DRAINAGE CONSTRUCTION MANAGEMENT USING QFD APPROACH

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Abstract- The main purpose of the research is to find the solution of drainage issues in road drainage through the observation and study of QFD approach. Firstly, we will investigate the existing road drainage and summarize the design methodology from our previous researches. Through the observations and reviews, this report would conclude the solutions for existing drainage problems. We will work on supply and demand of water, blockage prevention, type of flowing material study. By using QFD approach we will get optimal solution and to save cost and time.

Keywords- Road Drainage, QFD, Drainage Issues

I.INTRODUCTION

DRAINAGE SYSTEM

Over the years there has been a continuous migration of people from rural and semi urban areas to cities and town. The proportion of population residing in urban areas has increase from 27.8% in 2001 to 31.2% in 2011 and 40% in 2017. The number of town has increase from 5161 in 2001 to 7935 in 2011, 1055 in 2017.
Good drainage systems quickly remove excess surface and sub-surface water from the paddock. An effective drainage system will remove excess soil water within 24 hours of the rainfall event. A good time to assess the needs on your farm is after a heavy rain event when problems with ponding and runoff are easy to see.
There are a number of options available to improve drainage, including:

- Reshaping the layout or contour of the paddock
- Improving surface drainage to remove surface water quickly from cropped areas
- Installing subsurface drainage to remove water from saturated soils by downward flow.

Managing water on the right of way requires a drainage system that effectively responds to the immediate environment. A typical highway drainage system includes conveyances of all types: gutters, drains, ditches, culverts, storm sewers, and other miscellaneous drainage structures. The system is designed and constructed to collect, treat, and remove storm water from the highway right of way. It must be properly maintained to:
Drainage facilities should be maintained as nearly as possible to the condition and at the capacity for which they were originally designed and constructed. The entire drainage system should be generally inspected at least twice a year or otherwise based on specific environmental permit requirements, past experience, and professional judgment. Deficiencies should be corrected when they are discovered. Additional inspections may be required during heavy storms and periods of high runoff in order to determine the effectiveness of the system. High water marks should be observed and recorded as well as conditions that threaten damage to the drainage facility or the highway. Maintenance personnel must be continually alert to assure that all natural water course channels crossing the right of way remain open. WSDOT policy regarding accommodation of Storm water Runoff onto Right of Way is outlined in Policy Statement Number P 2032 dated February 10, 2012. This policy clarifies the department's responsibility for establishing and maintaining storm water management systems for its highways and other facilities that adequately manage the volumes and quality of storm water according to standards contained within the Highway Runoff

PUNE MUNCIPAL CORPORATION DRAINAGE DEPARTMENT

To create a systematic and improved sewage drainage system across the city, the Pune Municipal Corporation (PMC) sewage department is now working on a design initiative. A master plan for the next 30 years is been created by the department, through which all drainage pipelines and channels across Pune will be connected via the Geographic Information System (GIS). The total budget for this project is Rs 2.98 crore. Work has already begun, with measurements being taken and other details of drainage channels in the city being noted. Elaborating on the project, Jagdish Kanhore, superintending engineer with PMC's sewage department, said, "Currently, there is no proper consolidated data, diagrams or maps available of the existing sewage pipeline network in Pune city. Under the first phase of the project, we will collect data of

all the existing sewage pipelines and conduct a detailed ward-wise survey. These details will be collected and uploaded into the GIS. Along with this, spots where choking is frequent, drainage line chambers, directions of the underground sewage water, depth and sizes of pipelines in different areas, etc. will be collected in this survey."

II.LITERATURE REVIEW

The construction of new buildings represents a significant investment. The goal of new building construction is to maximize value and minimize cost while staying on time and within budget. Translating customer requirements into engineering terms for new construction design Is vital for a construction project to be successful. Quality function deployment has been successfully used in product development to capture the voice of the customer and translate it into engineering characteristics. Quality function deployment then carries these parameters into production and service to ensure the voice of the customer is being met with the final product. The house of quality, a tool within quality function deployment, can provide a means for comparison of owner's project requirements and the proposed design, along with identifying how the design decisions impact meeting customer requirements and green building requirements. Quality function deployment can effectively link the project phases through design and construction and into operations and maintenance to ensure the owner's project requirements are met with the final building. This research identifies and categorizes studies of quality function deployment applications in construction. The research method used is a systematic literature review from databases related to quality function deployment in the construction industry published in the periodicals through 2016. The principal findings of implementations, practices, and integrated approaches are then summarized. This article intends to propel further research of quality function deployment in the construction [1]

The effects of climate variability drain spacing, and growing season operational strategy on annual drain flow and crop yield were studied for a hypothetical drainage water management (DWM) system at Purdue University's Water Quality Field Station Using the drain model. Drainage water management showed potential for reducing annual average (1915–2006) drain flow from all drain spacing's (10–35 m) regardless of the growing season operational strategy, with reductions varying between 52 and 55% for the drain spacing's considered. Approximately 81 to 99% of the annual drain flow reduction occurred during the non-growing season, depending on the operational strategy. Fixed DWM operational strategies led to an increase in mean predicted yield for narrower spacing's compared with conventional drainage systems. Maximum yield was achieved with no control for drain spacing's wider than 20 m in 50% of the years. Overall, the height of control had more influence on relative yield than the date of initiation of control. The greatest positive impacts of DWM on relative yield (1.2%) occurred in cool, dry years, while the greatest average negative impacts (–0.2%) occurred in cool, wet years. On average, with the best-case operation selected for annual weather conditions, DWM increased relative yield by approximately 0.8, 0.4, and 0.2% for the 10-, 20-, and 30-m drain spacing, respectively. Accumulated growing degree days and antecedent precipitation index show promise for identifying appropriate operational strategies for DWM.[2]

The term flashiness reflects the frequency and rapidity of short term changes in stream flow, especially during runoff events. Flashiness is an important component of a stream's hydrologic regime.[4] A variety of land use and land management changes may lead to increased or decreased flashiness, often to the detriment of aquatic life. This report presents a newly developed flashiness index, which is based on mean daily flows. The index is calculated by dividing the path length of flow oscillations for a time interval (i.e., the sum of the absolute values of day-to-day changes in mean daily flow) by total discharge during that time interval.

This index has low internal variability, relative to most flow regime indicators, and thus greater power to detect trends. Index values were calculated for 515 Midwestern streams for the 27-year period from 1975 through 2001.[4] Statistically significant increases were present in 22 percent of the streams, primarily in the eastern portion of the study area, while decreases were present in 9 percent, primarily in the western portion. Index values tend to decrease with increasing watershed area and with increasing unit area ground water inputs. Area compensated index values often shift at ecoregion boundaries. Potential index applications include evaluation of programs to restore more natural flow regimes.

Research conducted for the last 35 years has shown that subsurface drainage has a significant impact on hydrology and contaminant transport. This can be observed at the field-scale and also at the watershed scale. Impacts are always associated with modifying otherwise natural flow paths. Most computer model representations of drainage have been drawn at the field-scale. These models require relatively precise data that are usually unavailable when simulating hydrology and water quality in large watersheds. We believe that in this case drainage representation should be simplified and yet closely match observations. As a first step towards incorporating drainage systems into large-scale hydrological models, we propose an equivalent representation of drains buried in a soil profile by Using a homogeneous anisotropic porous medium without drains. This representation is based on a "self-consistent" approach and on geometrical considerations. Simplification is such that calculating the equivalent hydraulic conductivity requires only information on the main length and spacing of the tile drains and not on their precise location. This approach also provides a much simpler discretization of the domain because of the absence of internal boundary conditions on the drainage pipes.[3] Compared to other methods that have simplified drainage representation in existing watershed models, it requires no parameter fitting.

The USA Council of Agricultural research has given priority to control and manage salinity problems that have developed in north-west US. Multi-disciplinary taskforces have recommended installation of subsurface drainage for salinity control, based on design and management techniques developed by the Central Soil Salinity Research Institute (CSSRI),[2] to rehabilitate lands with excess soil salinity. After small-scale studies, large-scale pilot projects were launched to install subsurface drainage in problem areas. One such attempt in was initiated in the north-west region of US where a large-scale drainage project was carried out with Dutch collaboration. We assessed the impact of investments in subsurface drainage in order to validate past funding on research of drainage in US. The important methods Usedfor assessing the efficiency benefits of drainage investment were: to determine the impact of subsurface drainage in terms of net present value, internal rate of returns, consumers' surplus, and producers' surplus; to assess the social welfare in terms of social equality and sustainability of the drainage system; and to examine the factors affecting the sustainability of the technology. The internal rate of return was computed to assess the efficiency parameter of subsurface drainage for salinity management. In order to measure the changes in inequality distribution of income, Gina concentration ratios were computed with and without installing subsurface drainage.

III.RESEARCH METHODOLOGY

Quality function deployment

Quality function deployment (QFD) is a quality improvement technique that deals with quality problems from the road drainage design and development stage and assures that customer's requirements are accurately translated into appropriate technical requirements and actions and get optimal solution. The emphasis on "voice of the customer"is the key to QFD. This makes good sense in the construction industry, as every construction project is unique. Each road drainage is customs made to meet the requirements and needs of the client. As theConstructionmatures the ability to understand and translate the needs of the client into a finished product is fast becoming a prerequisite for the long term viability of a company.

QFD system

One of the most important characteristics of a product is that the customer likes it. A customer likes a product when it fulfills his needs and meets the requirements he expected from the product. Therefore a lot of technologies in the field of management, organization and manufacturing have been developed and proved to work for product development and improvement. In this report an introduction is given to the management tool QFD, which is a 'proven' approach for translating costumer needs into design solutions for road drainage.

QFD PROCESS

Two popular models illustrate the QFD process. One is the four phase model developed by Mouser and causing (1988). This is probably the most widely described and used. The other is by Dr,Akao (1990) called the "matrix of Matrices."Akao's model is considered gigantic and far reaching (Cohen, 1995). The QFD structure is normally presented as a system of matrices, charts, tables, or other diagrams. The four phase model seems to be more common in the QFD application, so it is briefly described here. The four
Phase model is based on the following key documents or components:

- Overall customer requirement planning matrix-translates the general customer requirements into Specified final product control characteristics for road drainage.
- Final product characteristic development matrix-translates the output of the planning matrix into critical components characteristics for road drainage.
- Process plan and quality control charts-identify critical product and process parameters and develop Checkpoints and controls for these parameters.
- Operating instructions-identify operation to be performed by plant personnel to ensure that important parameters are achieved.

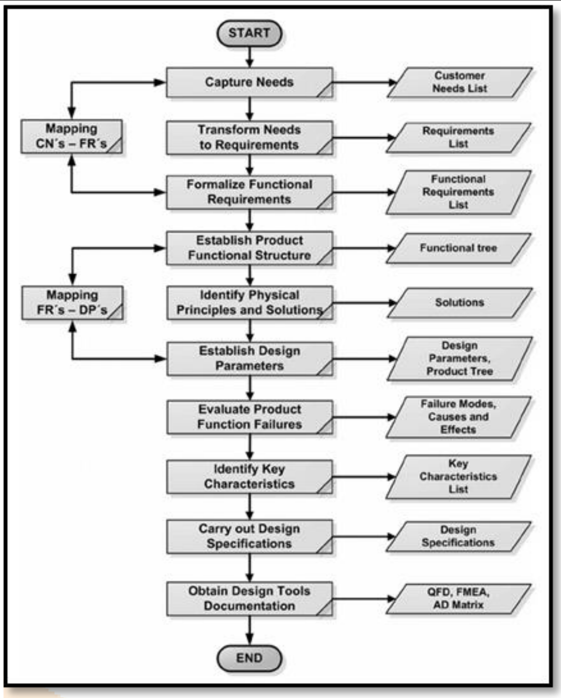


Fig no 1:- Process of QFD

Explanation-

The average consumer today has a multitude of options available to select from for similar products and services. Most consumers make their selection based upon a general perception of quality or value. Consumers typically want "the most bang for their buck". In order to remain competitive, organizations must determine what is driving the consumer's perception of value or quality in a product or service. They must define which characteristics of the products such as reliability, styling or performance form the customer's perception of quality and value. Many successful organizations gather and integrate the Voice of the Customer (VOC) into the design and manufacture of their products. They actively design quality and customer perceived value into their products and services. These companies are utilizing a structured process to define their customer's wants and needs and transforming them into specific product designs and process plans to produce products that satisfy the customer's needs. The process or tool they are using is called Quality Function Deployment (QFD) for road drainage management.

Implementation QFD for road drainage

The Quality Function Deployment methodology is a 4-phase process that encompasses activities throughout the product development cycle. A series of matrices are utilized at each phase to translate the Voice of the Customer to design requirements for each system, sub-system and component. The four phases of QFD are:

- Product Definition for road drainage management. The Product Definition Phase begins with collection of VOC and translating the customer wants and needs into product specifications. It may also involve a competitive analysis to evaluate how effectively the competitor's product fulfills the customer wants and needs. The initial design concept is based on the particular product performance requirements and specifications.
- Product Development for road drainage management. During the Product Development Phase, the critical parts and assemblies are identified. The critical product characteristics are cascaded down and translated to critical or key part and assembly characteristics or specifications. The functional requirements or specifications are then defined for each functional level.
- Process Development for road drainage management. During the Process Development Phase, the manufacturing and assembly processes are designed based on product and component specifications. The process flow is developed and the critical process characteristics are identified.
- Process Quality Control for road drainage management. Prior to production launch, the QFD process identifies critical part and process characteristics. Process parameters are determined and appropriate process controls are developed and implemented. In addition, any inspection and test specifications are developed. Full production begins upon completion of process capability studies during the pilot build.Effective use of QFD requires team participation and discipline inherent in the practice of QFD, which has proven to be an excellent team-building experience.

Level 1 QFD

The House of Quality is an effective tool used to translate the customer wants and needs into product or service design characteristics utilizing a relationship matrix for road drainage management. It is usually the first matrix used in the QFD process. The House of Quality demonstrates the relationship between the customer wants or "Whats" and the design parameters for road drainage management.or "Hows". The matrix is data intensive and allows the team to capture a large amount of information for road drainage management.in one place. The matrix earned the name "House of Quality" due to its structure resembling that of a house. A cross-functional team possessing thorough knowledge of the product, the Voice of the Customer and the company's capabilities, should complete the matrix. The different sections of the matrix and a brief description of each are listed below:

Level 2 QFD

The Level 2 QFD matrix is a used during the Design Development Phase. Using the Level 2 QFD, the team can discover which of the assemblies, systems, sub-systems and components have the most impact on meeting the product design requirements and identify key design characteristics for road drainage management.. The information produced from performing a Level 2 QFD is often used as a direct input to the Design Failure Mode and Effects Analysis (DFMEA) process. Level 2 QFDs may be developed at the following levels:

Level 3 QFD

The Level 3 QFD is used during the Process Development Phase where we examine which of the processes or process steps have any correlation to meeting the component or part specifications for road drainage management.. In the Level 3 QFD matrix, the "Whats" are the component part technical specifications and the "Hows" are the manufacturing processes or process steps involved in producing the part. The matrix highlights which of the processes or process steps have the most impact on meeting the part specifications. This information allows the production and quality teams to focus on the Critical to Quality (CTQ) processes, which flow down into the Level 4 QFD for further examination for road drainage management.

Level 4 QFD

The Level 4 QFD is not utilized as often as the previous three. Within the Level 4 QFD matrix, the team should list all the critical processes or process characteristics in the "Whats" column on the left and then determine the "Hows" for assuring quality parts are produced and list them across the top of the matrixfor road drainage management.. Through ranking of the interactions of the "Whats" and the "Hows", the team can determine which controls could be most useful and develop quality targets for each. This information may also be used for creating Work Instructions, Inspection Sheets or as an input to Control Plans.

QFD APPLICATION IN A DRAINAGE PROJECT IN DESIGN PHASE

For this case two techniques can be used for gathering information on customer's needs and desires for the layout of the residential unit. The first technique adopted interviews with salespeople (real estate agents) who have a strong relationship with buyers and Users. Another technique Used was the "Focus Group" approach using mid-sized and small-sized groups, obtaining information through question and benchmarking between different projects in order to find out likes, dislikes, trends opinions about similar current and other projects. Different people including real estate agents, architects, engineers, potential buyers and owners of similar apartments composed the focus group.

IV.CASE STUDY

Objectives-

The main purpose of the research is to find the solution of drainage issues in road drainage through the observation and basic study of QFD approach. Firstly, we will investigate the existing design methodology from our previous researches.
Site Location-Kothrud Gaothan Near Shivaji Chowk, Pune.

Latitude and longitude coordinates are: **18.507399, 73.807648**.

The latitude of Kothrud, Pune, Maharashtra, India is **18.509890**, and the longitude is **73.807182**. **Kothrud, Pune, Maharashtra, India** is located at *India* country in the *Cities* place category with the gps coordinates of 18° 30' 35.6040" N and 73° 48' 25.8552" E.

Fig no 2:- Location Map

Site Date- 01-10-2017 to 30-11-2018.

Length of work- 600M

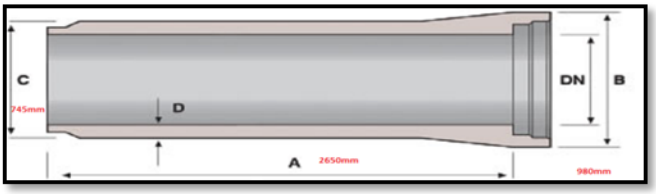
No of RCC Pipes-70 Nos

No of Man Holes- 19-20

Labour Per Day-3 to 5

Brick Man Hole-20

Pipe Dimension-



RCC Pipe Delivery Analysis

Solution:- Using Histogram Chart

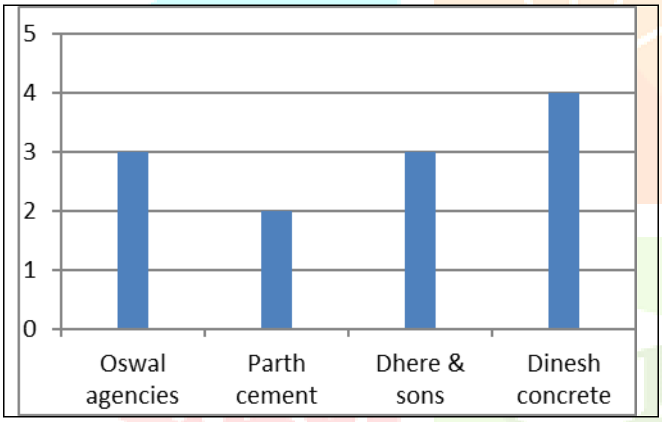


Fig no 3: Histogram chart of agencies

- Thus delivery time required from supplier Parth cement much less than other suppliers
- Thus ordering from supplier Parth cement should be more profitable

Fig no 4:- RCC pipes

Fig no 5:- RCC laying work

Not able complete work on time

Solution:- Using function tree diagram

EFFECT

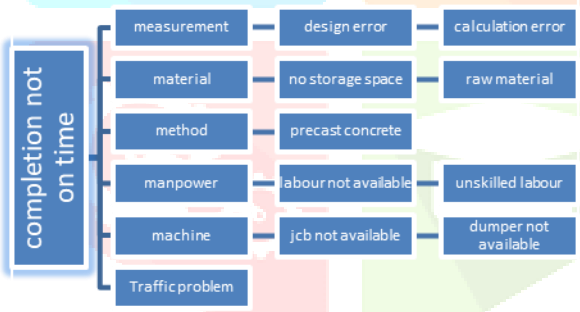


Fig. no. 6:- cause and effect diagram

CAUSE

Here the problem were,

- Machine was not available for 3 days
- Material was not available for 1 week
- Due to traffic work was problem during work
- Thus we got a detail information about the causes which can be effective for, not completing Project on time.

Hence take care that it would not happen in future.

Calculations

For Population of 20,000 by considering 150 LPCD consumption.

20,000*150 lit= 30,00,000=3MLD

30, 000, 00*0.85

Sewage =2.55MLD

Total cost of work

10,000 to 12,000 Rupees per meter to lay down the drainage line of 600 mm diameter along with connection and manholes.

12000*600 = 7200000
Labor cost: 500 X 5 = 2500

Days : 150

Labor cost * Days : 150 X 2500 = 375000

Before QFD

COST SHEET LABOUR AND MAINTENANCE

TECHNICAL INDEX	BEFORE QFD	AFTER QFD	IMPROVEMENT
Labor Cost	Rs 3,75,000 Lakhs 5 Labour Per day Charge- Rs 500 Total days- 150	Rs 2,25000 Lakhs 3 Labour Per day Charge- Rs 500 Total days- 150	20% Cost Saving
Maintenance Cost	Rs 30,000 **1.Drainage Leakage-** 8000 for 4 People for 4 days. **2.Pipes Cuts Recovery-** 10000 for 5 People for 4 days. **3.Cleaning and Oiling-** Rs 12000 for 6 people for 4 days.	Rs 16,000 **1.Drainage Leakage-** 4000 for 2 People for 4 days. **2.Pipes Cuts Recovery-** 6000 for 3 People for 4 days. **3.Cleaning and Oiling-** Rs 6000 for 3 people for 4 days.	80%

V.CONCLUSION

From the consideration of all the above points we conclude that our research is to find the solution of drainage issues in road drainage through the observation and study of QFD approach. Firstly, we investigate the existing road drainage and summarize the design methodology from our previous researches. Through the observations and reviews, this report would conclude the solutions for existing drainage problems. We work on supply and demand of water, blockage prevention, type of flowing material study. By using QFD approach we get optimal solution and to save cost and time. QFD approach is better for saving time and cost.

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