and their Effect on Environment

Bricks are traditional building materials which hold a lot of importance in Indian architecture. Brick manufacture in India and also in some parts of the world still use the traditional firing technique. After China, India is the second Read More ... (/tech-articles/others-article/40889-brick-kilns-and-their-effect-on-environment.html)

Building Materials, Testing & Sustainability



This comprehensive textbook by well-known and award-winning author, design consultant, and researcher, Dr, N Subramanian, is an invaluable source of knowledge for engineering students, architects, consultants, researchers, teachers, and all those Read More ... (/tech-articles/others-article/40776-building-materials-testing-sustainability.html)

Turning Plastic Waste into Eco-friendly Building Materials & Products

Since the past 65 years, about 8.3 billion tons of plastics have been produced worldwide, which is equivalent to 10,000 Eiffel Towers or 35,000 Empire State Buildings. But only 9 percent of all plastics gets recycled, while the rest ends up as trash Read More ... (/tech-articles/others-article/40473-turning-plastic-waste-into-eco-friendly-building-materials-products.html)

Lessons from Warfare to Manage Complex Marketing Projects

The fundamental definition of warfare is to compete and win over enemies with limited resources. Interestingly, it is fundamental to running a marketing function in a corporate company. My fellow marketing heads will agree that it is imperative Read More ... (/tech-articles/others-article/40472-lessons-from-warfare-to-manage-complex-marketing-projects.html)

Lightweight Fiber-Reinforced Houses

lex Liew Chung Meng, an innovator of Lightweight Concrete Methodology (LCM) for low-cost housing, has been approached by a Kolkata-based construction company, which has secured an order to build 18,000 low-cost housing units. To Read More ... (/tech-articles/others-article/40322-lightweight-fiber-reinforced-houses.html)

Water Management in High-Rise Buildings

According to a recent report by Niti Aayog, India is suffering from the worst water crisis in its history, with around 600 million people facing severe water shortage. If this continues, there will be a 6% loss in the country's GDP Read More ... (/tech-articles/others-article/40211-water-management-in-high-rise-buildings.html)

A Revolution in Concrete Floors-Free Movement (FM) and its Importance

With growth and Industrialization, the demand of industries has been increasing, especially for the fast-track projects. Consequently, the importance of flooring (mainly concrete flooring) in the operation of the industries is Read More ... (/tech-articles/others-article/40168-a-revolution-in-concrete-floors-free-movement-fm-and-its-importance.html)

SMART HIGHWAYS

Smart living through smart products and services is today a worldwide trend being promoted by IT companies. These companies are putting lot of efforts and resources to create useful digital solutions for promoting business Read More ... (/tech-articles/others-article/38917-smart-highways.html)

National Institute of Securities Markets

National Institute of Securities Markets (NISM) is an educational initiative of SEBI (Securities Exchange Board of India). In securities markets, NISM is already recognised all over the world. NISM entrusted the work Read More ... (/tech-articles/others-article/38891-national-institute-of-securities-markets.html)

Aerial Rope Transit - (Cable Car) for Public Transport

Aerial Rope Transit - (Cable Car) for Public Transport Advanced transport technologies have improved mobility of men and materials in both normal and specific conditions. Numerous transit technologies have been Read More ... (/tech-articles/others-article/38607-aerial-rope-transit-cable-car-for-public-transport.html)

The New Rural Reality: Impact of Digitisation

Tapan is a middle aged resident of Bhogpur village in District Purba Medinipur, 75 kms from Kolkata, involved in his traditional family business of farming. For several years he had been visiting his nearest

Read More ... (/tech-articles/others-article/38479-the-new-rural-reality-impact-of-digitisation.html)

Seismic Vulnerability Assessment and Strengthening of Existing Reinforced Concrete Buildings

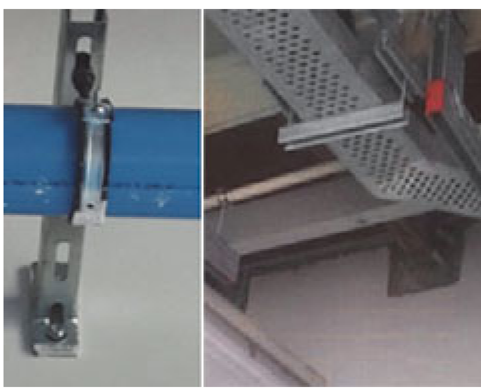
Some of the severe earthquakes that occurred across the world after the year 2005 are Nepal M 7.8 (2015), Haiti M 7.0 (2010), Southern Sumatra, Indonesia M 7.5 (2009), Eastern Sichuan, China M7.9 (2008), and Java, Indonesia Read More ... (/tech-articles/others-article/38202-seismic-vulnerability-assessment-and-strengthening-of-existing-reinforced-concrete-buildings.html)

Catalyzing Employability through Infra, Social and Rural Development Projects

With 65% of India's population composed of youngsters facing job

deficit, our demographics dictate that infrastructure, social and rural development projects can be one the important role models for solving Read More ... (/tech-articles/others-article/37993-catalyzing-employability-through-infra-social-and-rural-development-projects.html)

Seismic Design Concept for Non-Structural Connections using Post-installed Anchors



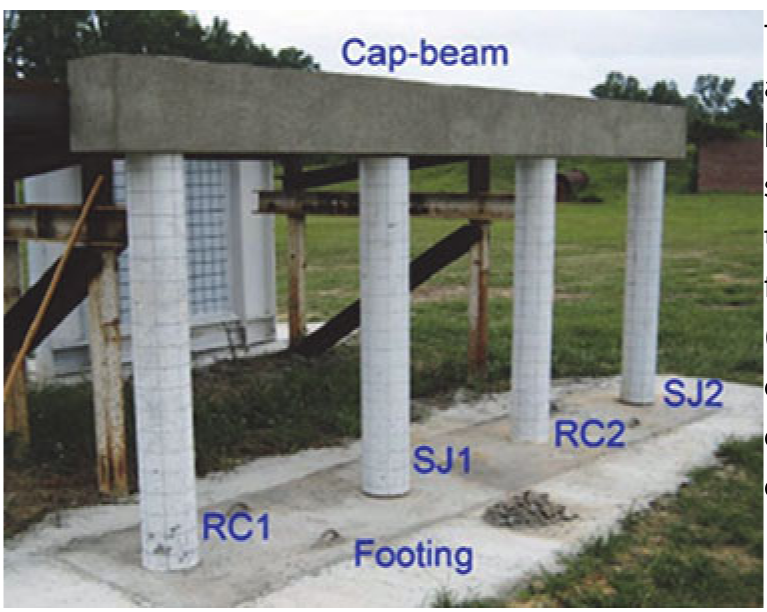
As the seismic activity in and around India, has been steadily increasing, the government has taken the initiative to conduct several workshops and trainings to spread awareness on the subject. Seismic design of Read More ... (/tech-articles/others-article/37992-seismic-design-concept-for-non-structural-connections-using-post-installed-anchors.html)

IESC: Transforming the skill landscape

Over the years, growth in the infrastructure equipment sector has been synonymous with the economic health of the country. In 2010, the sale of construction equipment was around 60,000 units

and expected Read More ... (/tech-articles/others-article/37650-iesc-transforming-the-skill-landscape.html)

Effects of Blast Loading on Engineering Structures – An Overview



The present study aims at providing an overview on the blast loading and blast effects on engineering structures. The use of vehicle bombs to attack city centers has been a feature of campaigns Read More ... (/tech-articles/others-article/37231-effects-of-blast-loading-on-engineering-structures-an-overview.html)


CII
EXCON 10th EDITION
10 - 14 DECEMBER 2019
Hall3 C 253
Kubota


KONE U MonoSpace™
KONE U MiniSpace®

(/component/banners/click/334.html)

(/component/banners/click/178.html)

NBM&CW

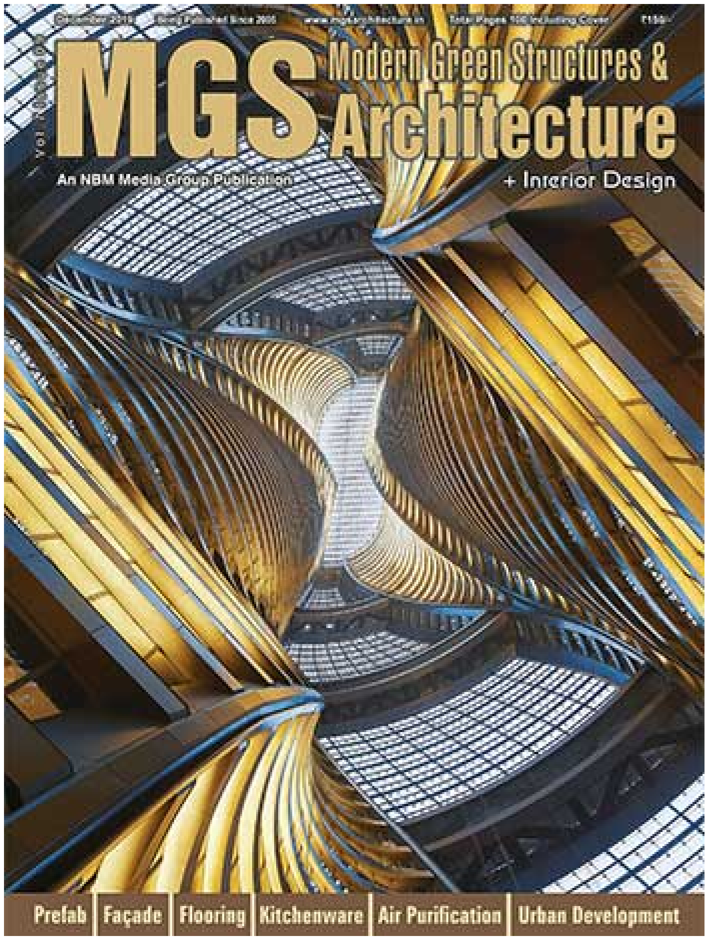
New Building Material & Construction World

(/about-nbmcw.html)

Previous Issues (/nbmcw-archives.html) Download (/nbmcw-download-latest-issue.html)

MGS Architecture

Modern Green Structures & Architecture



(/about-mgs-architecture.html)

Previous Issues (/mgs-architecture-archives.html)

Download (/mgs-architecture-download-latest-issue.html)

L&ST

Lifting & Specialized Transport

(/about-lifting-specialized-transport.html)

Previous Issues (/lifting-specialized-transport-archive.html) Download (/lifting-specialized-transport-download-latest-issue.html)

II&TW

Indian Infrastructure & Tenders Week

Published Fortnightly
An NBM Media Group Publication

Indian Infrastructure & Tenders Week

NBM Media - Disseminates to Develop   www.nbmcw.com

JAI bags Jewar Airport project and will invest Rs. 4,500-cr

Gaur Group goes for Rs. 750-cr realty projects

DMRC goes vertical in Phase-IV of the project

GMRCL fast tracks Rs. 12,020-cr metro in Surat

DBL wins Rs. 1,250-cr expressway project in UP

Hines unveils $500-mn investment plans in India

INDIAN INFRASTRUCTURE & TENDERS WEEK

(/about-iitw.html)

Previous Issues (/iitw-archives.html)   Download (/iitw-download-latest-issue.html)

TERMS & CONDITIONS (/terms-conditions.html)

PRIVACY POLICY (/privacy-policy.html)

CANCELLATION / REFUND POLICY (/cancellation-refund-policy.html)

DISCLAIMER (/disclaimer.html)

(https://www.facebook.com/nbmcw)   (https://twitter.com/nbmmedia)