

# Lean, Green and DMADV Tool Based Approach for an Effective Execution of Residential Building Construction Improvement

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**Abstract**— in this paper introduce how to use the principal of LEAN and SIX SIGMA in Residential Foundation Project and how to make Eco- Friendly and Green Foundation. Construction industry is major source of pollution and wastage. By the help of Lean and Six Sigma Principle, wastage problem and Harmful impact of construction material on environment and human health can be reduce.

**Keywords**— Lean, Six Sigma Tool, Eco-Friendly Materials, Green Buildings, Pollution, Foundation, Voice of customer.

## I. INTRODUCTION

This Research Paper Based on Application of Lean and Six Sigma Principal on Construction of Spread Footing Foundation. Construction industry is a major source of Pollution. By the help of Lean and Six sigma tool water supply system can be Redesign and impact of harmful construction material on environment can be reduce.

## II. TOOL

a. Lean-Lean is Principal introduce by Toyota. Lean shows the wastage of material and how to reduce the amount of wastage during the production.

b. Green-In this research paper Green word refers to reduce unhealthy Construction Impact on human body, because due to construction is major source of pollution emission.

c. DMADV-DMADV (Define, Measure, Analysis, Design, Verify) it is tool of six sigma. It is use for development of New product, New process.

**Design:** Define is the First Step of the Lean and Six Sigma Process. It consists of defining the problem, the process and the Customer.  
**Tools-** Project Charter, Voice of Customer, SIPOC (Supply, Input, Process, Output, Customer)

**Measure:** This phase consist of data analysis and find out the reasons of waste in the Process.

**Tool-** Cause & Effect Diagram or Fishbone Diagram.

**Analysis:** It is consist of statistical analysis of the problem.

**Tools-** Process Analysis, Data Analysis.

**Design-** It is consist of improvement of alternatives.

**Verify:** The Performance of design should be according to customer needs.

## III. CASE STUDY

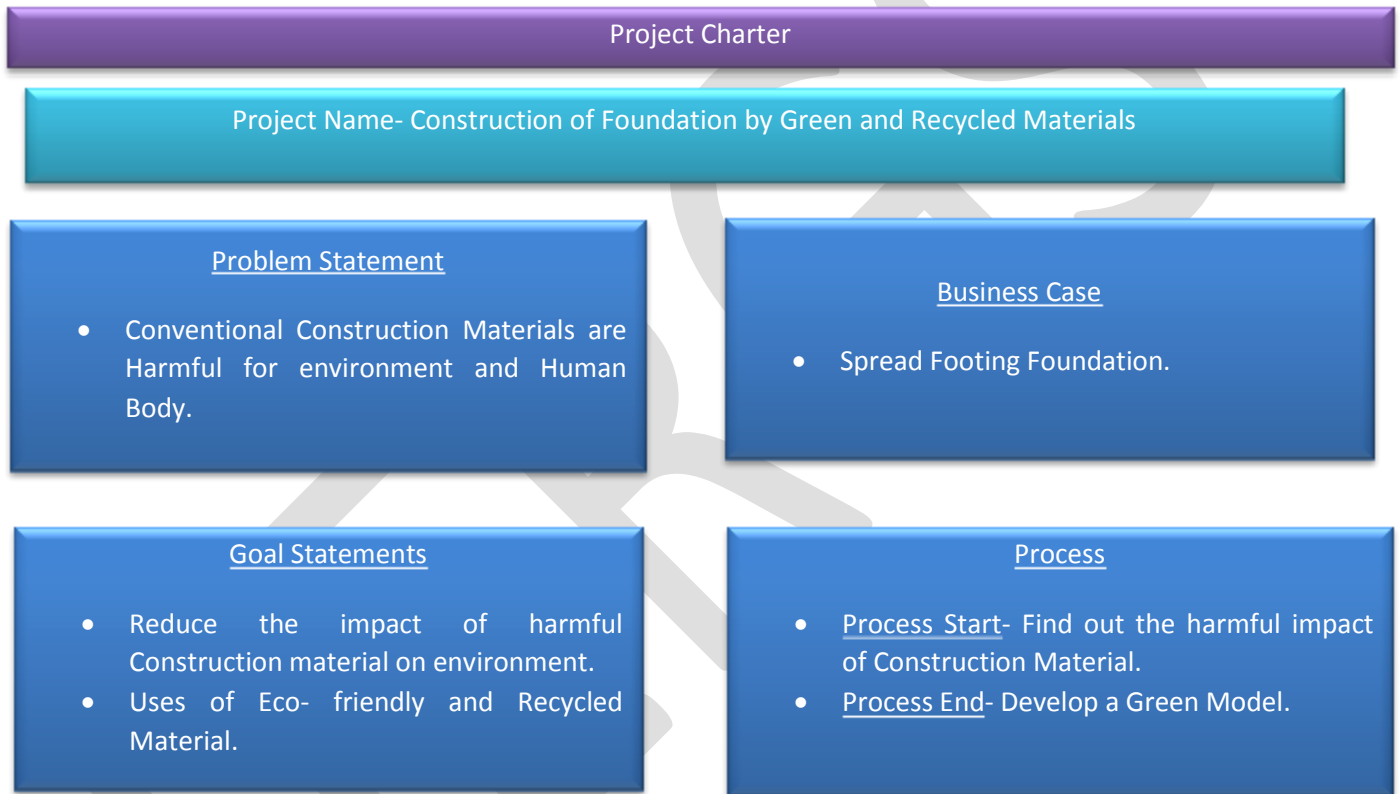
For application of lean and six sigma tool (DMADV). We are taking a construction of spread footing foundation. General Specifications:

Table 1  
 General Specifications of Spread Footing Foundation

Width of Concrete Base	80 cm
Width of 1 <sup>st</sup> footing	60 cm
Width of 2 <sup>nd</sup> footing	50 cm
Height of plinth	60 cm
Height of Wall	3.50 m
Thickness of wall	30 cm

**Define Phase**

Step 1- Define aim of Project.  
 Tool- Project Charter.



Step 2- Define Customer Requirement.  
 Tool- Voice of Customer Translation matrix.

Table 2  
 Voice of Customer Translation matrix

Customer Comment	Customer Requirement
Red List Building Materials are harmful to living creatures including Human or Environment	Uses of Non- Toxic and Non Chemical Materials

P.V.C responsible for Cancer Causing Vinyl Chloride monomer and ethylene dichloride	Find Out the Alternative of P.V.C
Silica can cause chronic obstructive pulmonary disease	Uses of Green Materials
Lead Found in Paints. It causes Kidney, nervous system and other Organ Damage	Uses of Eco Friendly Paints
Asbestos is found in insulation, pipe covering, Roof materials, acoustical materials, Fire proofing Insulation it can cause COPD	Find Out the Alternative Solution of Asbestos
The Cement industry is one of the primary Product of CO2.	Find out the Eco- Friendly Cement and Concrete.

Step 3- Define Process.  
 Tool- SIPOC.



**Measure Phase**

Tool- Fishbone Diagram.

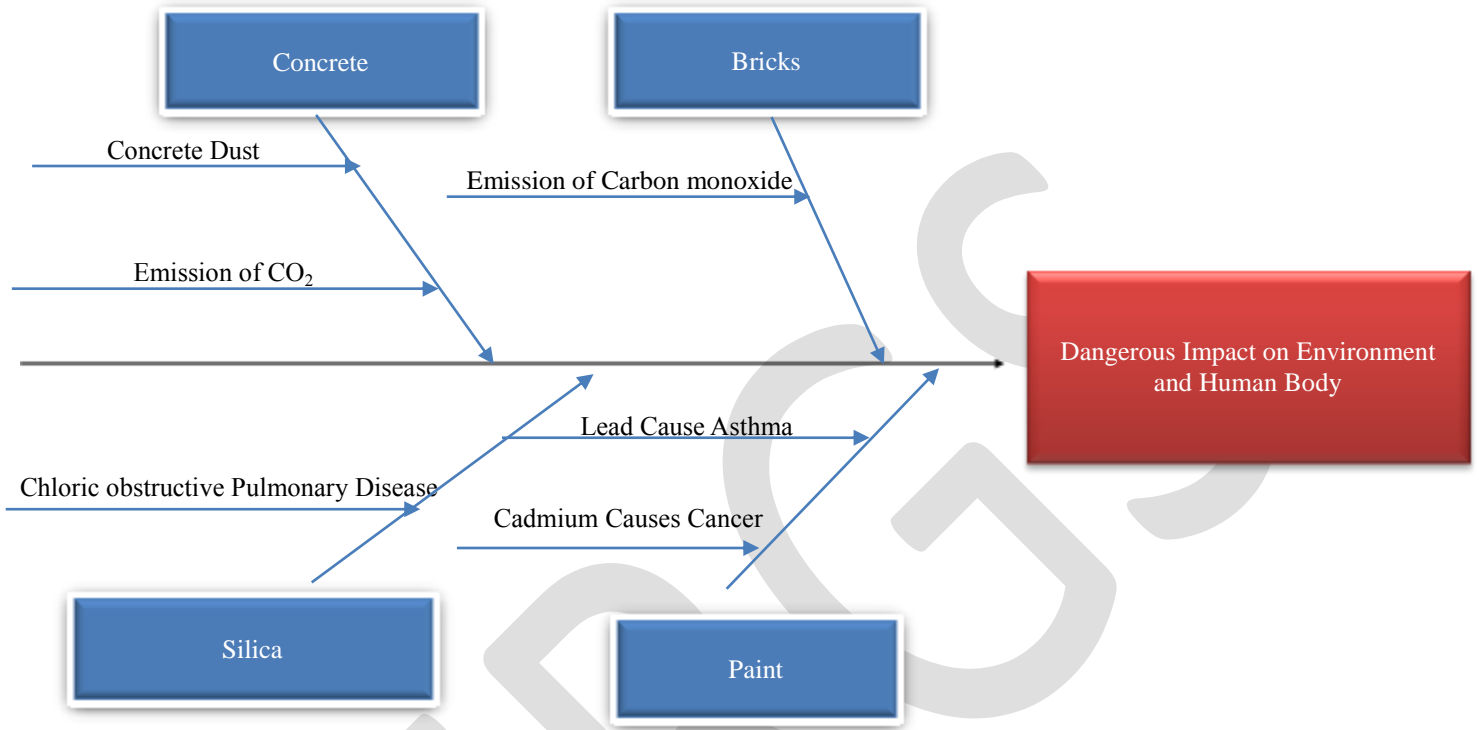


Fig. 1  
Fishbone Diagram

**Analysis Phase**

Tool- Process Analysis, Data Analysis.

Fly ash- sand-lime-Gypsum Brick

Use- for Walls in housing and all type of Building Construction

Table 3  
Properties of Fly ash- sand –lime –Gypsum Brick

Compressive Strength	80-150 kg/cm <sup>2</sup>
Unit Weight	3-3.5 kg/brick
Water absorption	8-10 %
Density	1800-1950 kg/m <sup>3</sup>

Clay Fly ash Burnt Brick

Use- For Walling

Table 4  
Properties of clay fly ash Burnt Brick

Compressive strength	75-150 kg/cm <sup>2</sup>
Water absorption	12-16%
Unit Weight	2.5-3 kgs

Bulk Density	1600-1825 kg/cm <sup>2</sup>
Colour	Red

Marble Slurry Bricks  
Use- For walling

Table 5  
Properties of Marble Slurry Bricks

Compressive strength	93 kg/cm <sup>2</sup>
Water absorption	14%
Volume of Brick	1687.5 cm <sup>2</sup>
Colour	White/grey

Cellular Light Weight Concrete  
Use- Reduction of Dead Weight of Foundation

Table 6  
Properties of Cellular Light Weight Concrete

Range of densities	400-1800 m <sup>3</sup>
Compressive strength	10-250 kg/ sq.cm
Water absorption	5% by Weight
Thermal Conductivity	0.082-0.555 w/mk

Eco- Friendly Paints

Major Manufactures of Natural Paints.

Table 7  
List of Natural Paints Manufactures

Aglaia	Livos	Auro
EcoDesign's Bioshield	SoyGuard	Silacte
Anna Sova	Green Planet Paints	Master Blend

Major Manufactures of Zero Volatile Organic Compound Paints.

Table 8  
List of Zero VOC Paints Manufactures

Earth paint	ECOS Paints	AFM Safecoat
ICI Life master	Best Paint Company	American Pride
Sherwin Williams	Mythic Paints	Homestead Paints

Major Manufactures of Low Volatile Organic Compound Paints.

Table 9  
List of Low VOC Paints Manufactures

Benjamin Moore Aura	Benjamin Moore Saman	Cloverdale Horizon
Cloverdale EcoLogic	Miller Paints	Timber Ox Green

**Design Phase**

Table 10  
Design of Foundation

Item No.	Description of Item	No.	Length	Breadth	Ht. or Depth	Quantities	Total Quantities
1	Earthwork in Excavation in Foundation	1	6.00m	.80m	.90m	4.32	4.32 cu.m
2	Lime Concrete in Foundation	1	6.00m	.80m	.30m	1.44	1.44 cu.m
3	1 <sup>st</sup> Class Eco Friendly brick work in lime Mortar in foundation and Plinth						
	1 <sup>st</sup> Footing	1	6.00m	.60m	.20m	.72	
	2 <sup>nd</sup> Footing	1	6.00m	.50m	.20m	.60	
	Plinth Wall up to G.L	1	6.00m	.40m	.20m	.48	
	Plinth Wall up to G.L	1	6.00m	.40m	.60m	1.44	
							Total= 3.24 m <sup>3</sup>
4	1 <sup>st</sup> Class Eco Friendly Brickwork in lime Mortar for Superstructure	1	6.00m	.30m	3.50m	6.3	6.3 m <sup>3</sup>
5	Non- Toxic White Washing	1	6.00m	-	3.50m	21.0	21.0 m <sup>2</sup>
6	Non –Toxic Colour Washing	1	6.00m	-	4.10 m	24.6	24.6 m <sup>2</sup>

**IV. CONCLUSION**

Overall, by the help of Design tool of Six Sigma Spread Footing Foundation can be Redesign and Eco-friendly construction will be possible. By the help of lean and six sigma tool Pollution can be reduce and also reduce the toxic impact of materials on human health. Any existing system can be redesign and it will be economical in compare to current price model and also reduce the wastage of materials by new system.

**REFERENCES:**

- [1] Arpad Horvath “Construction Materials and the Environment”
- [2] Center for Health Environment & Justic “Toxic chemicals in products and building materials purchased by New York Schools and Government Agencies”.
- [3] Jane Anderson “The embodied Impact of Construction Materials”.
- [4] Raid al Amor “Analysis of lean construction practices at Abu Dhabi construction industry”.
- [5] Sunil V. Desale, Sharad V. Dwadhar “An application of lean and six sigma principle for constructional process improvement in Indian organization”.
- [6] Sneha.p.sawant, Smita V. Pataskar “Applying six sigma principles in construction industry for quality improvement”
- [7] Abdul-Aziz Ali Bhawani “Improving construction processes by integrating lean, green, and six-sigma”.
- [8] Sunil v. Desale, Sharad V. Dwadhar “Eliminating waste in construction by using lean and six sigma Principal” by.
- [9] Mehmet Tolga “Critical Success factor for six sigma” by.
- [10] Atul Porwal “Construction waste management at source: A building information modelling based system dynamics approach”.
- [11] Seung Heon Han, M.ASCE, Myung Jin Chae, Ph.D, P.E, Keon Soon Im, P.E; and Ho Dong Ryu. “Six sigma Based Approach to improve performance in construction operations”.
- [12] Sophia Lisbeth Hsu “Life Cycle Assessment of Materials and Construction in Commercial Structure: Variability and Limitations”.