Chapter 14
Design and Development of Improved Methods of Curing of Bricks During Manufacturing Process and Construction Work to Save Water, Minimize Pollution and Human Effort

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Abstract Curing of bricks during manufacturing process and construction work has a significant impact on the strength, durability and wear resistance of concrete. If the concrete is not properly and adequately cured, it will fail to satisfy the purpose for which it is designed. Minimum 12–24 days curing is required for bricks during the manufacturing process and minimum 7 days water supply is required for masonry wall and concrete. Bricks require a lot of water and time for curing. Maximum use of water is an environmental issue and supply of water by laborers from tube wells to construction sites has an adverse impact on their health. In the present work we have developed two methods for curing bricks and concrete. First method will help for curing of bricks and concrete during the manufacturing process without the requirement of a single drop of water and the second method will help for better supply of water to constructional workplaces with minimum effort.

Keywords Cement concrete · Construction · Curing · Steam · Tube well · Vacuum chamber · Vacuum pump · Water supply

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14.1 Introduction

India, being a developing nation, provides ample opportunities in the construction sector which includes the construction of smart cities, roads, buildings and technology parks all over the country. The Government of India also introduces several programs like PMAY which is meant for constructing homes for the needy families in the urban areas. Such a demand paves the way for fledgling entrepreneurs to choose the construction sector as their major area of operation. For any kind of construction there is a constant requirement of a workforce which consists of skilled as well as unskilled laborers and the issues related to their health and environment have become prime concerns for the entrepreneurs. Bricks, being an important element in construction work, are required to be produced with a better technique in order to minimize environmental pollution so that the health condition of the workers will be improved. Due to the huge requirement of bricks, a large number of entrepreneurs are setting up brick industries as their first choice of business. Mainly there are two types of bricks—the fly ash brick and the clay bricks. Both the bricks, used largely in construction works, require proper curing after they are manufactured. A lot of water is used for curing cement concrete. As our objective is to save water, we focus on not using a single drop of water for curing. This system will make curing of cement concrete slabs, hume pipes and bricks, etc., which require curing, without water. At present there are water and steam curing processes available. In this process a lot of water is going to be wasted and it requires a period of at least 28 days for curing. In our proposed innovation, curing will be done without a single drop of water and within 24 h with the same strength and by saving a lot of cement. Hence, two benefits are going to be achieved at the same time. In this system, an airtight chamber will be designed in order to accommodate all the items that need to be cured. A vacuum pump will be attached to it. A chemical is going to be used, which generates water vapors for the purpose of curing. Curing will be done within 24 h. The technology is unique. The system of curing is completely new since people are using either water or steam for curing till now. Here, we are using neither water nor steam. This is the uniqueness of our product. A number of works have been done by researchers, where they have worked on different types of curing methods, focused on their working principles and advantages, but not a single work has been done earlier on vacuum curing without the use of water. In this chapter, we have also presented another product that helps for the supply of water for curing of constructional items, like masonry wall, concrete etc. with minimum effort. During construction work curing of bricks and concrete is also a major part. If proper water is not supplied to construction work, then there is a chance of failure of construction.

In this chapter two methods have been described, that is curing of bricks during its manufacturing process by vacuum curing method and curing of construction work by a simple method, where effort required for supplying water to construction work will be negligible. Nguyen et al. (2020) in their work describes how the pure slag destroys the performance of concrete and adding of gypsum changes the performance. Work by Shi et al. (2020a) presents how the performance of concrete changes due to implementation of steam curing methods. They found that due to this steam curing method the mechanical properties of the concrete developed. Mohammed et al. (2020) in their work described the disadvantage about the provision of plastic within concrete and mentioned that microwave curing method improves the chemical and hydrophobic resistivity and improved concert. Shi et al. (2020b) studied the advantages and disadvantages of steam curing methods in this work they indicate that steam curing method is a good method but higher temperature causes harm to the microstructure of the concrete. Yin et al. (2020) studied experimentally, the control of fly ash on the curing features of an epoxy resin and found that due to increasing rate of heat there is enhancement of curing rate takes place. Liu et al. (2020) in their work describe the advantages of steam curing method, highlighting that due to steam curing method, compressive strength and permeability improves and chances of damage decreases. They also represented that curing time is also a factor for steam curing methods. Based on the work of Shi et al. (2020c) on steam curing, it is indicated that in the microstructure of moisturizing products there are clear gradients of porosity and differences on the surface and inside of the concrete treated by steam, and the coefficient of surface absorption is more on the inside. By extending the preheating time higher strength can be accomplished, and the bonded porosity of the surface to atmosphere can be reduced by surface treatment.

Reddy and Hamsalekha (2020) worked on advanced curing method, where they used internet of things (IoT) to develop automatic curing system to create an automatic water-saving treatment mechanism for curing which depends on the moisture available in the concrete and the temperature of the ambient by the use of a humidity sensor. Chen and Gao (2020) studied carbonation curing methods and, in their work, they compared their work with conventional methods. Carbon treatment can effectively improve compressive strength, the carbonation becomes deeper and more homogeneous in the preceding concrete, and the effect of filtration can be reduced on the critical pore diameter through carbon treatment. However, the increase of large pore content which is caused by freeze-thawing can hardly be prevented. Zhang et al. (2013) found that the resin system has a curing time of 5 min with a 95%curing degree, and the processing time of the flakes can be controlled with the studied resin within 13 min under 120 °C with a curing degree of more than 95% and having a few defects. A slight decrease in thermal stability and bending property is exhibited by slides which are manufactured as per the short term curing schedule when it is compared to the cured slides used in the traditional curing schedule which takes more than two hours of curing time. Chang et al. (2020) studied the environmental effect on curing methods, and found that efflorescence crystallization can be inhibited when curing is made by using a cling film seal. Ge et al. (2020) studied the use of recycled clay and found that with pre-hydration time and an increase in RFCBA (recycled fine clay brick aggregate) content, there is a decrease in the initial stagnation flow and there is also an observation of the opposite trend of slum flow loss. It is also found that with an increase in the RFCBA content, there is a decrease in the compressive and bending strength of RFCBA slurry. RFCBA can significantly lag in reducing indoor relative humidity. Moreover, as the porous RFCBA stored water is released, the RFCBA content increases and the dry shrinkage resistance of the RFCBA slurry mixture gets improved. Taki et al. (2020) from their work found that the prepared fired bricks with lower thermal conductivity (0.48 W/m K) indicate better property of insulation. The unique highlight of our study is the potential use of the FA in order to stabilize SS so that the natural clay fired bricks can be sustainably replaced. A future study may investigate the compositional effect of FA on the thermodynamic and thermodynamic properties of bricks. Cheng et al. (2020) studied on laminates by composite methods and its effect; they found that the tensile and the repaired laminates with their comprehensive properties are hardly affected by the curing condition. However, the bonding quality is highly affected due to the adhesive inner voids. Sankar and Das (2019) worked to enhance the strength of bricks by reinforcing their method of work. They made a comparative study between standard composite samples and composite samples with graphene of equal dimensions to find out the effects on the comprehensive strength of the brick by supplementing various amounts of graphene. Dinh and Vinh (2019) worked on solar cure of bricks and found that temperatures above 50 °C can be achieved which is required for curing the concrete bricks. Hence, the feasibility for the use of solar energy could be confirmed for the treatment of concrete bricks depending on the condition of the climate. Li and Zhao (2016) worked on autoclave curing of bricks and they explained that the compressive strength increases due to such a type of curing method.

Zhou and Qu (2011) studied on autoclaved sludge bricks. They could find the produced brick with a comprehensive strength of 20.8 MPa and with a bending strength up to 5.4 MPa. They also discussed the forming and stirring conditions on the mechanical properties of the aseptic sludge bricks due to the effect of curing. Nam Boonruang et al. (2011) worked on soil bricks, present that Fly ash formulations greater than 25% by weight based on soil and from up to 14 days of curing time have proven to be economical mixtures of bearing slabs or brick-type structural elements according to the Thai Industrial Standard (TIS) for structural clay bearing - tile bearing. Therefore, commercial development is very promising. Sadrmomtazi and Haghi (2008) worked on thermal drying of bricks and found that thermal gradients play a role in describing the moisture profiles within a material when the thickness is large. Predictions of temperature and moisture content show that the leading edge dries faster as compared to other sides of the solid. The distributions of drying temperature and moisture content in the porous solid were not uniform due to the forward slack effect during convection drying.

Spraying water on constructional work, like masonry walls, concrete is also known as curing. A Lot of work has been done by a number of researchers; they focused on smart curing for construction and irrigation purposes. Not a single work is there, where minimum effort for lifting of water from tube wells for curing has been described. But our work is a unique work, where minimum effort is required for lifting water from tube wells for constructional and agricultural work. Singh et al. (2020) studied River liquid irrigation with weighty metal load effects soil organic actions and risk aspects and found Potential biological risk aspects (Er) were under little risk and all-inclusive probable ecological jeopardy indices (Ri) were found to be under truncated, reasonable and high-risk categories. Yanala and Pagilla (2020) studied usage of biochar to produce domesticated liquid for irrigation usage and found it commercially accessible. Granular activated carbon (GAC) performed much better than biochar for all the amalgams measured. Abioye et al. (2020) studied an assessment on monitoring and cutting-edge control approaches for meticulous irrigation and found that this assessment aims to support researchers in detecting guidelines and gaps for future study and work in this field. Salahoui et al. (2020) studied an amended tactic to guesstimating the infiltration physiognomies in surface irrigation systems and found that the infiltration function projected by means of the suggested tactic was more precise and rational than the infiltration function projected using the double ring infiltrometer (DRI), and pragmatic (Kostiakov model) approaches. Terence and Purushothaman (2020) studied organized assessment of the Internet of Things in clever farming and found that this lessens man power and upsurges resource exploitation in farming. Kukal and Irmak, (2020) studied Influence of irrigation on interannual unpredictability in the United States agricultural efficiency and found that the demonstration of spatial and chronological dynamic forces in Irrigation-Induced Reduction in Crop Yield Variability (IITV) could support in irrigation-water apportionments and implementation. Zhu et al. (2020) studied founding of agronomic drought loss replicas: A comparison of arithmetic procedures and found that the root mean square fault and the mean absolute fault of the multivariate step by step deterioration were 1.31 times and 1.38 times respectively greater than the root mean square fault and the mean absolute fault from the arbitrary forest model.

Anuradha et al. (2020) studied mathematically about water users connotation for justifiable improvement in agricultural products in rural areas and found that the deterioration equation condition for revenue depends on the size of the agronomic farms and disbursement for cultivation events which should be properly monitored to improve the living conditions of the people living in rural areas. Dehghan et al. (2019) studied the influence of weather change on Agronomy and Irrigation Network and found that the performance of irrigation grids is estimated in rapports of equity and appropriateness indices. Li et al. (2019) found in their study on agronomic water apportionment under ambiguity restructuring of water deficiency risk that the part of water privileges in risk restructuring was more important when the probability dispersal of water scarcity risk was asymmetric. Rajasekaran and Anandamurugan (2019) studied an assessment of remonstrance and implementation of Wireless Sensor Networks in Clever Farming and compared different conventional methods with clever farming in the agronomic domain. Singh (2018) studied an assessment on salinization of agronomic domains due to deprived drainage and provided an outline of various procedures and their appropriateness and restrictions in managing the land salinization and increasing groundwater level complications of irrigated zones. Aleotti et al. (2018) studied A Clever Accuracy-Agronomy Platform for Lined Irrigation Arrangements and found that such systems could help the farmers in various operations of the irrigation domain. Li et al. (2018) studied on Handling irrigation and pollination for the supportable gardening of greenhouse vegetables and found that mitigation procedures for N leaching contamination from greenhouse vegetable grounds should consider guidelines on irrigation and pollination. Prabha et al. (2018) designed and developed a smart irrigation system for farming of chilli based on IOT for improvement in fertilization and irrigation with reduced man power and water supply for reaching higher yields. Rahman et al. (2020) explained the usability of coconut husk. Wang (2020) studied the use and environmental effects of phosphogypsum (PG) in agriculture and found that although use of PG had several benefits, using waste PG could create issues of radiological impact, salt concentration and heavy metal toxicity. The effects of incentive mechanisms of different agricultural models on agricultural technology was discussed by Yu et al. (2020) and they found that ecological agriculture was preferred by most researchers and agricultural information technology management systems had a major role in the development of agriculture. The effects of climate change on the Hamadan-Bahar plain on various sides were studied by Mosavi et al. (2020) and found that climate change had negative effects on the agricultural sector in this region which could be tackled by improved irrigation technologies and by use of an ideal deficit irrigation strategy. Lalehzari and Kerachian (2020) studied a new methodology for distributing groundwater to agricultural lands and found that this strategy increased water productivity, economic efficiency of land and provided highest values of benefit per cost ratio. Water saving by agricultural virtual water trade (VWT) by considering various irrigation factors was studied by Cao et al. (2020) and found that irrigation played an important role in cultivating crops for both the import and export regions without virtual water trade. The simulation of the surface energy balance (SEB) was done by Ishola et al. (2020) who found that soil properties played an important role in finding surface fluxes. The calculation of efficiency of a semi-closed horizontal tubular photo-bioreactor (PBR) for removal of target compounds was done by Vassalle et al. (2020) and they found that this system could be a solid choice for treatment because of its parameters like pH in the closed system, the size of the reactors, high temperatures and the developed specific mixed cultures.

Arrieta-Escobar et al. (2020) studied the importance of 3D printing for improving the understanding of soil functioning and found that the accessibility of additive manufactured soil models could help researchers to conduct experiments for better understanding of soil functioning factors. The use of Machine learning for calculating emission of greenhouse gas from agricultural fields was studied by Hamrani et al. (2020) and they found that the LSTM model could be used for determining these emissions. Zhou et al. (2020) studied an integrated irrigation strategy WSQI and found that this could help researchers by providing a theoretical basis as well as help in improving agricultural production. Boyer (1982) studied the productivity of plants according to the environment and found that by understanding the fundamental mechanisms with help of scientific advances could help to improve productivity. Matson et al. (1997) studied the effect of agricultural intensification on ecosystems and found that although it is having a negative impact, these effects could be reduced as well as the agricultural sector could be improved by using ecologically based management strategies. The assessment of various prospects for improving yields in order to tackle the supply and demand problem due to increased population was studied by Mueller et al. (2012).They found that the demand could be met by utilizing underperforming landscapes and improving its yield by eliminating the overuse of nutrients and proper management of water supply.

14.2 Experimental Setups

Curing of bricks and concrete is an important task for any type of construction work. Generally bricks are prepared separately and need to be cured afterwards. Perfect cured bricks provide better results with regard to their strength. If bricks are not cured properly, failure of construction work may result due to the reduced strength of bricks. There are a number of methods available for curing of bricks such as water curing and steam curing. A number of works have been done by a number of researchers on these methods and it was found that there still exist a number of issues which need to be addressed. It was found that by the water curing method a lot of water is required and a minimum 24 days of curing period is required. Steam curing method requires a skilled laborer and it is a costly method. To overcome such problems, new techniques and methods are required. Nowadays, there is also unemployment which is a great challenge. A large number of entrepreneurs are now choosing the brick manufacturing industry as their first choice. Due to advancement of technology, it is required to apply new methods for curing to save the environment and maximize profit of business. In our work, we have developed two new methods. One of the methods, where a single drop of water is not required for curing of bricks during its manufacturing process and strength of bricks by using our curing method provides better strength than traditional methods. Time required for our curing method is only 24 h, and the other new method has been presented, where lifting water from a tube well is to be done by laborers with minimum effort. This method will help for the curing (Water supply) of concrete and bricks during construction work. So, in this work two experimental set-ups have been described below.

14.2.1 Curing of Bricks During Their Manufacturing Process

In this work, a new way of curing to bricks has been explained, where the chemical calcium sulphate dehydrate ($CaSO_4{\cdot}2H_2O$), vacuum chamber, vacuum pump are the main requirements. This method is known as Vacuum curing which is used in fly ash based brick Industry. Steam curing is the cheapest method till now to improve the strength of concrete. However, steam curing has the defect of causing cracks in reinforced precast concrete members. Further, immediate disposal of these products from the curing plant was also not possible due to rise in temperature and unavailability of skilled labourers. These defects can be overcome with our vacuum technology, where the concrete can be kept in a vacuum chamber with a low cost chemical under some external heat which is used for curing within 24 h. It is very cheap and does not require water at all.

For prototype development it will take 12 months. For scaling up to commercialization model requires 12 months and to reach break—even point for business, it requires 6 months. The profit margin is 60% of the sales. Since we are not going

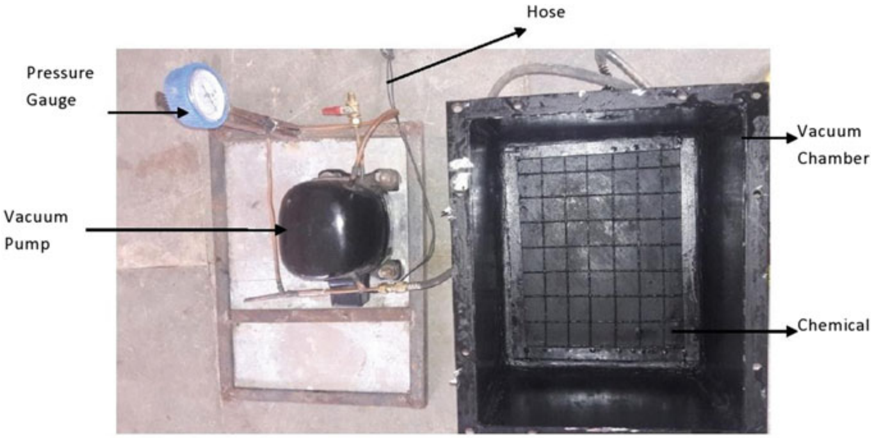

Fig. 14.1 overall arrangements for curing of bricks with chemical and vacuum chamber

to provide any material for construction, it is the responsibility of the customer to provide the materials as per our design for the preparation of the vacuum chamber.

The Fig. 14.1 below shows the overall arrangement of the setup. It consists of a vacuum pump, vacuum chamber, chemical, hose pipes and pressure gauge. Our experimental setup is designed for curing a single fly ash brick. In this system an air tight chamber has been designed to accommodate all the items to be cured, which is known as a vacuum chamber. Vacuum can be created by using a vacuum pump. One end of the vacuum pump hose is connected to the vacuum chamber and the other end is opened to the atmosphere. Vacuum pump is operated by an external electric supply. Proper vacuum creation is observed by the help of a pressure gauge.

In our work we have prepared a 6 in. fly ash brick by using a proper brick manufacturing method, and then kept in the vacuum chamber, a chemical in a container is placed outside the chamber and then the chamber is sealed, after that air from the chamber is extracted by using a vacuum pump. Due to extraction of air from the chamber, it becomes vacuum. The chemical, placed outside the vacuum chamber, is heated with less heat. Reactions from the chemical are sprayed to the vacuum chamber by nano nozzles to penetrate inside the voids of the brick. Curing is to be done for 24 h.

When the chemical calcium sulphate dihydrate ($CaSO_4 \cdot 2H_2O$) is heated, water vapour is produced. This water vapour can easily pass through the capillaries of the concrete. A traditional solution-free epoxy is provided to cover the concrete which acts as a vapour seal to prevent evaporation of water from the concrete. Hydrostatic pressure and osmotic stress can cause waterborne problems, with the latter having a greater impact on concrete. The pressure created by osmosis can surpass other forces and eventually degrade the coating of a floor. The conditions required for generation of osmosis are (i) water, (ii) semi-permeable membrane and (iii) soluble salts. As all these conditions are generally satisfied in concrete, it favours the generation of osmosis pressure.

The difference in the concentration of soluble salt associated with the permeability of concrete to inorganic salts between the upper and lower segments has been recognized as an important contributor to the development of osmotic pressure. The moisture content of concrete can vary from about 4% when the concrete fully cures to about 18% in freshly prepared "green concrete".

14.2.2 Curing of Bricks During Construction Work

In this chapter, a simpler method for curing of bricks and concrete during construction work has also been described. During construction work, water supply to masonry walls and concrete is required in order to improve the strength and accomplish other desired properties for their intended use. During this time water supply to construction parts like masonry wall, plaster, and concrete is very important. It is found that during this process, water is manually taken from the tube well and applied on these places. So, a number of extra labourers are required for this process. Moreover, lifting water and operating a tube well also affect the health of the labourers. So, in order to simplify this method, our designed product will be helpful with minimum effort and maximum efficiency.

The arrangement of water supply for curing bricks and concrete consists of a pair of spur gears, bearings, shaft, handle and flywheel. The system is connected with the tube well plunger rod in an eccentric way. Gears are arranged in simple gear train arrangements. Two different arrangements have separately been used for irrigation purposes. In simple gear train arrangement, the number of teeth on driver and driven gears are of 200 and 40 respectively. Two shafts having length of 640 mm and 600 mm are taken in this system. Driver and driven gears are attached on two shafts. Handle is connected at the end of one shaft and the flywheel is connected at the end of the other shaft. The shaft carries a flywheel at one end and contains a pulley on its other end. That pulley is connected with the plunger rod of the tube well. The shaft which is connected with the handle carries driver gear which has 200 numbers of teeth and the other shaft having flywheel and pulley carries the driven gear of 40 numbers of teeth. Both driver and driven gears are messed with each other. Bearings are provided for smooth rotation of shafts. The experimental set up is done in the workshop and for preparing the setup we have used a welding machine, cutting machine, and gear hobbing machine for generating teeth on gears. Spur gears having teeth of 200 and 40 numbers are manufactured by using gear hobbing machines with improved accuracy. After manufacturing the gears, black oxide finish method was used for preventing rust. The dimension taken for this purpose may be varied for any type of requirement.

A flywheel of 30 kg weight is provided for energy storage and smooth output power deliberation purposes. When the handle is rotated, the driver shaft and driver gear also rotate as the driven gear is meshed with the driver gear, so the driven gear causes to rotate the driven shaft, one end of the driven shaft is attached with a flywheel and the other end is attached with the pulley. Due to the rotation of the pulley the plunger rod connected with the pulley, moves up and down causing it to move up and down the plunger poppet. All such arrangements are provided on a frame made of (40 × 40 × 5) mm angle of mild steel. And water is lifted at the upward direction of the plunger rod.

A timeline has been developed for the product design and development, where time required for product development is 1 month, for scaling up to commercialization model it takes 2 months and for achieving break—even point requires 2 months. The profit margin for business purposes is 40% of the sales.

14.3 Results and Discussion

In this chapter, two experimental set ups have been developed and explained for curing of bricks and concrete. Both these designed models are helpful for construction work. One of the methods is for curing of bricks during its manufacturing process and other is for supply of water after construction work. In the Sect. 14.3.1 below, the curing of bricks without use of water during its manufacturing process has been described. Section 14.3.2, describes an innovative method for the supply of water with minimum effort for curing purposes after the construction work.

14.3.1 Method for Curing of Bricks During Their Manufacturing Process

In this work, a 6-in. fly ash brick before curing has been taken and placed inside a vacuum chamber. A vacuum pump is used to extract air from a vacuum chamber. Chemical is heated externally and products from the chemical are sprayed inside the chamber through a nano sprayer. This process continues for 24 h. After 24 h the chemical spray is stopped. And the brick from the vacuum chamber is taken out. The compressive strength of the brick has been measured by using a Universal testing machine (UTM). It is found that the compressive strength of the brick is more than a brick which is cured by the supply of water. This method of curing produces better finished bricks than traditional methods due to absence of water spray to bricks.

Our system has tremendous demand in the market. It has a B2B (business to business) and B2C (business to consumer) approach. It implies that it can be considered as a selling of service as well as product directly to the consumers. The product will be designed and modified as per the consumer requirement. Construction sector, brick industries, hume pipe industries, railway concrete sleeper and industries producing manhole slabs will be highly benefited by this system. They will place an order for this set up as per their requirement. The product can be customized as per the requirement of the consumers. From a competitor point of view the technology is unique and innovative. The system of curing is completely new since till date for

Table 14.1 Comparison between traditional and designed work

Factors	Traditional methods	Designed work
Curing	Water required	Not a single drop of water
Time required	15–24 days	24 h
Strength	8 MPa	9 MPa
Cost (frequency)	Always	Only initial set up
Environmental Issue	Mercury Pollution	Environment friendly

curing purposes people are using either water or steam. Here, we are using neither water nor steam. This is the uniqueness of our product. Our product will be sold in the market instantly. Every house will come forward and take this from the sales counter. Only we have to promote our product by giving an advertisement in the media and social network etc.

This developed system helps to create maximum opportunities to minimize unemployability. It is a continuous process. Throughout the year there are customers available as construction never stops. Hence, there is a repeated purchase of this product. The idea can be easily implemented because the system will be designed to serve the intended purpose. The material, which is the trade secret, will be provided by us. Although this method is designed for smaller scale of construction, we are in the process of developing the set up for a bigger scale of construction also. Table 14.1 shows the advantages of the newly developed curing method of bricks over the traditional method of curing. It clearly indicates that this new method of curing is helpful for addressing both environmental issues and business purposes.

14.3.2 Method for Curing of Bricks After Constructional Work

We have conducted a survey by taking our design model on construction work of a three storeyed building having 1200 ft^2 constructional area. During the time of construction, there were no facilities for water supply. Most of the construction works are done by using a tube well which was drilled earlier. We found that during construction work extra labourers were required for supply of water from tube wells for masonry and concrete work as operating the tube well for lifting of water is not an easy task. So, we set up our system in that construction area and found that lifting water became very easy for construction purposes. Table 14.2 shows a comparative statement of expenditure for curing during construction of the three storeyed building by manually operated tube well and by our designed model.

From Table 14.2, it can be observed that minimum man power is required for lifting water from tube wells for constructional work using our designed model as

Table 14.2 Comparison between manually operated tube well and designed model

Sl. no	Factors	Manually operated tube well	Designed model
1	Manpower required for water supply	60 labours	10 labours
2	Time required for water lift	200 h	100 h

compared with the traditional manually operated tube well. When our designed model was installed with the tube well at the construction area, it was found that even a lady and handicapped labourer could lift water with minimum effort.

The timeline to develop the product would be as follows. One month of time may be required for product development, one month for scaling up to commercialization of the model, and two months for achieving break—even point. The profit margin would be 40% of sales. There is a large market for this system as this is the best system for supply of water for curing of bricks and concrete. This model can also be used for supply of water for irrigation purposes. There will be no issue for such type of product development as it is an environment friendly system. The purpose of this system is to decrease environmental pollution without the use of electricity, petrol or diesel.

Our designed model is environment—friendly and it produces zero emission, as this system does not need any external source like electric, petrol and diesel for its operation. From a business point of view, our product will be used as there is a large number of construction works carried out all over the world. This is a unique product. Hence, there would be hardly any problem for marketing. The idea can be easily implemented because the raw materials used for this system are easily available in the market.

14.4 Conclusions

In this chapter, the design and development of two products have been described. Both methods are helpful for providing a better environment and better opportunities for business with reduced cost and minimum effort. The conclusions drawn from this analysis are given below.

14.4.1 Method of Curing of Bricks During Their Manufacturing Process

Nowadays, brick manufacturing industries are chosen for the first choice of business, due to huge demand on constructional works. A business and an industry will sustain if proper technologies are adopted. Generally in constructional work, supply of water for curing purposes is a main requirement. Our new technology will provide a better way for curing bricks during its manufacturing process.

(i) The technology is innovative and unique. The system of curing is completely new as people are using either water or steam for curing till today. Here, we are using neither water nor steam for curing purposes. This is the uniqueness of our product.
(ii) Our product will be sold in the market instantly. Every house will come forward and take this product from our sales counter by paying the cost of the product.
(iii) Throughout the year there are customers available as construction never stops. Hence, there is a repeated purchase of this product.
(iv) The idea can be easily implemented because the system will be designed by us. The material, which is the trade secret, will be provided by us. Steps are taken to set up the product for bigger construction projects.
(v) The designed method is environment—friendly.
(vi) Time of curing is reduced and the compressive strength of the bricks and concrete is improved by this method.
(vii) The initial cost of this product may be high but the running cost is very less and it produces better finished products as compared to other traditional methods of curing.

14.4.2 Method of Curing of Bricks After Constructional Work

Water supply for construction work in a number of construction sites is done by lifting water from tube wells or bore wells. Lifting of water from borewells or tube wells requires diesel, petrol, kerosene or electricity for the operation of pumps. In some constructional areas manual workers are engaged for such purposes. Lifting water manually is not an easy task especially when women workers and aged labourers are engaged for such purposes. To overcome such difficulties, our designed product will help a lot. Number of conclusions from this work is enumerated below.

(i) The concept that the increase of mechanical advantage which results in optimum efficiency is relevant right here.
(ii) The idea of energy storage by means of flywheel has been involved here, due to which by means of much less effort the lever of the tube performs smoothly.
(iii) There is no need for electrical supply, petrol or diesel for running this product.
(iv) The price of this product is so low that it can be purchased by poor people.
(v) The weight of this product is also less so that it can be easily taken to the workplaces for any constructional work.
(vi) This method also helps for agriculture purposes as the soil will be no longer affected because irrigation at any time can be made possible by the use of this technique.

(vii) Installation and maintenance of this product is so simple and is not a matter of concern for such a system.
(viii) Since there is no requirement of petrol, diesel or electricity, there will be no emission at all from this system which is a main advantage of such a system.
(ix) Any type of labourers and farmers can utilize this method.
(x) This could boost productivity resulting in the growth of the economy of the country.
(xi) A physically handicapped worker and farmer also can use it.
(xii) Multi activity is viable with the aid of the usage of this machine.
(xiii) A lady worker can use this product without difficulty for the supply of water to construction work and agriculture sites.

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