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SOCET Journal of Engineering & Technology



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**ADITYA SILVER OAK  
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**Silver Oak College of Engineering & Technology  
Gota, Ahmedabad**



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**Dr. Akshai Aggarwal**  
Vice Chancellor

### Message from your Vice-Chancellor

I am pleased to learn that the 2015 issue of Sarjan is to be published soon.

Such journals are expected to publish the research and creative work of Faculty Members and research students. While publication of such journals does encourage young persons to write learned papers and have their creative work published, care must be taken that such journals become progressively of higher quality. One method for maintaining high quality is of using double-blind reviews, through persons, who are known to have high quality work to their credit. It is difficult to get such persons. But efforts to get such reviewers must be made if a journal is to have external reviews.



Gujarat Technological University (GTU) has been stressing that technological research work must be relevant to the needs of the industries and the society. GTU has also made a major effort to encourage the Departments and the Colleges to lead the Final Year students towards taking up IDPs. While the Final Year projects are the capstone of engineering education and while the work on an IDP helps a student to graduate as an engineer, who understand the relevance of his/ her discipline in the practical field, IDPs can also help the Faculty Members and researchers to make their research more relevant. Theoretical research, logical development of ideas and carrying forward the published work of others are all accepted ways of doing research. But if a researcher is not able to situate his/ her technological research in a practical domain, where it can be used, the research work will not be able to fertilize new ideas and it will not be able to move the department and the College towards higher orbits of research. If Faculty Members and researchers take interest in IDPs and in the associated industries, even if these may be micro or small industries, they will be able to help their Final Year students do better quality of work. More importantly, they may be able to make their research work more productive.

If GTU's graduates are to become respected technologists, if India's engineering graduates are to be found not only among the top-most managers in the Fortune 500 companies but if they are to be known for their designs of products, used by the world, we shall have to make our laboratories and workshops more interesting and educative places and we shall have to see that Sarjan starts publishing work relating to innovative work in the practical components of education.

I wish this issue of Sarjan a great success and I hope Sarjan will become a trigger for unleashing the creativity of all the members of the Silver Oak group of Institutes .

  
Dr. Akshai Aggarwal

21<sup>st</sup> September 2015

Winners of : ICT Enabled University Award E-India - 2009 ♦ Mountain Award - 2009 ♦ GESIA Award - 2011  
♦ Digital Learning WES - 2011 Award ♦ AIMS International Innovative University Award - 2013

## **From the Desk of Editors**

It takes us immense pleasure to present the fourth edition of the institute's technical journal 'Sarjan'. This edition encompasses papers from all the disciplines of engineering in our college which highlights active contribution by all in the process. Research Papers are precipitates of the research work going on in the institute. They give us an opportunity to have a bird's eye view on the fields in which research is progressing. We can analyze the quality and direction of work which would help us in reviewing the course in which we are proceeding. A regular follower of the journal would surely find that we have moved a step ahead and we should continue to do so as improvement is a continuous process.

We are thankful to Dr. Saurin Shah, Principal, Silver Oak College of Engineering and Technology for giving us opportunity to shoulder the responsibility and to all the Head of the Departments who cooperated during the process. We are most thankful to all the contributors who submitted paper finding time, out of the busy schedule. Innovation and research is only possible if it promoted and financed by the management. We thank them heartily since it is only under their vision and active guidance that we have reached this far.

**Ninaad Athalye  
Hardik Shukla**

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# USE OF GUARGUM POWDER AS VISCOSITY MODIFYING AGENT IN SELF-COMPACTING CONCRETE

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**Abstract:** Concrete is the most widely manufactured material in the world. Over recent decades, technical innovations, especially in the use of admixtures, have improved not only the quality but also the range of potential application for this versatile construction product. The results show that for constant flow ability of the Self Compacting Concrete (SCC), replacement of cement with Guar Gum (GG) requires an increase in water/powder ratio and an increment in super plasticizer dosage. Both additions degraded the flow ability, consistence retention and hardening properties but not to a prohibitive extent. Limiting the content of guar gum by not greater than 2% replacement of cement and by keeping Super Plasticizer (SP) content same as 0.5% of water gives better result than normal concrete in terms of strength. Two grades of concrete i.e. M25 and M30 were tested for various percentages of GG and constant 0.5% of SP. Need to briefly discuss results in the end part of abstract.

**Keywords:** Guar Gum, Self compacting concrete, admixtures, super plasticizer

## 1. INTRODUCTION

Concrete is an adaptable material, which is widely used as a construction material in the world. It is obtained by mixing cement, water, aggregate and sometimes admixtures in required proportions. A freshly mixed material which can be molded into any shape and which hardens into a rock-like mass is known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to progressively higher compressive strength with age.

Concrete is the most preferred construction material in India. In the past five-six years, mega construction projects involving the use of concrete have been executed in the country in a large number. Some of them include construction of a large number of flyovers, Delhi metro rail, atomic and thermal power plants, golden quadrilateral road project, and reconstruction of Gujarat after 2001 earthquake. The quality and type of concrete being employed have undergone a transformation with the use of state of the art concrete technology. The recent developments in the field of concrete are Self Compacting Concrete (SCC), High Performance Concrete (HPC), Compacted Reinforced Concrete (CRC), and Reactive Powder Concrete (RPC).

The traditional concrete is uneconomical. Also, with high water to cement ratio and low workability, it is difficult to place, and is subjected to problems such as honeycombing and bleeding. To solve these problems, concrete with high workability and high durability, such as Self Compacting Concrete (SCC) has recently been developed and applied. Self-Compacting Concrete (SCC) is a special type of concrete with great self compacting ability that can fill the formwork and vacancy among reinforcement bars under its own weight without the need for vibrating compaction. Due to high fluidity of Self Compacting Concrete, it can be delivered to a larger distances by use of pipes. Due to its resistance against segregation, it can be used in under water concreting.

In this research, viscosity modifying agent and super plasticizer were used. By using particular amount of both admixtures, higher compressive strength, flexural strength and split tensile strength can be achieved. Both admixtures replaced cement content which improved flowing ability and strengthening characteristics of concrete. Self-Compacting Concrete must be highly workable so that it can move under the force of gravity without vibration, during mixing, transportation, handling, and placement. However, Self-Compacting Concrete must also be viscous enough so that the mortar suspends and carries coarse aggregate, maintaining a homogenous, stable mixture, resistant to segregation, bleeding, excessive air migration, or paste separation. It must have dynamic stability during mixing, transportation, handling and placement, and static stability during protection and curing. For Self Compacting concrete, workability is a function of its theology.

## 2. INTRODUCTION TO GUAR GUM AS A VISCOSITY MODIFYING AGENT

Guar is also known as cluster bean, a drought hardy leguminous crop. Guar is grown for seed, green fodder, vegetable and green manuring. It is an annual plant, about 4 feet high, vertically stalked, with large leaves and clusters of pods. Each pod is about 5-8 cm long and has on an average 6-9 small grayish-white pea shaped seeds. The pods are used as a green vegetable or as a cattle feed besides the industrial extraction of guar gum. Guar grows best in sandy soils. It needs moderate, intermittent rainfall with lots of sunshine. The crop is sown after the first rains in July and harvested in October- November. It is a short duration crop and is harvested within 3-4 months of its plantation. Guar is a rain dependent crop; rainfall influences the yield of the crop. Its seed consists of seed coat (14-17%), endosperm (35-42%) and germ (43-47%). It has attained an important place in industry because of its galactomannan rich endosperm.



Figure 2.1: Guar seeds and Guar powder

### 2.1 Properties of Guar Gum

The most important property of guar gum is its ability to hydrate rapidly in cold water to attain uniform and very high viscosity at relatively low concentrations. Apart from being the most cost-effective stabilizer and emulsifier, it provides texture improvement and water binding, enhances mouth feel and controls crystal formation. The main properties of guar gum are:

- It is soluble in hot & cold water but insoluble in most organic solvents.
- It has strong hydrogen bonding properties.

- It has excellent thickening, emulsion, stabilizing and film forming properties.
- It has excellent ability to control rheology by water phase management.

Chemically, guar gum is a straight chain galactomannan, which is 75-85% of the endosperm, has a chain of (1→4)-linked-β-D-mannopyranosyl units with single α-D-galactopyranosyl units connected by (1→6) linkages to, on the average, every 5 second main chain unit. The ratio of D-mannopyranosyl to D-galactopyranosyl units is about 1.8:1. The average molecular weight of guaran is in the range of  $1-2 \times 10^6$  Dalton. The cis-position is important since adjacent hydroxyl groups reinforce each other in hydrogen bonding reactions.

### 3. PROPERTIES / TESTS OF FRESH MIX OF SELF COMPACTING CONCRETE

Table 3.1: Properties/Tests of fresh mix of self-compacting concrete

| Property measured                 | Test method            | Material             | Recommended values  |
|-----------------------------------|------------------------|----------------------|---|
| Flow ability /<br>Filling ability | Slump flow             | Concrete             | 650–800mm<br>Average flow diameter                                  |
|                                   | T50                    | Concrete             | 2 – 5 sec<br>Time to flow 500 mm                                    |
|                                   | V – funnel             | Concrete /<br>mortar | 6 – 12 sec<br>Time for emptying of funnel                           |
|                                   | Orimet                 | Mortar               | 0 – 5 sec<br>Time for emptying of apparatus                         |
| Passing ability                   | U – box                | Concrete             | 0 – 30 mm<br>Difference in heights in two limbs                     |
|                                   | L – box                | Concrete             | 0.8 – 1.0<br>Ratio of heights at beginning and end of flow          |
|                                   | J - ring               | Concrete             | 0 – 10 mm<br>Difference in heights at the beginning and end of flow |
| Segregation potential             | Settlement column test | Concrete             | > 0.95 Segregation ratio  |
|                                   | Sieve stability test   | Concrete             | – 15% sample passing through 5 mm sieve                             |

### 4. EXPERIMENTS ON HARDENED SELF COMPACTING CONCRETE

Following test have been performed on cube for different proportion of powder, for M25 and M30 grades of concrete.

- Compressive Strength
- Tensile Strength
- Bond Strength
- Modulus of Elasticity
- Freeze/Thaw Resistance
- Shrinkage and Creep
- Durability
- Structural Performance

## 5. TEST RESULTS OF MATERIALS

The physical properties of cement used for the experimental work was satisfying all the criteria of IS: 12269 and IS: 4031 are as shown in Table 2.

Table 5.1: Cement test results

| Sr. No | Parameters   | Result Obtained | Requirements as per IS: 12269 (1987) |
|--------|--|-----------------|--------------------------------------|
| 1      | Fineness-Specific Surface (m <sup>2</sup> /Kg) by sieve Analysis | 285             | Minimum -225.0(m <sup>2</sup> /Kg.)  |
| 2      | Standard consistency in (%)                                      | 30%             | ---                                  |
| 3      | Setting time in Min.   |                 | ---                                  |
|        | (a) Initial setting time (Minute)                                | 47 min          | Minimum - 30 Minute                  |
|        | (b) Final setting time (Minute)                                  | 260 min         | Maximum- 600 Minute                  |
| 4      | Soundness (By Le-chat Expansion in mm)                           | 0.42 mm         | Maximum-10.00 mm                     |
| 5      | Compressive Strength in (MPa)                                    |                 | ---                                  |
|        | 3 Days   | 30.56 MPa       | Minimum- 27.00 MPa                   |
|        | 7 Days   | 39.81 MPa       | Minimum- 37.00 MPa                   |
|        | 28 Days  | 56.14 MPa       | Minimum- 53.00 MPa                   |

## 6. RESULTS

### 6.1 Strength test results obtained for M-25 grade

Table 6.1: Strength test results for M-25 grade

| Mix     | Comp. strength at 7 days | Flexural strength at 7 days | Split tensile | Comp. strength at 28 days | Flexural strength at 28 days | Split tensile |
|---------|--------------------------|-----------------------------|---------------|---------------------------|------------------------------|---------------|
| Normal  | 23.53                    | 2.17                        | 2.28          | 32.81                     | 2.78                         | 2.92          |
| 1% GG   | 22.28                    | 2.06                        | 2.13          | 29.32                     | 2.97                         | 2.68          |
| 2% GG   | 18.42                    | 1.72                        | 1.89          | 27.16                     | 2.13                         | 2.38          |
| 3% GG   | 17.71                    | 1.59                        | 1.70          | 25.55                     | 1.87                         | 2.05          |
| 0.5% SP | 23.78                    | 2.579                       | 2.34          | 33.89                     | 3.08                         | 2.87          |
| 1% SP   | 20.44                    | 2.27                        | 2.04          | 27.31                     | 2.63                         | 2.52          |

Table 6.2: Strength test results for M-25 grade

| Mix          | Comp. strength | Flexural strength | Split tensile | Comp. strength | Flexural strength | Split tensile |
|--------------|----------------|-------------------|---------------|----------------|-------------------|---------------|
| Normal       | 23.53          | 2.84              | 1.91          | 32.81          | 3.24              | 2.37          |
| 1% GG_0.5%SP | 18.45          | 2.09              | 1.41          | 27.62          | 2.13              | 1.62          |
| 2% GG_0.5%SP | 19.66          | 2.27              | 1.52          | 29.34          | 2.64              | 1.90          |
| 3% GG_0.5%SP | 21.89          | 2.49              | 1.56          | 33.96          | 2.88              | 2.14          |
| 4% GG_0.5%SP | 24.74          | 2.56              | 1.73          | 35.45          | 3.15              | 2.29          |

## 6.2 Strength test results obtained for M-30 grade

Table 6.3: Strength test results for M-25 grade

| Mix     | Comp. strength at 7 days | Flexural strength at 7 days | Split tensile at 7 days | Comp. strength at 28 days | Flexural strength at 28 days | Split tensile at 28 days |
|---------|--------------------------|-----------------------------|-------------------------|---------------------------|------------------------------|--------------------------|
| Normal  | 29.79                    | 3.09                        | 2.23                    | 42.14                     | 3.68                         | 2.72                     |
| 1% GG   | 24.35                    | 2.81                        | 1.60                    | 38.30                     | 2.92                         | 2.10                     |
| 2% GG   | 21.39                    | 2.10                        | 1.57                    | 33.80                     | 2.43                         | 2.03                     |
| 3% GG   | 19.10                    | 1.83                        | 1.32                    | 28.12                     | 2.16                         | 1.84                     |
| 0.5% SP | 26.13                    | 2.62                        | 1.51                    | 41.16                     | 2.89                         | 1.93                     |
| 1% SP   | 24.04                    | 2.29                        | 1.38                    | 38.22                     | 2.56                         | 1.78                     |

Table 6.4: Strength test results for M-25 grade

| Mix          | Comp. strength | Flexural strength | Split tensile | Comp. strength | Flexural strength | Split tensile |
|--------------|----------------|-------------------|---------------|----------------|-------------------|---------------|
| Normal       | 29.79          | 3.09              | 2.23          | 42.14          | 3.68              | 2.72          |
| 1% GG_0.5%SP | 22.52          | 2.37              | 1.72          | 36.45          | 2.40              | 1.81          |
| 2% GG_0.5%SP | 23.64          | 2.42              | 1.78          | 38.53          | 2.71              | 2.16          |
| 3% GG_0.5%SP | 27.84          | 2.76              | 2.11          | 44.66          | 3.42              | 2.43          |
| 4% GG_0.5%SP | 30.38          | 3.14              | 2.19          | 47.29          | 3.50              | 2.60          |

## 7. CONCLUSION

As per objective of study, experimental work was carried out to achieve different physical properties by varying Guar Gum content with or without super plasticizer.

It can be seen that by adding super plasticizer content compressive strength, flexural strength and split tensile strength increases. The same decreases without super plasticizer.

At 7 days, mixture of (3% Guar Gum + 0.5% SP) and (4% Guar Gum + 0.5%SP) gave higher compressive strength, but flexural strength and split tensile strength were reported to be lower than conventional concrete.

At 28 days, compressive strength for mixture of (3% Guar Gum + 0.5% SP) and (4% Guar Gum + 0.5%SP) was higher. On the other hand, flexural strength and split tensile strength for (4% Guar Gum + 0.5%SP) were found to be almost same as that for conventional strength.

Workability results indicated that by adding Guar Gum Content T50 time concrete flow increases and flow spread decreases.

For (1% Guar Gum + 0.5% SP), flow ability of concrete was found to be more than any other mix proportions.

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# **PROPERTIES AND INDUSTRIAL APPLICATIONS OF RICE HUSK**

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**Abstract:** This research paper focuses on utilization of rice husk ash for the production of porcelain. Due to the fast polluting environment there is an increasing demand for durable construction materials. Rice is a great example of alternate material. Rice husk is a byproduct of rice milling industry. It constitutes about 50% cellulose, 30% lignin, and 20% of silica. This rice husk can be used as great source of fuel. When it is burnt under specific set of temperature and conditions lignin and cellulose are removed and only rice husk ash which is also known as RHA is obtained. This obtained RHA contains approximate 95% of silica. This silica can be used for the production of porcelain. These RHA produced porcelain to be more effective supplementary material as it is economical, less costly, strong and durable Both rice husk (RH) and Considering the importance and increasing demand of this material, a systematic study based on properties and industrial applications has been carried out and reviewed in this paper. Potential and suitability of RH for use in possible new areas in near future has also been highlighted.

*Keywords:* Rice Husk; Durability, porcelain, rice husk, RHA (Rice Husk Ash), silica

## **1. INTRODUCTION**

Rice husk is one of the most widely available agricultural wastes in many rice producing countries around the world. Globally, approximately 600 million tons of rice paddy is produced each year. On average 20% of the rice paddy is husk, giving an annual total production of 120 million tones RHA is a great environment threat causing damage to land and surrounding area where it is dumped. Therefore, commercial use of rice husk and its ash is the alternative solution to disposal problem. In this paper we have discussed a preliminary analysis of the numerous reported properties and uses of rice husk and its ash. Attempt has been made to collect data and information from various research work related to RH and RHA. Recent studies in literature have been covered in the past on rice husk. Also various research papers have been published on the use of rice husk. One of the example of such type of work is the use of rice husk in production of concrete blocks. Current situation demands of more durable and environment friendly materials due to polluting environment.

Small sector process industries use fixed low capacity boilers, which are manually fired using rice husk as a fuel. Partial and uneven fuel combustion lead to smoke emission and decrease the fuel efficiency. As husks are available virtually for free, the boiler efficiency and the degree of combustion were the issues of receiving the latest attention. Plants with capacity 2-10 MW range can become commercially viable and this biomass resource can be utilized to a much greater extent than at present. It has been seen that to produce 1MWh, approximately 1 tonne of rice husk is required. So, the technical and economic factors decide the effective use of rice husk as fuel for power generation. Also, rice husk has been used as a useful and alternative fuel for household energy. RH is also used as fuel in brick kilns, in furnaces etc.

## 2. PROPERTIES

Rice husk pyrolysis at different temperature Rice husk contains 75-90 % organic matter such as cellulose, lignin etc. and rest mineral components such as silica, alkalis and trace elements a typical analysis of rice husk is shown in table 1. The content of each of them depends on rice variety, soil chemistry, climatic conditions, and even the geographic localization of the culture [5]. Table 1 Typical analysis of rice husk [6] Property Range Bulk density (kg/m<sup>3</sup>) 96-160 Hardness (Mohr's scale) 5-6 Ash, % 22-29 Carbon, %  $\approx$  35 Hydrogen, % 4-5 Oxygen, % 31-37 Nitrogen, % 0.23-0.32 Sulphur, % 0.04-0.08 Moisture 8-9

Table 1: Typical analysis of rice husk

| Property                          | Range        |
|-----------------------------------|--------------|
| Bulk density (kg/m <sup>3</sup> ) | 96-160       |
| Hardness(Mohr's scale)            | 5-6          |
| Ash,%                             | 22-29        |
| Carbon, %                         | $\approx$ 35 |
| Hydrogen,%                        | 4-5          |
| Oxygen,%                          | 31-37        |
| Nitrogen,%                        |              |
| Sulphur,%                         | 0.04-0.08    |

Rice husk is an agricultural residue or the byproduct of rice milling industry. The chemical composition of different rice samples is found to be varying due to difference in climatic conditions, About 650 million of rice is produced worldwide of which 20% is obtained as rice husk. The present conditions of world Demands greatly for the use of durable materials which is also strong. Rice husk is a great example of such material. Burning the rice under controlled conditions at temperature below 800? C produced silica in amorphous form. This silica can be utilized for constructional works. In the production of porcelain around 20% silica is required. This demand can be full filled from rice husk.

## 3. APPLICATION OF HUSK

Suitability of RH to be used for different applications depends upon the physical and chemical properties of the husk such as ash content, silica content etc. Direct use of rice husk as fuel has been seen in power plants. Apart from its use as fuel, RH finds its use as source raw material for synthesis and development of new phases and compounds. A detailed description related to application of rice husk in industrial sectors as well as other fields has been given below.

### 3.1 As a fuel in power plant

Rice husk is mostly used as fuel in boilers for processing paddy and generation of process steam. Heat energy is produced through direct combustion. Small sector process industries use fixed low capacity boilers, which are manually fired using rice husk as a fuel. Partial and uneven fuel combustion lead to smoke emission and decrease the fuel efficiency. As husks are available virtually for free, the boiler efficiency and the degree of combustion were the issues of receiving the latest attention. Plants with capacity 2-10 MW range can become

commercially viable and this biomass resource can be utilized to a much greater extent than at present. It has been seen that to produce 1MWh, approximately 1 tonne of rice husk is required. So, the technical and economic factors decide the effective use of rice husk as fuel for power generation. Also, rice husk has been used as an useful and alternative fuel for household energy.

### **3.2. Use in ceramic and refractory industry**

Rice husk ash is used in the manufacture of refractory bricks because of its insulating properties. It has been used in the manufacture of low-cost, lightweight insulating boards. RHA has been used as silica source for cordierite production. Replacement of kaolinite with rice husk silica in the mixture composition, yields higher cordierites with a lower crystallize temperature and decrease in activation energy of crystallization.

### **3.3. Insulating fire brick using RH**

Bricks made using rice husk develop plenty of pores during heat treatment due to burning out of organic material. The more the percentage of rice husk in a brick, the more porous would be the brick and better thermal insulation. Presences of entrapped air in pores have thermal insulating characteristics and thus make the porous fire brick structure suitable for back up insulation.

### **3.4 RHA in steel industry**

RHA is used during the production of high quality flat steel. The ash also finds application as an excellent insulator, having fine insulating properties including low thermal conductivity, a high melting point, low bulk density and high porosity. It is used as "tundish powder" to insulate the tundish container, prevent rapid cooling of steel and ensure uniform solidification in casting process. RHA is also used as a coating over the molten metal in the tundish and in ladle which acts as a very good insulator and does not allow quick cooling of metal.

### **3.5 Use of RHA as silica source**

Due to presence of large silica content in ash, extraction of silica is economical. Silica is also precipitated in customized forms to meet the requirements of various uses. Some of the uses of silica are in rubber industry as reinforcing agent, in cosmetics, in toothpastes as a cleansing agent and in the food industry as an anti-caking agent There is a growing demand for fine amorphous silica in the production of high performance cement and concrete, use in bridges, marine environments.

### **3.6 RHA in cement and construction industries**

The increasing need for stronger and durable building materials has been to some extent fulfilled by a new concept i.e., blended cement. Blending of reactive rice husk ash in cement has become a common recommendation almost in all the international building codes. Extensive research has been carried out on application of RHA as mineral additive to improve performance of concrete. Reports indicated RHA as a highly reactive pozzolana RHA is mainly used a replacement of silica fume or as an admixture in manufacturing of low cost concrete block.

### **3.7 Other uses**

RH is used as a raw material for production of xylitol, furfural, ethanol, acetic acid, lingo sulphonic acids. It is used as cleaning or polishing agent in metal and machine industry, in manufacturing of building materials etc. RH has been used as an industrial raw material e.g. as an insulating board material, fillers in plastics, filling material, building materials, for making panel board, activated carbon etc. Little effort has been made to manufacture composite products based on two surface structure of rice husk. Despite so many well established uses, little portion of rice husk produced is utilized in a meaningful way, remaining part is allowed to burn in open piles or dumped as a solid waste. Rice Husk ash finds large number of industrial applications which are described below.

## **4. MARKETS WITH POTENTIAL IN THE FUTURE**

As already described above, RH and its ash are suitable materials for a wide range of industrial as well as research applications. In consideration with its low cost and easy availability, application of RH and RHA is still limited and there is tremendous potential of this material for use in upcoming industrial processing and technology. Potential future markets include manufacturing of silicon chip, synthesis of activated carbon, production of light weight construction materials and insulation etc. Small markets exist for RHA in the manufacture of refractory bricks and as oil absorbent which can be expanded in to a large volume market. Though RHA finds largest and most commercially viable markets in cement, concrete and steel industries, constraints to the expansion of this market is due to the health issues associated with using crystalline ash and hence there is a great potential for use of amorphous RHA in these area.

### **4.1 Other applications**

Basha, et al examined the possibilities of improving residual soil properties by mixing RHA and cement in suitable proportions as stabilizing agents. Indian Space Research Organization has successfully developed a technology for producing high purity silica from RHA that can be used in manufacturing of silicon chip in industry ref. Saha, et al studied the possibility of using RHA in water purification. Attempts have been made to utilize RHA in vulcanizing rubber H Ismail et al studied use of Rice Husk to synthesize High-Performance Phosphors. Other uses of RH are in control of insect pests in Stored Food Stuffs, in the water purification, in vulcanizing rubber, as flue gas desulphurization absorbents. RHA has been found to be effective as an oil spill absorbent, and for use in waterproofing chemicals, flame retardants, and as a carrier for pesticides and insecticides. Its absorbent and insulating properties are useful to many industrial applications.

## **5. CONCLUSIONS**

Rice husk has been used directly or in the form of ash either as a value added material for manufacturing and synthesizing new materials or as a low cost substitute material for modifying the properties of existing products. Presence of silica is an additional advantage in comparison to other byproduct materials which makes RH an important material for a wide range of manufacturing and application oriented processes. Easy availability and low price of rice husk in rice producing countries is an extra benefit towards the use of this material. Despite having high potential and suitability in so many well established uses, use of rice

husk has been limited. In the competitive market, proper utilization of rice husk and its ash will benefit industrial sectors. The use of rice husk as fuel/electricity generation in efficient manner is likely to transform this agricultural waste material in to a valuable fuel for industrial sectors. A systematic approach to this material can give birth to a new industrial sector of rice husk.

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**WATER SUPPLY SCHEME TO PROVIDE**  
**24 X 7 WATER**  
**CASE STUDY: SCIENCE CITY AREA (ZONE-I), AHMEDABAD**

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**Abstract:** 24x7 water can deliver improved water quality and optimum quantity to all urban consumers with a reduction in coping costs, health burden and also reduce burden on water recourses. The problem with intermittent water supply is that it leads to serious public health issues and weakens the system by leakages. Efficiency of water supply system is of primary importance in designing either new water distribution networks or expanding existing ones. Water distribution network, a hydraulic infrastructure consisting of elements such as pipes, tanks, reservoirs, pumps, and valves etc., is crucial to provide water to the consumers. In the light of above, aim of the present study is to design the water supply scheme for 24x7 water supply using EPANET - a computer based program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks.

**Keywords:** Unaccounted For Water (UFW); Continuous Water Supply (CWS); Intermittent Water Supply (IWS); Central Public Health and Environmental Engineering Organization (CPHEEO), Liters Per Capita per Day (LPCD)

## 1. INTRODUCTION-WATER CONSUMPTION

Domestic water use/demand is a complex function of socio-economic characteristics, climatic factors and public water policies and strategies (Babel 2007).<sup>[1]</sup> Water consumption is defined as the amount of water actually supplied (or estimated to be supplied) for some (legitimate) purpose whereas demand indicates the amount of water estimated to be required for the purpose. Gross consumption is inclusive of distribution losses, which include leakage and wastage that frequently reach values of 30% or even 40% from all drinking water supply system (Araujo 2006).<sup>[2]</sup> Unaccounted for water (UFW) which is also known as non-revenue water is defined as the difference between water produced and supplied to the distribution system.<sup>[3]</sup> Water which is not accounted for separately like distribution leakages from main valves, service pipe connections etc. and unmetered supplies are the distribution losses. Leakage from trunk mains and service reservoirs can often be measured directly, but this is not the case with distribution system. For practical purposes, the best measure of leakage is obtained from minimum night flow (during which no legitimate water requirement is anticipated) modified by subtracting the known metered consumption (Andey and Kelkar 2007; Tabesh 2008).<sup>[4][5]</sup>

Water consumption by a community depends on number of factors like season, climate, cultural habits and local customs. The seasonal variation in the daily demand may vary from  $\pm 10\%$  to 30% of the average daily demand for the year. The hourly variations in water demand during the day is much greater compared to the average daily demand. Generally water requirement is more during morning and evening hours than the noon demand. As far as the design of distribution system is concerned, hourly variation in demand has an influence on the residual pressures in the system. These fluctuations in demand are

accounted for by peak factor at the design stage. A water distribution system is designed to supply the maximum hourly demand. In developing countries the water distribution systems are designed for continuous water supply (CWS) with peak factors in the range of 2.0 to 3.0 as per central public health and environmental engineering organization (CPHEEO)-1999 [12] where as in actual practice due to non-availability of adequate quantity of water at source and financial constraints, it is not practically possible to operate drinking water systems for 24 hr/day (Rajiv 2003). [6] So despite considerable negative impacts, the distribution systems are operated on intermittent mode, resulting in inequitable water flow and pressures in the system (Vairavamoorthy and Elango 2002; Totsuka 2004). [7][8]

Intermittent water supply (IWS) creates high peak factors in the distribution system which causes low pressures at a number of locations. People are required to store water in their houses for the whole day consumption. Most people living in cities would like to be connected to a 24-hr supply of piped water (Joshi 2002). [9] In most Asian cities, less than 30% of the residents are enjoying 24-hr water supply. Low service coverage and intermittent supply have become a norm rather than exemption (Seetharam 2005). [10]

### 1.1 24x7 is achievable

24x7 water supply is achievable. The best example can be seen at foreign countries like Australia, Colombo, France, Indonesia and United Kingdom as well at many places in our country like Belgaum, Gulbarga, Hubli-Dharwar in Karnataka and Nagpur, that a well-operated water supply system can deliver water supply for 24 hours a day, seven days a week, in Indian cities, bringing an affordable, reliable service to urban households including the poorest. Poor water service levels have led to consumers adopting expensive coping strategies that include installing underground storage tanks and household filters. Those without a connection have to queue at stand posts with the additional burden of often not knowing to the nearest day when water may come. [11]

What is 24x7 water supply? 24x7 supply is achieved when water is delivered continuously to every consumer of the service 24 hours a day, every day of the year, through a transmission and distribution system that is continuously full and under positive pressure. The minimum consumption of water is 135 liters per capita per day (LPCD). Break-up of minimum domestic water supply standard as per CPHEEO manual is as shown below in Table 1.1.

Table 1.1 Break-up of minimum domestic water supply

| Use/Activity                              | Amount (LPCD) | Percentage of Total |
|---|---------------|---------------------|
| Drinking & Cooking                        | 15            | 10 %                |
| Bathing, Washing clothes, vessels & floor | 75            | 55 %                |
| Flushing toilet                           | 45            | 35 %                |
| Total                                     | 135           | 100 %               |

## 2. PILOT PROJECT AT SCIENCE CITY

Ahmedabad is growing towards its peripheral area like any other developing city. New west zone is developing in fast pace like Jodhpur area, of Ahmedabad city. Science city area and Bhopal are the two parts developing in too fast rate these days. To make the project landmark and setting an example for entire city, Science city area have been selected as the study area as the area is well planned with defined town planning schemes and detailed road network. There is also chance of development of water supply system and sewerage system

for future development. Whereas Bhopal is haphazardly growing without any town planning schemes (TPS). In Science city area initial development at present and in the future is around the Sarkej-Gandhinagar (S.G.) highway and Sardar Patel (S.P.) ring road is anticipated to be a combination of convenience facilities such as: highly residential and commercial units, school, colleges, hospitals, hotels and restaurants etc. The major attraction of the place is “Science City”, a scientific marvel, a must to visit. With an objective to create conceptual framework to provide continuous water supply to the end-users and provide a methodology to calculate water requirement, water supply timing, and pressure in water distribution network.

## 2.1 Methodology

- Collection of data like latest population from census record for the science city area
- To study existing water supply scheme and present water distribution network scenario
- Forecasting the future demand of water estimating future population growth
- Preparing the new network map of the whole area
- Designing the water supply network for 24x7 using EPANET
- Assessing the advantage of continuous water supply from intermittent water supply

## 2.2 Data collection for reduce level at junction points & Zone-wise R.L. at the nodes

The town planning scheme is planned by Ahmedabad Municipal Corporation (AMC), which includes the layout and dimensions of plot, sub-plots and road net-work. Every intersection of the road is defined as node/junction and network path is chosen according to the reduced level (R.L.) of the ground. The R.L. at the node/junctions were taken from the Google Earth by super imposing the AutoCAD drawing on the Google earth image as shown below in Figure 1.1.

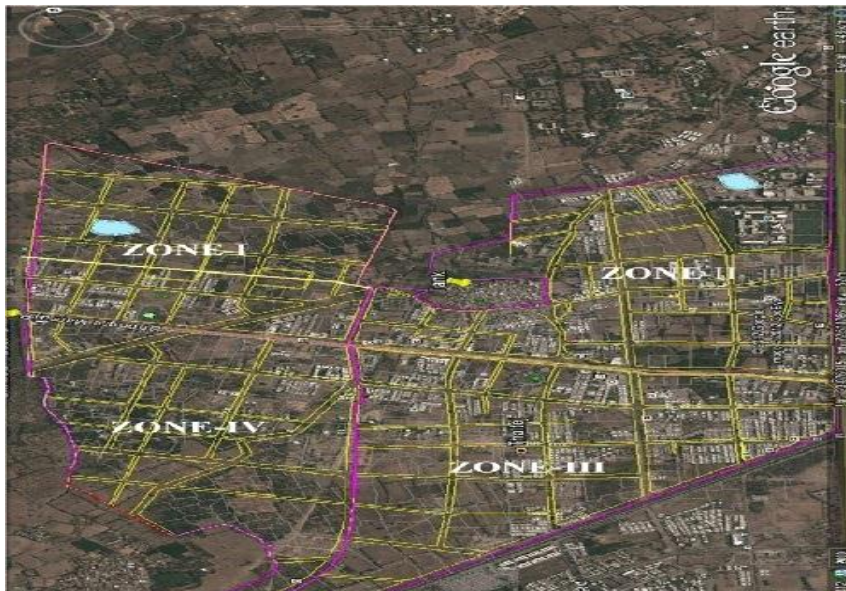


Figure 2.1 AutoCAD drawing superimposed on Google Earth

The R.L. is marked in meters for Zone- I to IV is as shown below in Table 3.4 to 3.7 respectively. To check the feasibility of the study R.L.’s were taken from Google earth and checked at few node/junctions on site. Table 1.2 Node and Level at Zone-1

Table 2.1 Node and Level at Zone-1

|      |           |      |           |
|------|-----------|------|-----------|
| Node | Level (m) | Node | Level (m) |
| 1    | 52.00     | 17   | 50.00     |
| 2    | 52.00     | 18   | 50.00     |
| 3    | 50.00     | 19   | 48.00     |
| Node | Level (m) | Node | Level (m) |
| 4    | 52.00     | 20   | 51.00     |
| 5    | 51.00     | 21   | 52.00     |
| 6    | 51.00     | 22   | 52.00     |
| Node | Level (m) | Node | Level (m) |
| 7    | 52.00     | 23   | 51.00     |
| 8    | 50.00     | 24   | 49.00     |
| 9    | 51.00     | 25   | 51.00     |
| 10   | 50.00     | 26   | 53.00     |
| 11   | 49.00     | 27   | 52.00     |
| Node | Level (m) | Node | Level (m) |
| 12   | 50.00     | 28   | 52.00     |
| 13   | 50.00     | 29   | 49.00     |
| 14   | 51.00     | 30   | 52.00     |
| 15   | 50.00     | 31   | 51.00     |
| 16   | 50.00     | 32   | 51.00     |

### 2.3 Length of pipe

The length of pipe is taken with the help of Google Earth. Like R.L.'s even the length of the pipe were cross checked at the site and rectified. The length of pipe for the water distribution network for Zone-I in Table 1.3

Table 2.2 Length of pipe for the water distribution network for Zone-I

| From | Node | Length (m) | From | Node | Length (m) |
|------|------|------------|------|------|------------|
|      | 1    |            | 13   | 17   | 100.00     |
| 1    | 2    | 35.00      | 15   | 18   | 256.00     |
| 2    | 3    | 270.00     | 18   | 19   | 666.00     |
| 2    | 4    | 85.00      | 18   | 20   | 270.00     |
| 4    | 5    | 90.00      | 20   | 21   | 621.00     |
| 5    | 6    | 175.00     | 20   | 22   | 156.00     |
| 6    | 7    | 197.00     | 22   | 23   | 642.00     |
| 7    | 8    | 270.00     | 7    | 24   | 260.00     |
| 6    | 9    | 260.00     | 24   | 25   | 404.00     |
| 5    | 10   | 250.00     | 24   | 26   | 280.00     |
| 5    | 11   | 90.00      | 26   | 27   | 443.00     |
| 6    | 12   | 100.00     | 26   | 28   | 220.00     |
| 4    | 13   | 250.00     | 28   | 29   | 215.00     |
| 13   | 14   | 168.00     | 29   | 30   | 150.00     |
| 13   | 15   | 192.00     | 29   | 31   | 250.00     |
| 15   | 16   | 140.00     | 31   | 32   | 110.00     |

### 2.4 Design Period

It is envisaged the design period shall take 1 year and 2-3 years for construction activities. Design life for any civil engineering project is thirty years at max and also the investment in cost of construction is also huge so the project has to be divided into phases. So population projection is been considered for 2021, accordingly 2031 shall be the intermediate year and 2041 shall the ultimate design year for this project. The analysis has been done for the population projected for intermediate year.

- Design period is estimated based on the following:
- Useful lives of the component, considering obsolescence, wear, tear, etc.
- Expandability aspect
- Anticipated rate of growth of population, including industrial, commercial developments & migration-immigration
- Available resources
- Performance of the system during initial period

### 2.5 Total Water Demand at Science City

Since Science City Area is expanding at high rate with piped network of water supply for the near future, the residential demand of 180 LPCD has been taken into consideration while for floating population 15 LPCD has been taken into consideration. The total water demand including floating demand, fire demand and losses for various stages of design, for the place is calculated as shown below in Table 2.1.

Table 2.3: Total water demand for Science city area

| Year | Population Considered | Floating Population | Water Demand @ 180 lpcd | Distribution Losses, 15% UFW | Transmission Losses, 2% | Treatment Losses, 2% | Source Losses, 1% | Floating Population Demand @ 15 lpcd | Total Demand, MLD | Fire Demand, MLD | Total Demand at Source, MLD | WTP Capacity, MLD (Excluding 1% Source Losses) |
|------|-----------------------|---------------------|-------------------------|------------------------------|-------------------------|----------------------|-------------------|--------------------------------------|-------------------|------------------|-----------------------------|--|
| 2011 | 100,000               | 10,000              | 18.00                   | 21.18                        | 21.69                   | 22.22                | 22.50             | 0.19                                 | 22.69             | 1.000            | 23.6875                     | 23.451   |
| 2021 | 150,475               | 10,000              | 27.09                   | 31.87                        | 32.63                   | 33.44                | 33.86             | 0.19                                 | 34.04             | 1.227            | 35.2711                     | 34.918   |
| 2031 | 223,255               | 10,000              | 40.19                   | 47.28                        | 48.42                   | 49.61                | 50.23             | 0.19                                 | 50.42             | 1.494            | 51.9140                     | 51.395   |
| 2041 | 318,340               | 10,000              | 57.30                   | 67.41                        | 69.04                   | 70.74                | 71.63             | 0.19                                 | 71.81             | 1.784            | 73.5982                     | 72.862   |

The town planning scheme (TPS) is planned by the local authority for some portion of Science city area, which includes layout and dimension of plots and sub plots with road network. For expanding zones, new road networks have been considered. Based on the pre-define road networks, the proposed water distribution network (WDN) have been defined. At every intersection or some critical location of the pipe network of water system is define as node/junction. The base demand on each node is calculated depending upon the forecasted population served by that node and per capita demand per day. The base demand is calculated by considering the projected population at every node for all zones. So, we have base demand at Zone-I 94.01 LPS

### 3. ANALYSIS AND DESIGN FOR ZONE-I

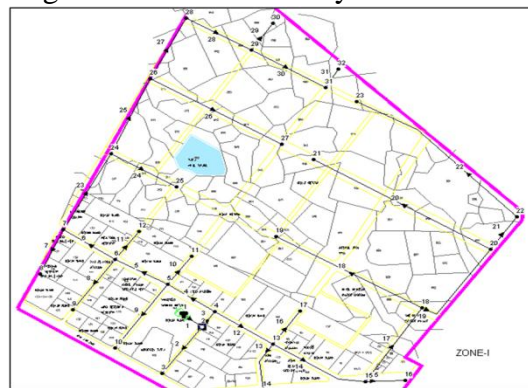
The Table 2.2 below shows the detail analysis of the Zone-I. Population considered for the Zone-I is 44858 by considering the area of Zone-1 and demand consideration in that area.

Table 3.1: Detailed analysis of Zone 1

| From | Node | Length | Level | Population | Rate | Lpcd      | Lps  |
|------|------|--------|-------|------------|------|-----------|------|
|      | 1    | 0.00   | 52.00 | 0          | 180  | 0.00      | 0.00 |
| 1    | 2    | 35.00  | 52.00 | 206        | 180  | 37111.41  | 0.43 |
| 2    | 3    | 270.00 | 50.00 | 1590       | 180  | 286288.02 | 3.31 |
| 2    | 4    | 85.00  | 52.00 | 501        | 180  | 90127.71  | 1.04 |
| 4    | 5    | 90.00  | 51.00 | 530        | 180  | 95429.34  | 1.10 |
| 5    | 6    | 175.00 | 51.00 | 1031       | 180  | 185557.05 | 2.15 |
| 6    | 7    | 197.00 | 52.00 | 1160       | 180  | 208884.22 | 2.42 |
| 7    | 8    | 270.00 | 50.00 | 1590       | 180  | 286288.02 | 3.31 |
| 6    | 9    | 260.00 | 51.00 | 1532       | 180  | 275684.76 | 3.19 |
| 5    | 10   | 250.00 | 50.00 | 1473       | 180  | 265081.50 | 3.07 |
| 5    | 11   | 90.00  | 49.00 | 530        | 180  | 95429.34  | 1.10 |
| 6    | 12   | 100.00 | 50.00 | 589        | 180  | 106032.60 | 1.23 |
| 4    | 13   | 250.00 | 50.00 | 1473       | 180  | 265081.50 | 3.07 |
| 13   | 14   | 168.00 | 51.00 | 990        | 180  | 178134.77 | 2.06 |
| 13   | 15   | 192.00 | 50.00 | 1131       | 180  | 203582.59 | 2.36 |
| 15   | 16   | 140.00 | 50.00 | 825        | 180  | 148445.64 | 1.72 |

| From | Node | Length | Level | Population | Rate | Lpcd      | Lps  |
|------|------|--------|-------|------------|------|-----------|------|
| 13   | 17   | 100.00 | 50.00 | 589        | 180  | 106032.60 | 1.23 |
| 15   | 18   | 256.00 | 50.00 | 1508       | 180  | 271443.46 | 3.14 |
| 18   | 19   | 666.00 | 48.00 | 3923       | 180  | 706177.12 | 8.17 |
| 18   | 20   | 270.00 | 51.00 | 1590       | 180  | 286288.02 | 3.31 |
| 20   | 21   | 621.00 | 52.00 | 3658       | 180  | 658462.45 | 7.62 |
| 20   | 22   | 156.00 | 52.00 | 919        | 180  | 165410.86 | 1.91 |
| 22   | 23   | 642.00 | 51.00 | 3782       | 180  | 680729.29 | 7.88 |
| 7    | 24   | 260.00 | 49.00 | 1532       | 180  | 275684.76 | 3.19 |
| 24   | 25   | 404.00 | 51.00 | 2380       | 180  | 428371.70 | 4.96 |
| 24   | 26   | 280.00 | 53.00 | 1649       | 180  | 296891.28 | 3.44 |
| 26   | 27   | 443.00 | 52.00 | 2610       | 180  | 469724.42 | 5.44 |
| 26   | 28   | 220.00 | 52.00 | 1296       | 180  | 233271.72 | 2.70 |
| 28   | 29   | 215.00 | 49.00 | 1267       | 180  | 227970.09 | 2.64 |
| 29   | 30   | 150.00 | 52.00 | 884        | 180  | 159048.90 | 1.84 |
| 29   | 31   | 250.00 | 51.00 | 1473       | 180  | 265081.50 | 3.07 |
| 31   | 32   | 110.00 | 51.00 | 648        | 180  | 116635.86 | 1.35 |

Figure 3.1: Detailed analysis of Zone 1



## 4. CONCLUSION

Based on data collection from various sources and finalized layout of water distribution system for all zones and using computer software EPANET the finalization of diameter of pipes of the 24 x 7 water distribution system is designed by keeping head loss and pressure within acceptable limits.

### 4.1 Result Of Zone-I

The area of Zone-I is 1.30 sq.km. with total length of pipe network of 7615.00 m. This zone includes residential and even commercial units on the stretch of main road. This zone has Swaminarayan School with hostel facility in-built, hospital and also medical and engineering college. Thus base demand has been considered for the each node of the zone accordingly.

Table 4.1: Network table showing nodal analysis details for Zone-I

| Node ID | Elevation (m) | Base Demand (LPS) | Head (m) | Pressure (m) |
|---------|---------------|-------------------|----------|--------------|
| Junc 2  | 52            | 0.43              | 74.85    | 22.85        |

| Node ID | Elevation (m) | Base Demand (LPS) | Head (m) | Pressure (m) |
|---------|---------------|-------------------|----------|--------------|
| Junc 3  | 50            | 3.31              | 74.83    | 24.83        |
| Junc 4  | 52            | 1.04              | 74.5     | 22.5         |
| Junc 5  | 51            | 1.66              | 74.39    | 23.39        |
| Junc 6  | 51            | 2.15              | 74.23    | 23.23        |
| Junc 7  | 52            | 2.42              | 74.09    | 22.09        |
| Junc 8  | 50            | 3.31              | 73.94    | 23.94        |
| Junc 9  | 51            | 3.19              | 74.09    | 23.09        |
| Junc 10 | 50            | 3.07              | 74.36    | 24.36        |
| Junc 11 | 49            | 1.1               | 74.34    | 25.34        |
| Junc 12 | 50            | 1.23              | 74.16    | 24.16        |
| Junc 13 | 50            | 3.07              | 74.25    | 24.25        |
| Junc 14 | 51            | 2.06              | 73.97    | 22.97        |
| Junc 15 | 50            | 2.36              | 74.1     | 24.1         |
| Junc 16 | 50            | 1.72              | 74.08    | 24.08        |
| Junc 17 | 50            | 1.23              | 74.24    | 24.24        |
| Junc 18 | 50            | 3.14              | 73.78    | 23.78        |
| Junc 19 | 48            | 8.17              | 73.62    | 25.62        |
| Junc 20 | 51            | 3.31              | 73.41    | 22.41        |
| Junc 21 | 52            | 7.62              | 73.01    | 21.01        |
| Junc 22 | 52            | 1.91              | 73.35    | 21.35        |
| Junc 23 | 51            | 7.88              | 73.21    | 22.21        |
| Junc 24 | 49            | 3.19              | 73.82    | 24.82        |
| Junc 25 | 51            | 4.96              | 73.71    | 22.71        |
| Junc 26 | 53            | 3.44              | 73.45    | 20.45        |
| Junc 27 | 52            | 5.44              | 73.29    | 21.29        |
| Junc 28 | 52            | 2.7               | 73.34    | 21.34        |
| Junc 29 | 49            | 2.64              | 73.28    | 24.28        |
| Junc 30 | 52            | 1.84              | 73.08    | 21.08        |
| Junc 31 | 51            | 3.07              | 73.22    | 22.22        |
| Junc 32 | 51            | 1.35              | 73.14    | 22.14        |
| Tank 1  | 65            | 94.01             | 75.00    | 10.00        |

To describe the outcome of the analysis performed in the design zone various templates with different combination are shown in Fig. 3.1 to 3.5. Elevation, length, base demand, diameter, head, velocity, pressure and unit head loss have been highlighted in the charts with the direction of flow of water in the entire network for Zone-I.

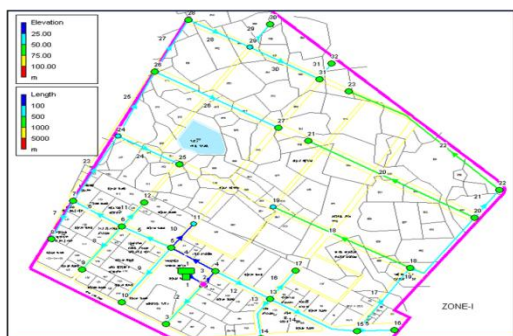


Figure 4.1: Template for Elevation – Length for Zone-I

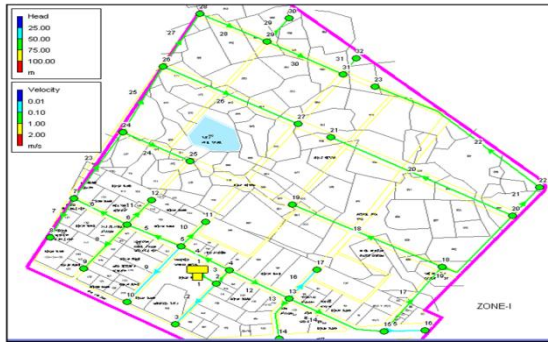


Figure 4.2: Template for Base demand – Diameter for Zone-I



Figure 4.3: Template for Head – Velocity for Zone-I

Figure 4.4: Template for Pressure – Unit head loss for Zone-I

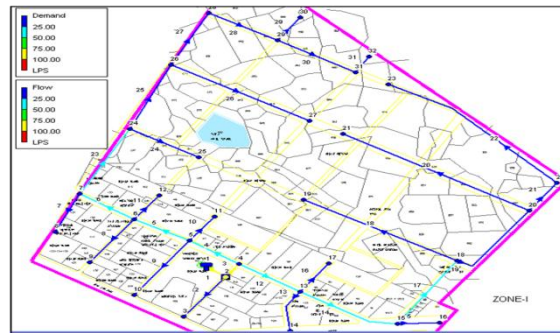


Figure 4.5: Template for Demand – Flow for Zone-I

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## 7. APPENDIX

Table 7.1: Details of site visit and data collection

| Sr. No. | Concern Person                          | Purpose of visit     | Place of visit | Remark   |
|---------|---|----------------------|----------------|--|
| 1.      | Mr. R.S. Pujara,<br>Prof. Pratima Singh | Site visit           | Jaspur         | Site visit to Jaspur WTP   |
| 2.      | Mr. Mayur Patel                         | Information          | AMC, city      | Understand water supply in Ahmedabad   |
| 3.      | Mr. R.B. Rathod                         | Submission of letter | AMC, Bodekdev  | Submission of letter for permission of data collection   |
| 4.      | Mr. R.B. Rathod                         | Information          | AMC, Bodekdev  | Got permission to collect data from Ognaj, AMC   |
| 5.      | Mr. Vipul Gandhi                        | Data collection      | AMC, Ognaj     | Acquired map of science city area with existing network distribution                                   |
| 6.      | Mr. Mayur Patel                         | Data collection      | AMC, Ognaj     | Collected data regarding nos. and capacity of ESR and sump   |
| 7.      | Mr. R.B. Rathod                         | Presentation         | AMC, Bodekdev  | Presented presentation to Mr. R.B. Rathod and his team giving awareness about continuous water supply. |

| Sr. No. | Concern Person       | Purpose of visit | Place of visit                        | Remark                           |
|---------|----------------------|------------------|---------------------------------------|----------------------------------|
| 8       | Mr. Mangesh Kumbhare | Data collection  | Census Department Office, Gandhinagar | Collection of population census. |

## COMPARISON OF RCC AND LOAD BEARING STRUCTURE FOR THE SAME GROUND CONDITION

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### **Abstract**

Comparison between RCC framed structure and Load bearing structure has always been an important issue for both Structural engineers and Architects. In real times RCC structures have completely replaced Load bearing structures because of its high strength, durability and also due to its economy in very large projects. But in small scale projects, there lies confusion in choosing between RCC framed and Load Bearing structure. For defining the best of the above two construction techniques we have chosen this project. Project includes the detailed study of RCC framed and Load bearing structure for the same ground condition. Estimation of the quantities of raw materials in both construction methods have been carried out. Also the costing has been done as per new SOR copy 2008-2009. The Site is located in R2 zone as per the bylaws of the AUDA. It has been found that the soil has bearing capacity of 15 ton/m<sup>2</sup>. The report is regarding the issue between these two methods of construction and choosing the best of them. So there are few solutions based on economy and strength is concluded in this project. Cost of both construction methods have been carried out in this project.

**Keywords: RCC (Reinforced cement concrete), Load Bearing, Quantity, Strength, Economy.**

### **I.INTRODUCTION**

It is well known that conventionally civil engineers were using bricks as units of building construction. From ancient Egyptian structures we can notice that the stones are the main units of the construction work. The brick work used with cement or lime mortar is known as Masonry work. Masonry work is usually adopted generally in rural area in the past. But now it has been replaced by the RCC work. The main advantage of the load bearing structure is its ease in designing the structure and the easy availability of materials. Reinforced concrete is concrete in which reinforcement bars ("rebar"), reinforcement grids, plates or fibres have been incorporated to strengthen the concrete in tension. Other materials used to reinforce concrete can be organic and inorganic fibres as well as composites in different forms. Concrete is strong in compression, but weak in tension, thus adding reinforcement increases the strength in tension. For a strong, ductile and durable construction the reinforcement shall have the following properties: High strength, High tensile strain, Good bond to the concrete, Thermal compatibility, Durability in the concrete environment. An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer, in such a structure takes place from the slabs to the beams, from the beams to the columns and then to the lower columns and finally to the foundation which

in turn transfers it to the soil. However, for a load bearing structure, the loads are directly transferred to the soil through the walls that are designed to specifically carry the loads.

As far as we are concerned about our Industrial problem, we have a sample of soil on the site of "Ohmkar Streets". The structure we have to design according to one of above type is going to be used for the residential purpose. The site is located in R2 zone as per the bye laws of the AUDA. The building is a G+3 storey building. On the basis of the Soil Bearing Capacity, the construction at the site should be Load bearing or RCC Framed is found out. The soil samples have been tested for different depths up to 6 m. It has been found that the soil has bearing capacity of 15 Tons/m<sup>2</sup>. The soil stratum at the site is Loose or Soft soil. Estimation of the cost of the building is found out. The comparative study is done on the basis of two parameters, which are: (1) Economy (2) Strength.

## II. QUANTITY AND COST COMPARISON OF RCC AND LOAD BEARING STRUCTURE BASED ON ECONOMY

Quantity required for different materials like sand for filling, cement, concrete, reinforcement, bricks etc. are found out. Comparison of quantity of different materials for R.C.C. framed structure as well as Load bearing structure is shown in table 2.1.

| Sr. No. | Quantity Required for | R.C.C. Framed Structure | Load Bearing Structure |
|---------|-----------------------|-------------------------|------------------------|
| 1       | Excavation            | 4400 Cum.               | 3250 Cum.              |
| 2       | Filling               | 3155 Cum.               | 1630 Cum.              |
| 3       | Foundation            | 1480 Cum.               | 950 Cum.               |
| 4       | Columns               | 640 Cum.                | -                      |
| 5       | Beams                 | 780 Cum.                | 150 Cum.               |
| 6       | Slabs                 | 1950 Cum.               | 1950 Cum.              |
| 7       | Bricks                | 2250 Cum.               | 6960 Cum.              |
| 8       | Reinforcement         | 379970 Kg.              | 156990 Kg.             |

**Table 2.1**Quantity required of materials for R.C.C. and Load Bearing Structures.

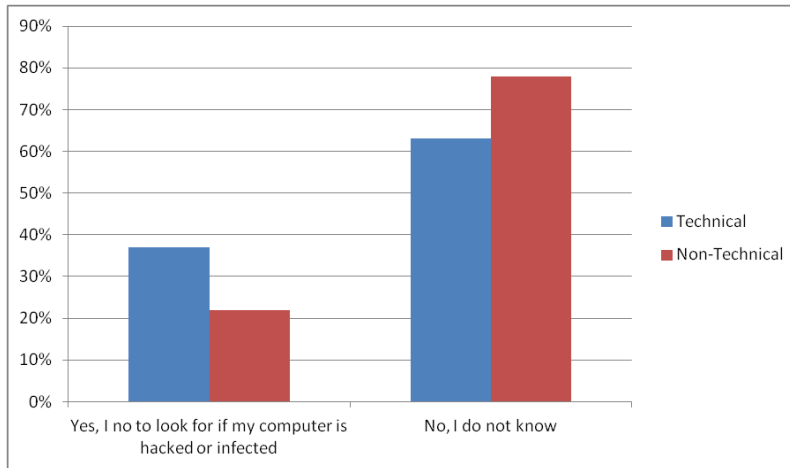
Costing of different materials according to the current rates are calculated. Comparison of cost of different materials for R.C.C. and load bearing structure is shown in table 2.2 Rates of material is taken from New SOR copy 2008-2009.

| Sr. No. | Cost Required for | R.C.C. Framed Structure | Load Bearing Structure |
|---------|-------------------|-------------------------|------------------------|
| 1       | Excavation        | 2,06,646.               | 1,52,636.              |
| 2       | Filling           | 7,90,263.               | 49,389.                |
| 3       | Foundation        | 54,52,626.              | 20,56,208.             |
| 4       | Columns           | 37,10,306.              | -                      |
| 5       | Beams             | 46,38,064.              | 7,76,550.              |
| 6       | Slabs             | 97,15,374.              | 96,96,073.             |
| 7       | Bricks            | 46,88,014.              | 1,45,01,594            |
| 8       | Reinforcement     | 1,55,75,044.            | 64,45,458.             |
| 9       | 1 House           | 38,20,000.              | 31,41,000.             |

**Table 2.2**Costing of materials for R.C.C. and Load Bearing Structures.

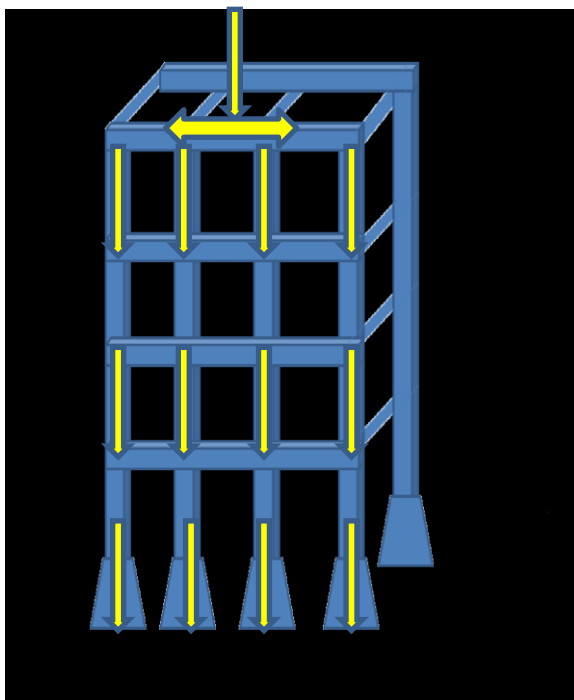
## III. COMPARISON OF R.C.C. AND LOAD BEARING STRUCTURE BASED ON STRENGTH

When a building experiences earthquake vibrations its foundation will move back and forth with the ground. These vibrations can be quite intense, creating stresses and deformation throughout the structure. Some factors affecting the building during Earthquake are: Irregular balconies and cantilever structure may be dangerous during earthquake, Reservoirs, water tower and other weak or poorly constructed buildings adjoining to your house or building can

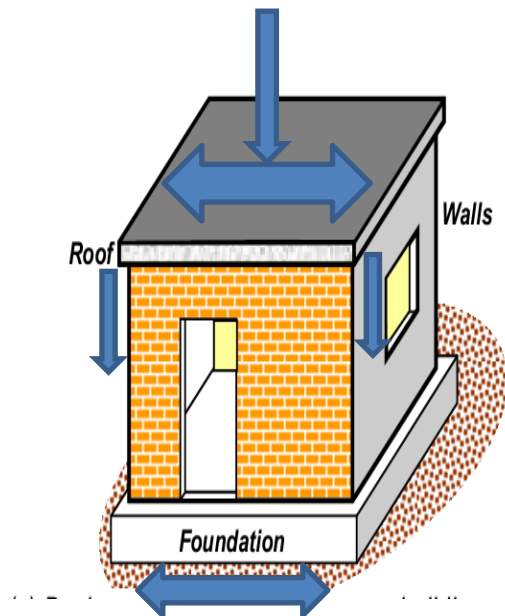


be harmful at the time of earthquake, Nature of soil also has great effect on the safety of the building during earthquake, Sandy soil can be easily affected by earthquake, Type of building structure whether R.C.C. frame, steel frame, wooden frame or load bearing masonry walls also affect the building structure during earthquake. The load transfer path in RCC framed

structure is through Slabs to beams to columns to foundation through soil.



**Fig.1.** R.C.C.Framed Structure



**Fig.2.** Load Bearing Structure

#### **IV. Conclusions**

The cost of RCC framed structure and Load bearing Structure has been carried out in above tables using MS Excel.

Total cost of a block having two floors of given area for the RCC framed construction is 4,58,25,600. And the cost of construction for Load Bearing Structure method is 3,76,91,800

for the same block. So the Load Bearing Structure is economical compared to RCC framed structure.

The cost of the estimated materials and labour work has been carried out as per new SOR copy 2008-2009.

But considering the Strength point of view, RCC Framed structures have been proved better in earthquake loads than Load bearing Structures. So it is suggested that RCC framed structures is preferable against Load bearing structures.

Though RCC structures are costly but they are more safe in earthquake conditions and do not collapse in moderate earthquakes.

Load bearing structures are best suitable for the above ground condition. and RCC structures are more suitable for the higher storey.

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# COMPARATIVE STUDY AND ANALYSIS OF G+3 RESIDENTIAL BUILDING USING STAAD-PRO IN DIFFERENT SEISMIC ZONES OF GUJARAT

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## **Abstract:-**

The principle objective of this project is to analyse and design a multi-storeyed G+3 Residential building situated in different seismic zone of India with 3-dimensional frame using STAAD-Pro. The analysis and design involves load calculations manually and analyzing the whole structure by STAAD- Pro. The main objective of this project during is to analyse same geometry with different seismic loads and study seismic behaviour of the same.. Main intension of this project is to learn world's most popular and professional design and analysis tool STAAD-Pro. By using STAAD-Pro we will study behaviour of building under different loads and load combinations. From analysis results we will observe and compare analysis results between 4-STAAD models which we have prepared.

**Keywords:** *StaadPro, Seismic zones, G+3 Building .*

## **1. Introduction**

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches

In 21st century due to huge population the no of areas in units are decreasing day by day. Few years back the populations were not so vast so they used to stay in Horizontal system(due to large area available per person).But now a day's people preferring Vertical System(high rise building due to shortage of area).In high rise buildings we should concern about all the forces that act on a building ,its own weight as well as the soil bearing capacity .For external forces that act on the building the beam, column and reinforcement should be good enough to counteract these forces successfully. And the soil should be good enough to pass the load successfully to the foundation.

The design is made using software on structural analysis design (staad-pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams, columns, slabs etc and live loads. The horizontal load consists of the earthquake forces thus building is designed for dead load, live load and earthquake loads as **per IS 875**. The building is designed as two dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per **IS456-2000**. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software

STAAD-Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic

analysis capabilities. From model generation, analysis and design to visualization and result verification, STAAD-Pro is the professional's choice for steel, concrete, timber, aluminium and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

**The STAAD analysis and design engine:** It is a general-purpose calculation engine for structural analysis and integrated Steel, Concrete, Timber and Aluminium design. To start with we have solved some sample problems using STAAD Pro and checked the accuracy of the results with manual calculations. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations regarding loadings on buildings and also considered seismic and wind loads. Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behaviour of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.

## **2. MULTI STORY BUILDING – STATE OF THE ART**

A Multi-Storey is a building that has multiple floors above ground in the building.

Multi-storey buildings aim to increase the floor area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases, money (depending on material used and land prices in the area). The building with the most storeys is the BurjKhalifa, with 162

### **2.1 TYPES OF LOADS**

In general the loads on structure are classified as vertical or gravity loads, horizontal loads and longitudinal loads.

The various loads expected on structure may be classified into the following groups.

1. Dead loads
2. Live loads
3. Wind loads
4. Snow loads
5. Earthquake loads
6. Shrinkage, creep and temperature effects

#### **2.1.1 Dead Load (DL)**

Dead load is defined as the load on a structure due to its own weight (self-weight). It also added other loads if some permanent structure is added to that structure. All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced

concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 kN/m<sup>3</sup> and 25 kN/m<sup>3</sup> respectively.

### 2.1.2 Live Load (LL)

Live load or imposed load is defined as the load on the structure due to moving weight. The live load varies according to the type of building. For example generally for a Residential Building the live load is taken as 2kn/m<sup>2</sup>.

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

### 2.1.3. Wind Load

Wind load is defined as the load on a structure due to wind intensities. Generally wind intensities vary from time to time. So it is suggested to take maximum probable wind intensities calculation for a structure for which damage can be avoided.

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term 'wind' denotes almost exclusively the horizontal wind, vertical winds are always identified as such. The wind speeds are assessed with the aid of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 metres above ground.

The wind load on a building shall be calculated for:

- a) The building as a whole,
- b) Individual structural elements as roofs and walls, and
- c) Individual cladding units including glazing and their fixings

## 3Design Seismic Base Shear

The total design lateral force or design seismic base shear ( $V_b$ ) along any principal direction shall be determined by the following expression:

$$V_b = A_h \times W$$

Where,

$A_h$  = horizontal acceleration spectrum

$W$  = seismic weight of all the floors

### 3.1 Distribution of Design Force

#### 3.1.1 Vertical Distribution of Base Shear to Different Floor Level

The design base shear ( $V_b$ ) shall be distributed along the height of the building as per the following expression:

$Q_i$  = Design lateral force at floor  $i$ ,

$W_i$  = Seismic weight of floor  $i$ ,

$h_i$  = Height of floor  $i$  measured from base, and

$n$  = Number of storeys in the building is the number of levels at which the masses are located.

#### 3.1.2 Distribution of Horizontal Design Lateral Force

Distribution of Horizontal Design Lateral Force to Different Lateral Force Resisting Elements in case of buildings whose floors are capable of providing rigid horizontal diaphragm action, the total shear in any horizontal plane shall be distributed to the various vertical elements of lateral force resisting system, assuming the floors to be infinitely rigid in the horizontal plane. In case of building whose floor diaphragms cannot be treated as infinitely rigid in their own plane, the lateral shear at each floor shall be distributed to the vertical elements resisting the lateral forces, considering the in-plane flexibility of the diagram

### 3.2 SEISMIC LOAD CALCULATION:

According to the IS-CODE 1893(part 1) the horizontal Seismic coefficient  $A_h$  for a structure can be formulated by the following expression

$$A_h = ZISa/2RG$$

Where,

$Z$  = Zone factor depending upon the zone the structure belongs to.

For Zone II ( $Z=0.1$ )

For Zone III ( $Z=0.16$ )

For Zone IV ( $Z=0.24$ )

For Zone V ( $Z=0.36$ )

$I$  = Importance factor, For important building like hospital it is taken as 1.5 and other for other building it is taken as 1.

$R$  = Response reduction factor.

$S_a/g$  = Average Response Acceleration coefficient.

### 3.3 LOAD COMBINATION

For seismic load analysis of a building the code refers following load combination.

1.5(DL + IL)

1.2(DL + IL ± EL)

1.5(DL ± EL)  
0.9 DL ± 1.5 EL

#### 4. Problem Statement

| SR. NO. | DESCRIPTION              | REMARKS                |
|---------|--------------------------|------------------------|
| 1       | Use of building          | Residential            |
| 2       | No. of stories           | Ground + 3 story       |
| 3       | Type of construction     | RCC Framed structure   |
| 4       | Depth of foundation      | 2.4 m from below NGL   |
| 5       | Plinth height            | 0.6 m above NGL        |
| 6       | Floor height             | 3m                     |
| 7       | Total height of building | 12.6 m from NGL        |
| 8       | Width of building        | 9.46 m o/o             |
| 9       | Length of building       | 6.40 m o/o             |
| 10      | Type of wall             | 230mm thick Brick wall |
| 11      | Column size              | 230 x 600              |
| 12      | Beam size                | 230 x 450              |

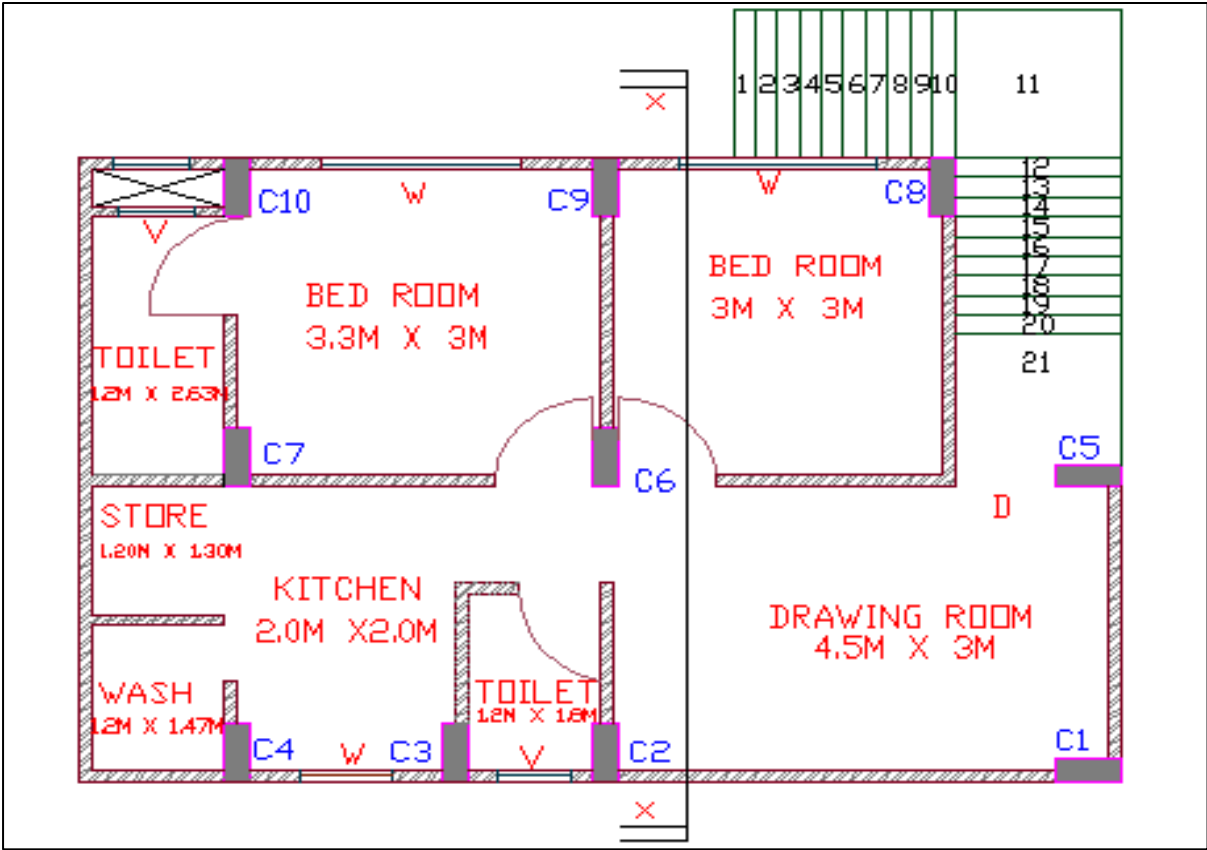


Fig.1 Architectural plan of building

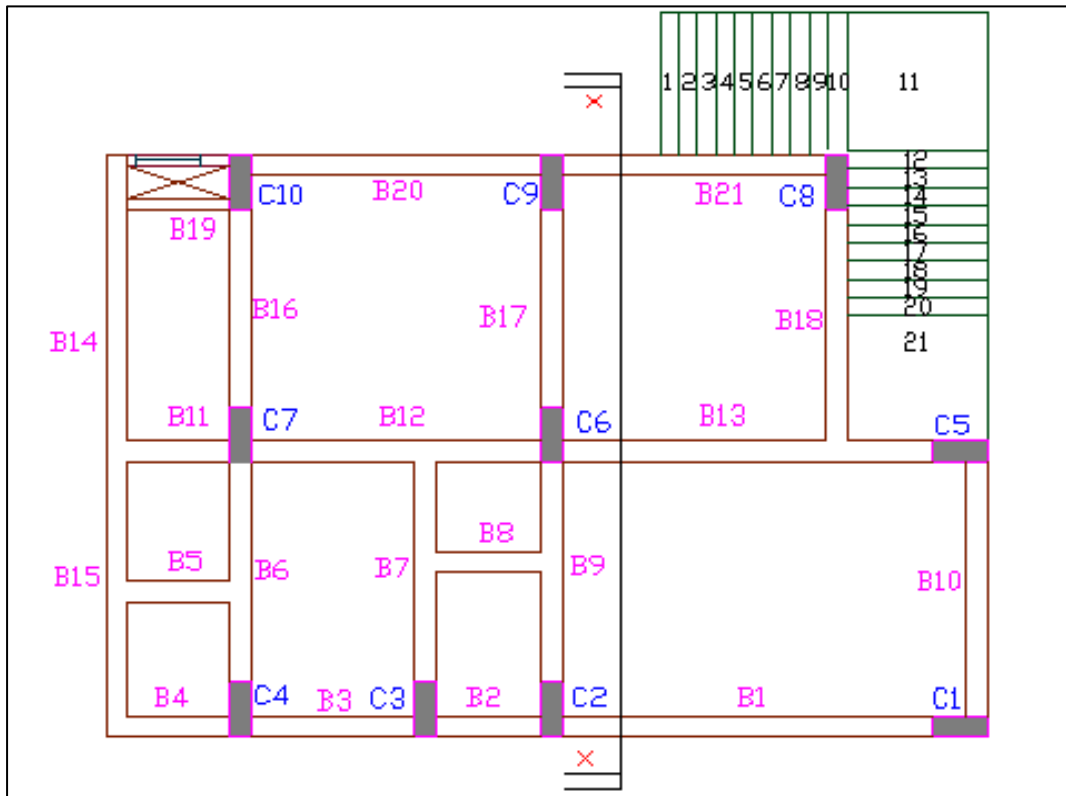


Figure: 2 Typical Beam grid

## 5 WORKING WITH STAAD-PRO

Our project involves analysis and design of Residential Building [G + 3] using a very popular designing software STAAD Pro. We have chosen STAAD Pro because of its following advantages:

Easy to use interface,  
Conformation with the Indian Standard Codes,  
Versatile nature of solving any type of problem,

### 5.1 BASICS OF STAAD-PRO

We have to follow following three steps to reach our project goal using STAAD-PRO.

Prepare input file.

Send input file to the analysis/design engine.

Read the results and verify them

#### 1.1.1. Input file

Creating input file takes place in the Modelling Mode. It is the first step in working in STAAD Pro. What is input file? Input file is the place you describe our case; what do we have? And what do we want? We can cut the input file into two parts:

In the first part you will describe your structure. This includes the geometry, the cross sections, the material and geometric constants, the support conditions, and finally the loading system.

The second part may contain the analysis command, and printing commands.

#### 1.1.2. Send input file to the analysis and design engine

Just like any programming language compiler, STAAD-Pro analysis and design engine, will start reading the input file from left to right, and from top to bottom. The engine will mainly check for two things:

Making sure that the user used the syntax of STAAD Pro commands, or else the engine will produce an error message.

Making sure that all the data needed to form a stable structure exists in the input file, or else, the engine will produce an error message.

If these two things are correct, STAAD will take the values mentioned in the input file (without verification) and produce the output files.

As a rule of thumb, generating the output files doesn't mean that results are correct! The concept of GIGO (Garbage in Garbage Out) applies. Based on this concept, don't take the results generated by STAAD Pro as final, but verify each piece of the output data, to make sure that your input data was correct.

#### 1.1.3. Read results, and verify them

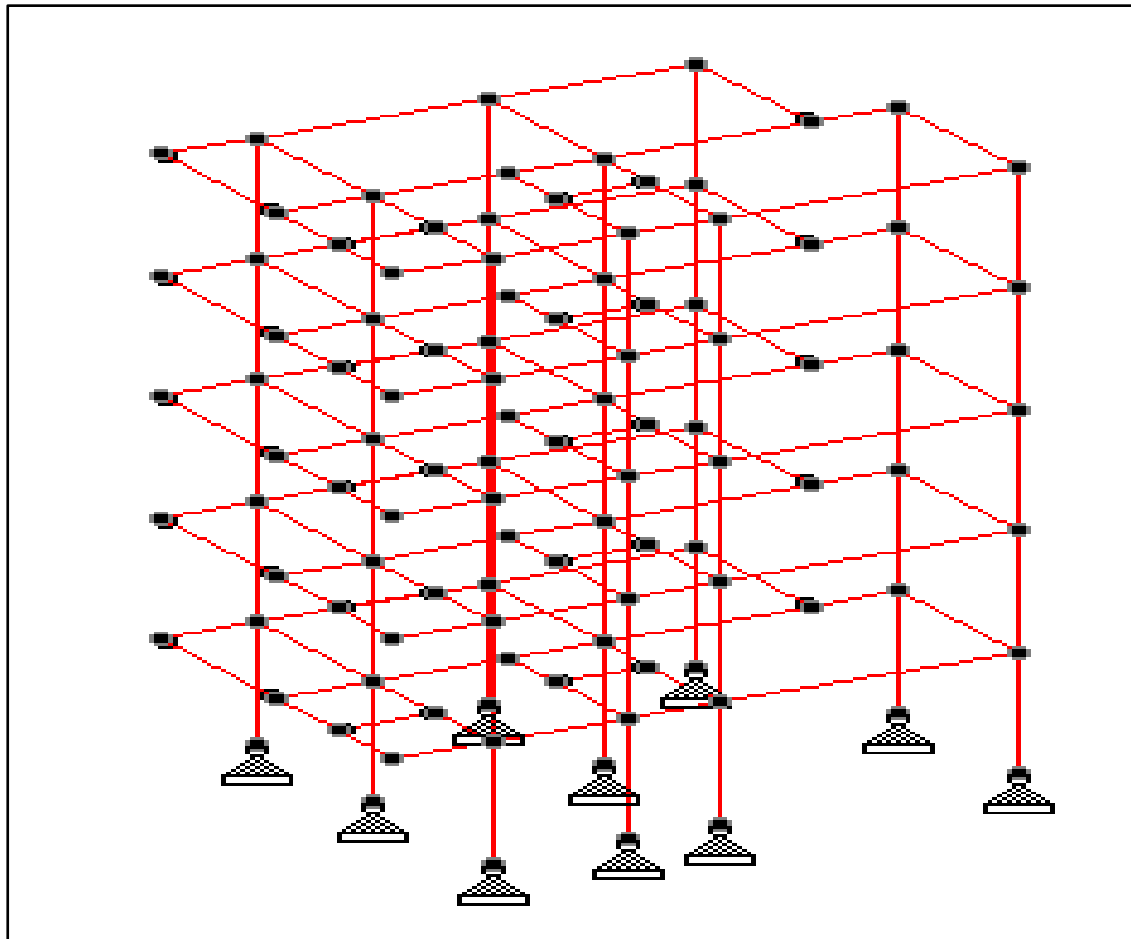
Reading output takes place in Post Processing Mode. It includes:

Seeing the results as tables and/or as graphical output.

Changing the scale of each graphical output to visualize the correct shapes, and showing values, or hiding them.

After reading and verifying our results we may decide to go back to our Modelling Mode to alter the input file, for either to correct the input file, or to change some values to examine different results. The input file always has extension of STD

#### 5.2.4STAAD-PRO OUTPUT AND RESULT SUMMARY



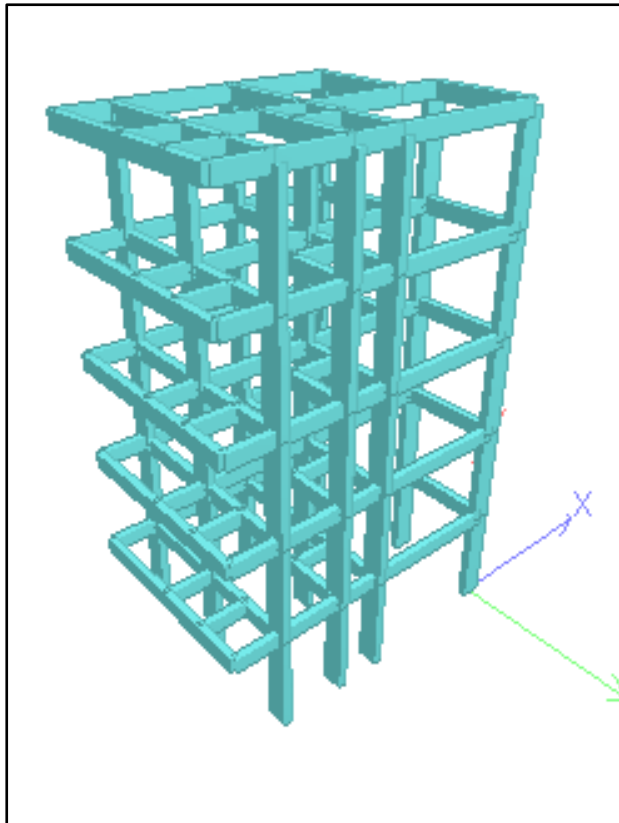


Figure: 3 STAAD-Pro 3-D view of geometry

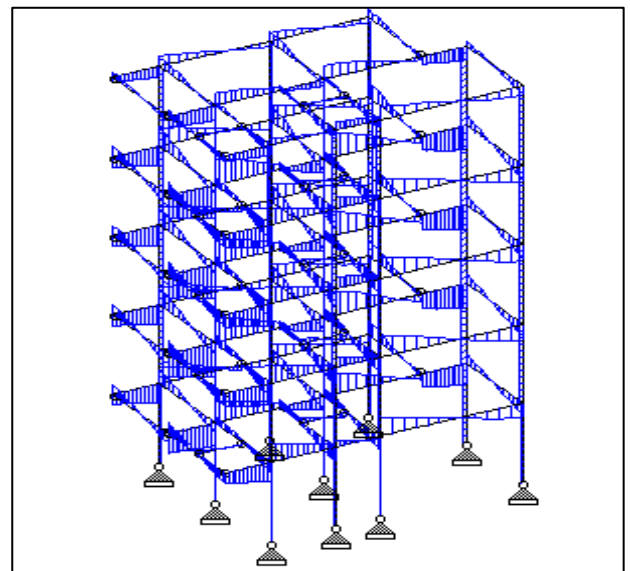
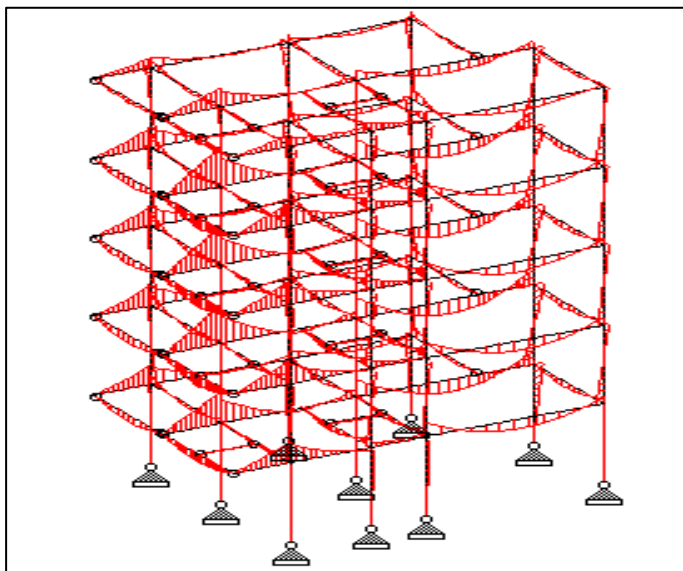


Figure: 4 STAAD-Pro Bending moment diagram Figure: 5 STAAD-Pro Shear force diagram

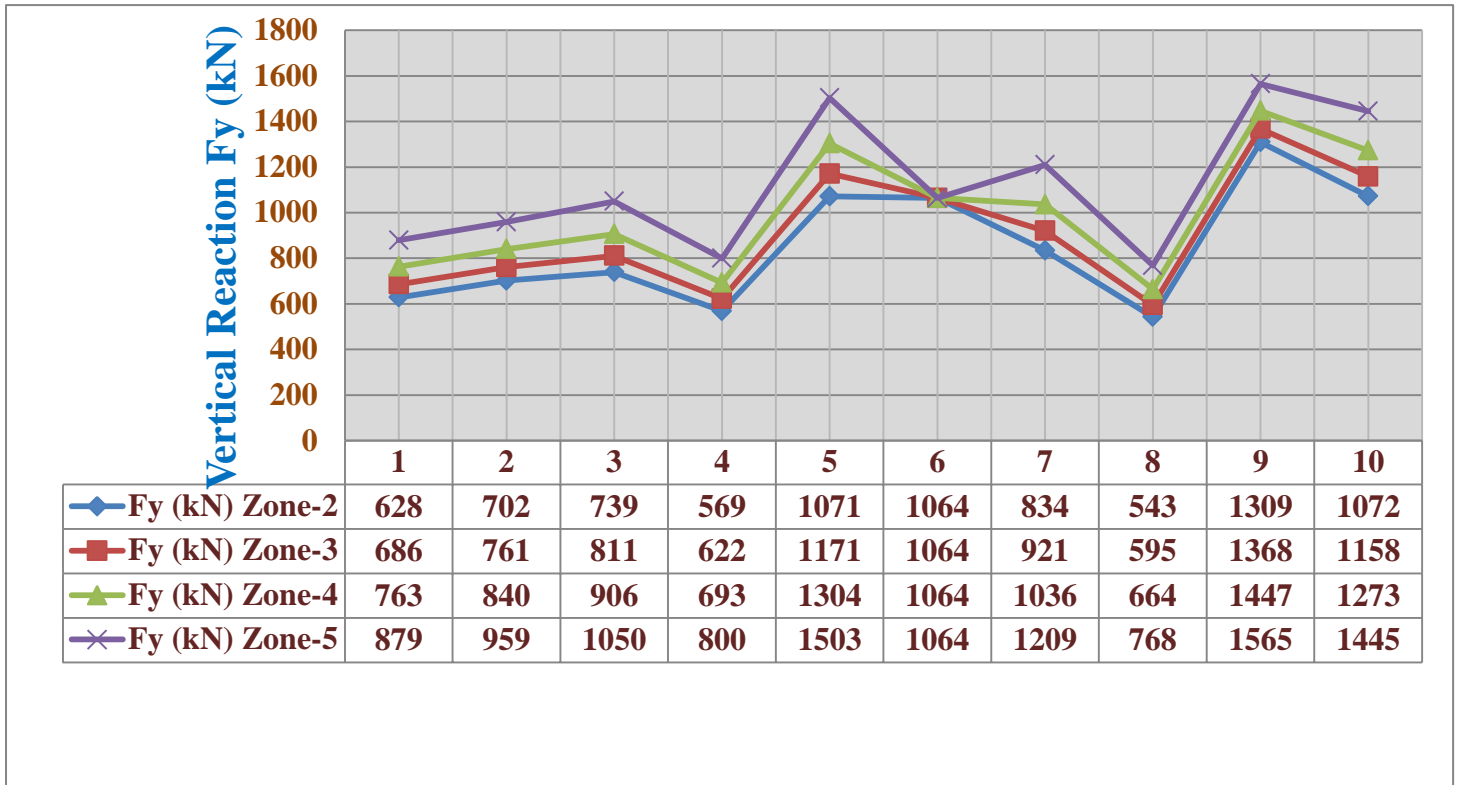


Figure: 6 Comparison of vertical reactions at support

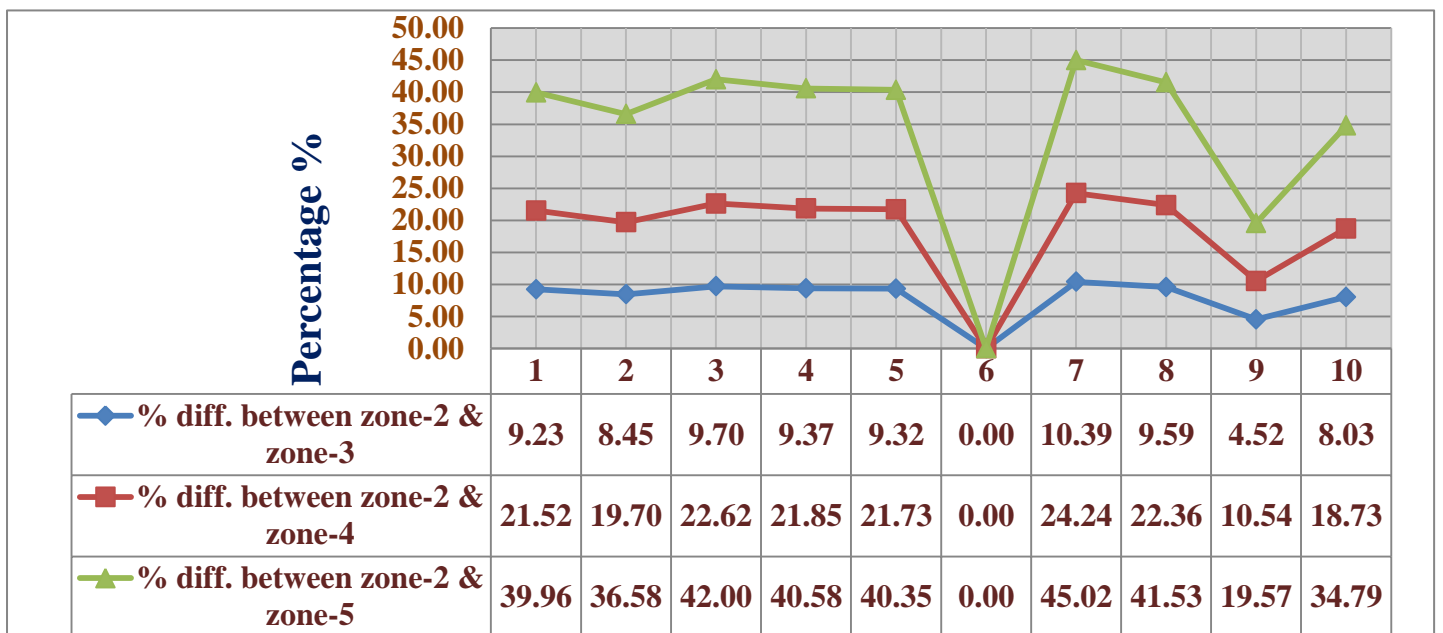


Figure: 7 Comparison of vertical reactions at support in percentage (%)

## 6. Conclusion

From this work and after studying analysis result following conclusions are drawn: Comparison results of all the load combinations from STAAD-Pro of vertical reactions at supports for different seismic zones shows that the for zone-2 reaction value is minimum and maximum for zone-5 among all the seismic zones.

From comparison it is clearly visible that reactions of zone-3 are almost 10% higher than zone-2, reactions of zone-4 are almost 20% higher than zone-2 and reactions of zone-3 are almost 40% higher than zone-2.

For centre columns the moment values are greater for live and dead load combination than the seismic load combinations.

Columns are more critical in bending under earthquake loads rather than axial loads.

For few beams negative moments are greater in earthquake loads compare to dead and live loads, positive moments are greater in dead and live load combination compare to earthquake loads.

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# **ALTERNATIVE MATERIALS & ITS APPLICATION FOR CONSTRUCTION**

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**ABSTRACT:** Conventional materials such as bricks, tiles, and bitumen are being used extensively in construction industry however alternative materials such as fly ash, geo synthetic materials and various chemical which used for flooring can be used in place of their conventional materials. Some of these materials are found cost effective, economical, better in strength as compared to their conventional counterparts. In our study alternative materials which can be used in construction industry will be studied. The advantages and limitation of their material will be discussed. These material will be tested in laboratory and compared with conventional materials for a different criteria such as strength, functionally and flexibility. These materials are not being used extensively in the construction industry. At the end of the study whether the use of these materials in the construction industry are justified or not.

**KEYWORDS:** A.A.C Blocks

## **1. INTRODUCTION**

Conventional materials such as bricks, tiles, bitumen are being used extensively in construction industry. However with the advent of technology new alternative materials such as, Autoclaved aerated concrete, geo-synthetic materials and various other chemical which used in construction are now being used in place of earlier conventional materials. Some of these materials are found to be cost effective, economical, better in strength as compared to their conventional counterparts. In this chapter we will describe about various alternative materials.

## **2. INTRODUCTION TO AUTOCLAVED AERATED CONCRETE:**

Autoclaved Aerated Concrete also known as autoclaved cellular concrete (ACC) or autoclaved lightweight concrete, was invented in the mid-1920s by the Swedish architect and inventor Johan Axel Eriksson. It is a lightweight, precast building material that simultaneously provides structure, insulation, and fire and mould resistance. AAC products include blocks, wall panels, floor and roof panels, and lintels. It has been refined into a highly thermally insulating concrete-based material used for both internal and external construction.



**Figure 1.1 – Autoclaved Aerated Concrete Block**

## **2.1 PROPERTIES OF A.A.C BLOCKS:**

It is a lightweight, precast building material that simultaneously provides structure, insulation, and fire and mould resistance. A.A.C products include blocks, wall panels, floor and roof panels, and lintels. It has been refined into a highly thermally insulating concrete-based material used for both internal and external construction. Besides AAC's insulating capability, one of its advantages in construction is its quick and easy installation, for the material can be routed, sanded, and cut to size on site using standard carbon steel band saws, hand saws, and drills.

Even though regular cement mortar can be used, 98% of the buildings erected with AAC materials use thin bed mortar, which comes to deployment in a thickness of  $\frac{1}{8}$  inch. This varies according to national building codes and creates solid and compact building members. AAC material can be coated with a stucco compound or plaster against the elements. Siding materials such as brick or vinyl siding can also be used to cover the outside of AAC materials.



**Figure 1.2 Construction of Autoclaved Aerated Concrete**

### BENEFITS OF A.A.C:

- Faster assembly
- Material available throughout the year
- Cutting, chasing, nailing etc. easily possible
- Better sound absorption
- Enhance the seismic resistance of the building
- Ideal for multi-storied buildings, add-on floor and extensions using FSI/TDR

**TABLE 1 COST COMPARISION BETWEEN BRICKS & A.A.C BLOCK**

| Sr. no | Description Of Item   | No. | L<br>m | B<br>m | H<br>m | QTY<br>m <sup>3</sup> | T. QTY<br>m <sup>3</sup> |
|--------|---|-----|--------|--------|--------|-----------------------|--------------------------|
| 1      | Brick masonry upto plinth<br>using 1st class bricks 1:6 c.m |     |        |        |        |                       |                          |
|        | Long wall=4+0.1+0.1=4.2m                                    | 2   | 4.2    | 0.2    | 3      | 5.04 m <sup>3</sup>   |                          |
|        | Short wall=3+0.1+0.1=3.2m                                   | 2   | 3.2    | 0.2    | 3      | 3.84 m <sup>3</sup>   |                          |
|        | Height upto l. 3m   |     |        |        |        |                       |                          |
|        | Total brick masonry work                                    |     |        |        |        |                       | 8.88 m <sup>3</sup>      |
| 2      | Cement Plaster 8 mm thick in<br>1:4 c.m                     |     |        |        |        |                       |                          |
|        | inside plaster work   |     |        |        |        |                       |                          |
|        | Long wall   | 2   | 4      | -      | 3      | 24 m <sup>2</sup>     |                          |
|        | Short wall  | 2   | 3      | -      | 3      | 18 m <sup>2</sup>     |                          |
|        | Total plaster work  |     |        |        |        |                       | 42 m <sup>2</sup>        |

### RATE ANALYSIS OF A.A.C BLOCK

#### A.A.C Block masonry:

Actual size of block = 20cm x 20 cm x 60cm

Nominal size of block = 21 cm x 21 cm x 61cm

(With mortar joint)

Therefore for 8.88 m<sup>3</sup>

$$\begin{aligned} \text{No. Of A.A.C block required} &= \frac{\text{volume of A.A.C block}}{\text{Volume of 1 A.A.C block with mortar joint}} \\ &= \frac{1 \text{ m}^3}{0.21 \times 0.21 \times 0.61} \\ &= 38 \text{ nos} \end{aligned}$$

For 8.88x3.8 m<sup>3</sup> of A.A.C block masonry, 340 A.A.C block are used.

#### Mortar:

Mortar for 8.88 m<sup>3</sup> brickwork.

Actual volume of A.A.C blocks in 8.88 m<sup>3</sup> of block masonry.

$$= 38 \times (0.20 \times 0.20 \times 0.60)$$

$$= 0.912 \text{ m}^3$$

Therefore volume of wet mortar in 8.88 m<sup>3</sup> aac block masonry  
 = 1 - 0.912  
 = 0.09 m<sup>3</sup>

For frog fillings, cut bricks, bonding, wastages etc increase this quantity by 15%.

Therefore volume of wet mortar = 0.09 + (0.15 x 0.09) = 0.103 m<sup>3</sup>

Volume of dry mortar reduces by 25% when water is added.

Therefore volume of dry mortar = 0.103 + (0.25 X 0.103) = 0.128 m<sup>3</sup>

For 8.8\*0.128 m<sup>3</sup> A.A.C block, 1.13m<sup>3</sup> of mortar is required.

**Materials for 1: 6 A.A.C block:**

Quantity of A.A.C block = 8.88 m<sup>3</sup>

Proportion = 1:6

Volume of dry mortar = 1.13 m<sup>3</sup>

1:6 = 7

C: S

For 1 bag of cement

Weight = 50 kg

Volume = 0.035 m<sup>3</sup>

Cement = 1/7 x 1.13 = 0.162/0.035 = 4.62 bags

Say 5 bags.

Sand = 6/7 x 1.13 = 0.96m<sup>3</sup>.

**Plastering:**

For filling up joints and for uneven surface, 30% more mortar is required. To get the dry volume of mortar, wet volume may be further increased by 25%.

**(i) Materials for 42m<sup>2</sup> area and 8 mm thick plaster (1 : 4) :**

Volume of wet mortar = area x thickness

= 42 x 0.008

= 0.336 m<sup>3</sup>

For filling up joints and for uneven surface, 30% more mortar is required.

Therefore volume of wet mortar = 0.336 + (0.30 x 0.336)

= 0.3696 m<sup>3</sup>

To get the dry volume of mortar, wet volume may be further increased by 25%.

Therefore volume of dry mortar = 0.3696 + (0.25 x 0.3696)

= 0.462 m<sup>3</sup>

Proportion = 1:4 = 5

Cement = 1/5 x 0.462 = 0.092 /0.035 = 2.64 bags say 3bags

Sand = 4/5 x 0.462 = 0.3696 m<sup>3</sup>

| Particulars  | Quantity or Number | Rate Rs. | Per            | Amount                    |
|--------------|--------------------|----------|----------------|---------------------------|
| 1. materials |                    |          |                |                           |
| AAC Block    | 340                | 35       | Nos            | 11900                     |
| Sand         | 1.32               | 1000     | M <sup>3</sup> | 1320                      |
| Cement       | 8                  | 300      | bags           | 2400                      |
| Sundries     |                    |          |                | 80                        |
|              |                    |          |                | Material cost = 15700 Rs. |

|               |   |     |          |                           |
|---------------|---|-----|----------|---------------------------|
| 2. labour     |   |     |          |                           |
| Mason         | 4 | 400 | Day      | 1600                      |
| Male coolie   | 4 | 250 | Day      | 1000                      |
| Female coolie | 4 | 220 | Day      | 880                       |
| Bhistie       | 1 | 250 | Day      | 250                       |
| Mistry        | 1 | 500 | Day      | 500                       |
| Scaffolding   |   |     | Lump sum | 300                       |
| Sundries      |   |     |          | 70                        |
|               |   |     |          | Labour cost =<br>4600 Rs. |

Material and labour cost Rs. = 20300.00

Add 1.5% water charges Rs. = 300.00

Add 10% contractors profit Rs.= 2000.00

Rate per 8.88 m<sup>3</sup> = 22600 Rs    Rate per m<sup>3</sup> = 2550 Rs.

| <b>4mx3m Room Masonry &amp; plaster Work</b> |                                   |
|--|-----------------------------------|
| <b>Brick</b>                                 | <b>A.A.C Block</b>                |
| size : 190 mm x 90 mm x 90 mm                | size : 600mm x 200 mm x 200 mm    |
| Cement : 5100 Rs.                            | Cement : 2400 Rs.                 |
| Sand : 3135Rs.                               | Sand : 1320 Rs.                   |
| Labour : 8000 Rs.                            | Labour : 4600 Rs.                 |
| Bricks: 4450no.s = 17800 Rs.                 | A.A.C Block : 340 nos = 11900 Rs. |
| Total = 38000 Rs.                            | Total = 22600 Rs.                 |

- There are other important distinguishing properties too, which differentiate AAC Block from red brick:
  1. AAC Block is stronger and possesses better compressive strength than red brick.
  2. AAC Block can be used as the heat insulator 6 times better than red brick.
  3. 2 – 4 times lighter than red brick which helps to save the structure.
  4. Heat prevention in summer, energy consumption from using air conditioning can be saved up to 60%.
  5. AAC Block can be nicely plastered without causing any crack problems.
  6. Only 10 mm of plaster thickness is requiring which helps to reduce plaster mortar usage up to 60%.
  7. AAC Block can be easily cut and can be rapidly laid since it is 3 times larger than red brick.

### CONCLUSION:

In construction technology alternative materials are beginning used from long time. By calculating and estimating quantity and cost of room of 3m x 4m, it shows that A.A.C blocks are cheaper than that of bricks and also consists better strength. If A.A.C blocks are used than 15 to 20% of reinforcement can be reduced in design and less plaster work has to be done. It takes less time in construction compare to tradition bricks and also gives better appearance of elevation as compare to traditional bricks.

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**INTERRUPTION IN EXECUTION OF FOUNDATION &  
DEFORMATION OF BASEMENT FLOOR DUE TO HIGH WATER  
TABLE  
A CASE STUDY: SILVER SCREEN MULTIPLEX, GODHRA**

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**Abstract:** A multiplex case study where in problems due to rise in water table are sorted out. A case study of multiplex @ Godhra in East zone of Gujarat for Interruption in execution of foundation and deformation of basement floor due to high water table. After various meetings with developer and structural engineer, some various methods available which can be used during construction and suitable for site condition, soil stratum, and cost effective. After deep discussion finally it was decided to use **admixtures** in concrete mix. **Retaining wall** and design **trimix flooring** was also used to prevent seepage and deformation of basement flooring.

**Keywords:** Admixture, Retaining Wall, Silver screen, Seepage Water, Trimix Flooring, Water Table

## 1. INTRODUCTION

Project is based on controlling seepage water during excavation. Site is located at Godhra City, Panchmahal district, Gujarat. Its altitude & longitude is 22.77<sup>0</sup>N 73.62<sup>0</sup>E respectively. It has been observed during excavation, for the purpose of soil report, that seepage water is available at a depth of 2.5 meter, while the boring depth for soil report is 9m. Hence, it becomes a problem to control seepage water from coming out and carry out the excavation work easily for footing work of construction work. It is also observed in the nearby buildings that after construction; still the seepage water comes out from floor and creates the deformation of basement/ground flooring. It also weakens the building strength. Flooding in basement also creates a problem to the residents or other commercial use for which the structure is constructed. Hence, it is necessary to control seepage water during construction phase as well as prevent seepage water from coming out from flooring after construction also.

In this area, high water table is due to the location of site. Site is located near KANELAV LAKE. The distance between the lake & the site is around 200 m only. Due to this reason & lower contour level, the nearby construction sites are facing higher water table.



**Figure 1. Kanelav Lake near by site**

## **2. PROBLEM**

2.1 It has been observed during excavation, for the purpose of soil report, that seepage water is available at a depth of 2.5 meter, while the boring depth for soil report is 9m.

2.2 In surrounding structures, there is a problem of basement deformation due to high water table.



**Figure 2. Deformation of basement flooring at nearby site**



**Figure 3 Failure of slump due to seepage water at ‘Silver Screen Multiplex’**

2.3 There is a problem of dampness on the faces of sub structure.

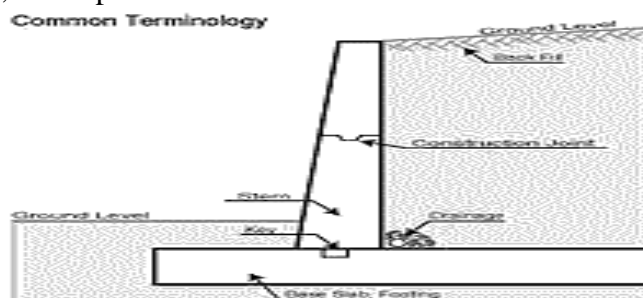
### **3. PROPOSED SOLUTION**

1) Retaining Wall 2) Admixtures 3) Trimix Flooring

#### **3.1 Retaining Wall**

**Retaining walls** are structures designed to restrain soil to unnatural slopes. They are used to bound soils between two different elevations often in areas of terrain possessing undesirable slopes or in areas where the landscape needs to be shaped severely and engineered for more specific purposes like hillside farming or roadway overpasses. A retaining wall is a structure designed and constructed to resist the lateral pressure of soil when there is a desired change in ground elevation that exceeds the angle of repose of the soil.

A basement wall is thus one kind of retaining wall. But the term usually refers to a cantilever retaining wall, which is a freestanding structure without lateral support at its top. These are cantilevered from a footing and rise above the grade on one side to retain a higher level grade on the opposite side. The walls must resist the lateral pressures generated by loose soils or, in some cases, water pressure.



**Figure 3. Retaining Wall**

### 3.2 Admixtures

Admixtures are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

We can use various kinds of admixtures to reduce setting time of concrete mix such that the ground water and seepage water does not affect much to the foundations. This type of admixture is known as **accelerators**.

By maintaining proper ratio of concrete mix and admixture as per soil characteristics and amount of water which interrupt the execution of foundation we can increase workability and quality of work.



**Figure 4. Admixtures**

According to site condition, we felt that the best suitability for the condition: High Water Table & Seepage Water.

Accelerators speed up the hydration (hardening) of the concrete. It increases in the rate of hydration of the hydraulic cement and thus shortens the time of setting, increases the rate of strength development, or both.

From the market survey,

| Sr. No. | Name Of Accelerators   | Cost/kg |
|---------|--|---------|
| 1       | CaCl <sub>2</sub> ( Calcium chloride )                             | 12₹     |
| 2.      | Ca(NO <sub>3</sub> ) <sub>2</sub> ( Calcium nitrate )              | 18₹     |
| 3.      | NaOH ( Caustic soda )  | 16₹     |
| 4.      | NaNO <sub>3</sub> ( Sodium nitrate )                               | 72₹     |
| 5.      | C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub> ( Triethanolamine ) | 120₹    |

**TABLE 1 NAMES & COST OF ACCELERATORS**

We made cubes using three different types of accelerators admixtures named **Calcium Chloride, Calcium Nitrate and Caustic Soda**. From the results, we proposed the contractor to use Caustic Soda due to their high compressive strength among these three and lower cost.. Details of test reports are given below.

Admixture Calcium Chloride:

## CUBE TEST REPORT

|                      |  |                  |
|----------------------|--|------------------|
| MTL No.: 1404/304/15 | REF. No. : E.No.-1027/280                              | DATE: 06/03/2015 |
| Name of client:      | Silver Group Of Company, Ghodhra                       |                  |
| Details of cube:     | Calcium Chloride Is Added In Concrete Mix As Admixture |                  |
| Name of work:        | Ghodhra Multiplex, Ghodhra                             |                  |

### COMPRESSIVE STRENGTH RESULTS

| Sr No. | Marking if any | Area of cubes (cm <sup>2</sup> ) | Wt. (gm) | Load (KN) | Comp. strength (kg/cm <sup>2</sup> ) | Comp. strength (N/mm <sup>2</sup> ) | Reported date of casting | Date of testing | Required as per IS 456                     |
|--------|----------------|----------------------------------|----------|-----------|--------------------------------------|-------------------------------------|--------------------------|-----------------|--|
| 1.     | M25            | 225                              | 8610     | 410.5     | 178.3                                | 17.76                               | 06/03/2015               | 13/03/2015      | 16.5 N/mm <sup>2</sup> or more for 28 days |
| 2.     | M25            | 225                              | 8590     | 425       | 185.96                               | 18.52                               |                          |                 |  |
| 3.     | M25            | 225                              | 8630     | 430.5     | 190.91                               | 19.01                               |                          |                 |  |

### Admixture Caustic Soda:

## CUBE TEST REPORT

|                      |  |                  |
|----------------------|--|------------------|
| MTL No.: 1404/304/15 | REF. No. : E.No.-1027/280                          | DATE: 06/03/2015 |
| Name of client:      | Silver Group Of Company, Ghodhra                   |                  |
| Details of cube:     | Caustic Soda Is Added In Concrete Mix As Admixture |                  |
| Name of work:        | Ghodhra Multiplex, Ghodhra                         |                  |

### COMPRESSIVE STRENGTH RESULTS

| Sr No. | Marking if any | Area of cubes (cm <sup>2</sup> ) | Wt. (gm) | Load (KN) | Comp. strength (kg/cm <sup>2</sup> ) | Comp. strength (N/mm <sup>2</sup> ) | Reported date of casting | Date of testing | Required as per IS 456                     |
|--------|----------------|----------------------------------|----------|-----------|--------------------------------------|-------------------------------------|--------------------------|-----------------|--|
| 1.     | M25            | 225                              | 8710     | 415.5     | 188.3                                | 18.46                               | 06/03/2015               | 13/03/2015      | 16.5 N/mm <sup>2</sup> or more for 28 days |
| 2.     | M25            | 225                              | 8650     | 428       | 193.96                               | 19.02                               |                          |                 |  |
| 3.     | M25            | 225                              | 8600     | 434.5     | 196.91                               | 19.31                               |                          |                 |  |

## Admixture Calcium Nitrate:

### CUBE TEST REPORT

|                      |   |                  |
|----------------------|---|------------------|
| MTL No.: 1404/304/15 | REF. No. : E.No.-1027/280                             | DATE: 06/03/2015 |
| Name of client:      | Silver Group Of Company, Ghodhra                      |                  |
| Details of cube:     | Calcium Nitrate Is Added In Concrete Mix As Admixture |                  |
| Name of work:        | Ghodhra Multiplex, Ghodhra                            |                  |

### COMPRESSIVE STRENGTH RESULTS

| Sr No. | Marking if any | Area of cubes (cm <sup>2</sup> ) | Wt. (gm) | Load (KN) | Comp. strength (kg/cm <sup>2</sup> ) | Comp. strength (N/mm <sup>2</sup> ) | Reported date of casting | Date of testing | Required as per IS 456                     |
|--------|----------------|----------------------------------|----------|-----------|--------------------------------------|-------------------------------------|--------------------------|-----------------|--|
| 1.     | M25            | 225                              | 8510     | 418       | 183.22                               | 18.30                               | 06/03/2015               | 13/03/2015      | 16.5 N/mm <sup>2</sup> or more for 28 days |
| 2.     | M25            | 225                              | 8560     | 410       | 177.80                               | 17.68                               |                          |                 |  |
| 3.     | M25            | 225                              | 8600     | 422       | 185.93                               | 18.46                               |                          |                 |  |

### 3.3 Trimix flooring

Trimix flooring is a special type of flooring mostly being done in the industrial sector. It provides better wearing and tearing properties. It is generally used for industrial purpose, where rigid surface necessary for machine foundation, light load carrier vehicle and light weight cranes. Generally the mix of concrete used for Trimix is 1:1:5:3 (1 cement: 1.5 sand and: 3 stone aggregates), mostly rich mix of 1:1:2 preferred for better wear and tear.

#### Benefits of Trimix

- Compressive strength of floor increase by upto 60% resulting in higher structural strength & therefore durability.
- Tensile strength increases by @ 70%.
- Cement consumption is reduced to the extent of 40%, as no cement is required separately for finishing the surface.
- Abrasion resistance of the floor increases by @ 60% resulting in less wear & tear of the floor surface.
- Permeability is reduced as a result of which liquids falling on the floor have less detrimental effect on the concrete.
- Impact strength is increased.
- Shrinkage of concrete is reduced & the floor warps less.
- Numbers of joints are reduced as this method allows long strip floor as against conventional checkered method.
- Floors can be put to use much earlier because of lesser curing time.
- Water/cement ratio is reduced by @ 18%.

- Hard surface in lesser time thus can be used in earlier.
- Voids in concrete near the surface are less hence concrete flooring is durable.

### **Drawback**

- If it is being done in small room or along the wall in large space, one has to left narrow passage for fixing, removing & operating float vibrator. The space is filled later on with concrete leaving a construction joint.
- Edges of panel are broken during dismantling of side forms & repairing using ordinary method is not successful.

## **4. METHODOLOGY**

### **4.1 Methodology of Retaining Wall**

#### **Stage 1: Preliminary Survey**

1. Before proceed with any works, survey and setting out shall be conducted to provide the guide on levels and alignment for the construction of the Reinforce concrete Retaining Walls
2. Survey and setting out shall be done in the present of Resident Engineer or his representative.
3. Request for inspection shall be submitted prior to start the works.

#### **Stage 2: Earthworks (Excavation)**

1. Earthworks can only commence after the setting out was done and accepted by Resident Engineer.
2. The excavation at will be done until it reaches the proposed platform level where it will provide wider temporary diversion during the construction of the Retaining wall structure.
3. The excavation work will only commence after the completion of stage 1.
4. The stage 2 will provide access for existing traffic during the excavation work activities at stage 1.
5. The Layout after completion of earthworks activities for both sequences will be as following.

#### **Stage 3: Construction of RC Retaining Wall Structure.**

##### **Level 1: Piling Works**

1. Piling works will commence after the completion of first half of the sequence 2 earthworks.
2. The sequence of the piling works will be done starting form the end Chainage of the Retaining wall progressing to the front Chainage.
3. The excess of drive R.C pile will be cut as soon as the Piling works reaches practical numbers of piling points to enable the pile cut off activities.

##### **Level 2: Construction of the R.C Retaining wall Base.**

1. The construction of the base will commence as soon as after the preparation of the pile head reaches the practical length of the standard steel bar supply length or safe working area. (eg. Standard steel bar supply length / pcs = 12m )
2. All of the installed reinforcement must be free from rust, properly tied and being installed according to construction drawings and specifications.

#### Level 3: Concreting works.

1. Concreting works will only commence after the installed reinforcement being inspected and accepted and approved for next sequence of works by Resident Engineer or his or her representative.
2. The sequence of concreting activities will also start from the end chainage of the R.C Retaining Wall base.
3. Concreting works will commence as soon as the installed reinforcement for the base reaches the possible delivery concrete volume to site per day and practical output of the concreting works.
4. Prior to concreting activities, all installed formworks for the base shall be properly secure to avoid formwork failure.
5. During concreting activities, test cube and numbers of the cube to be prepared shall be as per directed by Resident engineer or his or her representative.
6. There shall be no concreting activities during raining day.
7. The flow of the installation of the reinforcements and concreting activities shall be as per diagram

#### Level 4: Construction of R.C Wall.

1. The construction of the R.C concrete wall shall proceed as soon as the Concreted base is ready to accept the next sequence of the works.
2. Construction of the wall shall start for both side of the retaining wall concurrently. However some section of the wall might need to be left open to suite the site condition and the movement of machineries.
3. R.C wall construction activities shall start from end chainage of the retaining wall.
4. The height of each wall that is ready for concreting shall not exceed 2.4 meter high. This is to avoid the formwork failure.
5. Prior to fully erect the formwork, wall reinforcement must be inspecting by Resident engineer or his representative for acceptance and approval for next sequence of work.
6. Prior to concreting activities formwork shall be properly secured to avoid formwork failure during concreting activities.
7. There shall be no concreting activities conducted during raining day.
8. Flow of the R.C Wall Construction is as shown in the following Diagram 4.

#### **Stage 4: Backfilling to completed Retaining Wall.**

1. Backfilling activities will commence as soon as the fully completed section of the retaining wall is ready to received backfill material and also practically safe for the other on-going construction activities for remaining Retaining wall structure.
2. Each layer of backfill shall be not more than 500mm thick and shall be properly compacted before lying of subsequence layer of backfill. This process is repeated until the whole height of the retaining wall is filled.
3. Backfill activities will commence from the end chain age of the retaining wall towards the CH 6 + 200.

#### **Stage 5: Miscellaneous works.**

1. Miscellaneous works will commence upon completion of the whole retaining wall Structure inclusive of backfilling works.

2. The miscellaneous works are the flexible pavement, drains and road furniture.

## 4.2 Methodology of Admixtures

The use of accelerator in concrete mix of same slump and cement content, the increased strength at early and final stage with better workability can be achieved even at reduced water cement ratio. Dosages ranging from 0.06 to 3% by wt. of cement, for different products are recommended by different manufactures but it shall be fixed as per design requirement and site trials.

## 4.3 Methodology of Trimix Flooring

### 4.3.1 Solution of Deformation of Basement Floor

- **Design of Basement Slab:** We will provide design of basement floor detail which will prevent the restoration of floor at basement.
- **Damp Proof:** One of the basic requirements of a building is that it should remain dry or free from moisture travelling through walls, Roofs or floors. Dampness is the presence of hygroscopic or gravitational moisture. Dampness gives rise to unhygienic conditions, apart from reduction in strength of structural components of the building, damp prevention is therefore one of the important items of building designs. Every building should be damp proof. Provision of damp proof courses prevents the entry of moisture in the building.
- **Methods of damp proofing:**
  1. Membrane damp proofing
  2. Integral damp proofing
  3. Surface treatment
  4. Cavity wall construction
  5. Guniting
  6. Pressure grouting
- **Retaining Wall in Basement:** Retaining walls are structures designed to restrain soil to unnatural slopes. They are used to bound soils between two different elevations often in areas of terrain possessing undesirable slopes or in areas where the landscape needs to be shaped severely and engineered for more specific purposes like hillside farming or roadway overpasses.

## 5. CONCLUSION

### 5.1 Problems Which Found During Project

1. It has been observed during excavation, for the purpose of soil report, that seepage water is available at a depth of 2.5 meter, while the boring depth for soil report is 9m.
2. In surrounding structures, there is a problem of basement deformation due to high

water table.

3. There is a problem of dampness on the faces of sub structure.

## **5.2 Challenges Faced Due To the Above Mentioned Problem**

1. There was a problem in the excavation process due to high water flow. It becomes a problem to control seepage water from coming out and carry out the excavation work easily for footing work of construction work.
2. Due to deformation of basement floor, basement cannot be used for parking, warehouse or any other purposes. Hence seepage water has to be controlled anyhow.
3. A problem occurs during concreting for PCC work in foundation due to continuous flow of seepage water from the ground and side faces of excavated pits.
4. Cracks are developed in basement wall due to seepage pressure of outer side of basement wall.

## **5.3 Solutions Proposed**

1. We gave design of retaining wall to prevent seepage of water from the surrounding areas. We propose two types of retaining wall; one is brick masonry retaining wall while the other one is composite retaining wall made up of brick masonry and Reinforced Cement Concrete.
2. To prevent the deformation of basement flooring, we gave trimix flooring with Reinforced Cement Concrete instead of Plain Cement Concrete. So that it can resist water from below the ground level and deformation of basement flooring can be resisted.
3. In addition to it, we choose accelerators type admixtures in proper ratio in concrete mix to decrease the setting time of concrete, earlier strength of concrete and execution of construction work in high water table condition.

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# MODIFICATION IN POWER PRESS MACHINE TO INCREASE PRODUCTIVITY AND QUALITY

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## **Abstract:-**

The power press is an important machine tool which is used to change the shape of metal. In the ancient times metal was shaped manually using hand hammers. Later on big hammers were used to press large quantities of metal at a time, or to press a thick metal work piece. A helper was specially required to swing the sledge hammer while smith positioned the work piece. Then after steam power and wind mills were utilized to operate the large steam hammers. Later on due to electrification, most of the power presses now use electrical power or hydraulic power to obtain the required pressure. At the same time various types of dies were also discovered for use within the power press. Moreover advanced methods and high accurate machines were also invented. Today the power presses are categorized based on the mechanisms either mechanical press or hydraulic press [1][2].

**Keywords:** *Power press machine, stripper bolt, dent mark*

## **1. INTRODUCTION**

Power press machine is used for the production for the part used in car by Honda Company. It consists of 250 ton force for the different processes like punching, shearing, blanking, forming, bending and sizing. Stoppages occur due to different reasons and that will result in poor productivity, poor quality, waste of material, waste of electricity. So it is necessary to eliminate this type of machine stoppages. Different stoppages that have been find out are loosening of stripper bolt, breakage of stripper bolt, resetting of machine, bending of raw material sheet and dent marks. Solutions of these stoppages are given in this paper and this will also help to reduce the manpower on 250 ton power press machine in order to reduce cost of the product. Specifications for the 250 ton power press machine and the details of the raw material is given in below table:

|                      |                     |
|----------------------|---------------------|
| Machine Name         | 250 Ton Power Press |
| Product Name         | Honda Support       |
| Crank Shaft Diameter | 165 mm              |
| Slide Adjustment     | 70 mm               |
| Hole in Ram          | 63 mm               |
| Hole in Bed          | 229 mm              |
| Length of Bed        | 1067 mm             |
| Width of Bed         | 778 mm              |
| Distance Bed to Ram  | 544 mm              |
| RPM                  | 1440                |

|                          |                 |
|--------------------------|-----------------|
| Approximate Weight in KG | 11700           |
| H.P.                     | 25kW            |
| Raw Material             | Stainless Steel |
| Raw Material Size        | 286 X 2.90 mm   |

**Table.1. details of the power press and raw material**

Final product comes out from the power press is used in Honda car assembly. Different processes involved in production of final product are as below punching, shearing, blanking, forming, bending, and sizing. Due to some stoppages occurs during operation continuous production cannot be achieved. Because of these stoppages productivity and quality of product is reduced. Also different types of wastages involved like waste of time, waste of material, wastage of power, waste of manpower so total cost of final product is increased. So these problems must be eliminated to increase productivity, quality and profit.

By taking the observation of machine during production we have found out certain problems (stoppages) that occur repetitively are as below:

- I. Loosening of stripper bolt
- II. Breakage of stripper bolt
- III. Resetting of machine
- IV. Bending of raw material sheet
- V. Dent mark

## **2. SOLUTION FOR STOPPAGES**

### **2.1 Loosening of stripper bolt:**

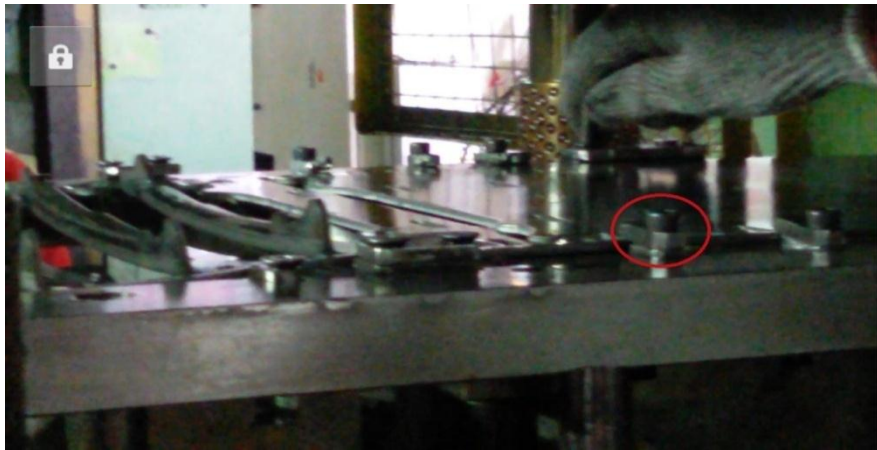
Introduction of problem: During the operation when load applied on the stripper, stripper along with stripper bolt move downward. For the downward movement of stripper springs are given and for downward movement of the stripper bolt space is provided below the stripper bolt. When load applied on the stripper, stripper bolt strike with base plate loosening of stripper bolt occurs. This type of loosening of stripper bolt occurs 8 to 10 times in an hour.

Solution of problem: Due to the why-why analysis it came to know that the stripper bolt space provided in the base plate is insufficient. So, there is requirement to increase the space provided in the base plate for the downward movement. So, stripper bolt space is increased by 5mm.

### **2.2 Breakage of stripper bolt:**

Introduction of problem: As discussed in above problem the stripper bolt space provided in the base plate is insufficient. Due to the repetition of strike between base plate and stripper bolt, the breakage of the bolt occurs. Due to breakage of the bolt during operation the stripper bolt falls inside the cutting tool assembly. So whole cutting tool has to disassemble to remove bolt. This will take 40 to 50 minute. This type of breakage of bolt occurs 2 to 3 times in one day.

Solution of problem: After elimination of the loosening of bolt problem this problem can also be eliminated.



(a)

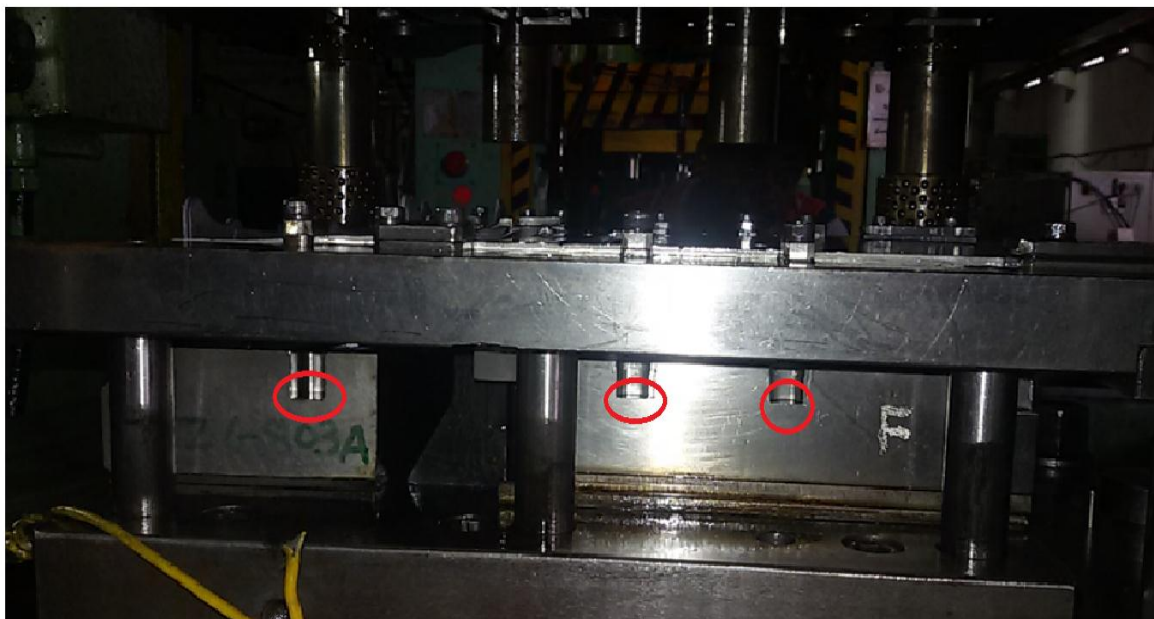


(b)



(c)

**Fig.1. Before the modification (a) assembly (b) maintenance (c) stripper bolt failure**



**Fig.2. After the modification**

**2.3 Resetting of machine:**

Introduction of problem: During operation sometimes due to the low air pressure machine suddenly stops and operator has to reset the machine.

Pressure for Machine before Improvement:

|                          | ON Condition |         | Pressing Condition |         |
|--------------------------|--------------|---------|--------------------|---------|
|                          | Maximum      | Minimum | Maximum            | Minimum |
| Clutch Pressure          | 4.57         | 3.59    | 4.27               | 3.29    |
| Counter Balance Pressure | 3.90         | 3.57    | 4.20               | 3.85    |
| Cushion Pressure         | 4.81         | 4.02    | 5.01               | 4.67    |
| HOS Pressure             | 3.97         | 3.85    | 4.10               | 3.95    |

**Table.2. Pressure for Machine before Improvement**

Solution of problem: It was found out that there is leakage in air flow pipe and leakage in the oil tank. So leakage in air flow pipe is eliminated by replacing air flow pipe. Leakage in oil tank is eliminated by welding oil tank.

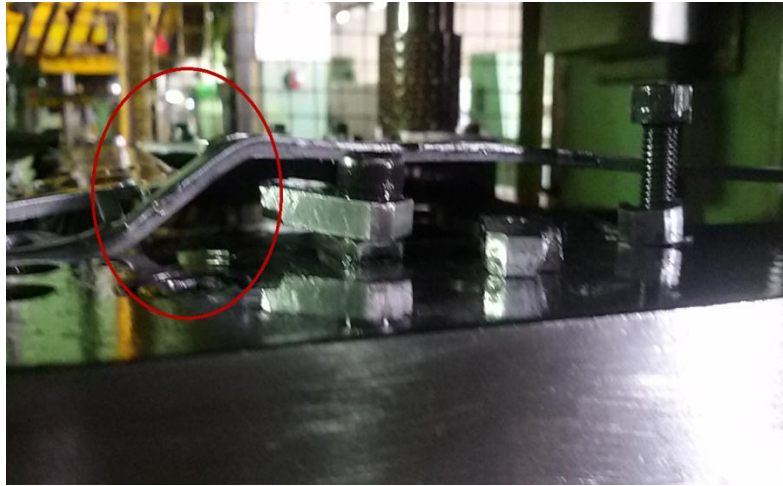
Pressure for Machine after Improvement:

|                          |        | ON Condition  |               | Pressing Condition |               |
|--------------------------|--------|---------------|---------------|--------------------|---------------|
|                          |        | Maximum (bar) | Minimum (bar) | Maximum (bar)      | Minimum (bar) |
| Clutch Pressure          | Before | 4.57          | 3.59          | 4.27               | 3.29          |
|                          | After  | 5.87          | 5.17          | 5.41               | 4.67          |
| Counter Balance Pressure | Before | 3.90          | 3.57          | 4.20               | 3.85          |
|                          | After  | 4.50          | 4.40          | 4.96               | 4.73          |
| Cushion Pressure         | Before | 4.81          | 4.02          | 5.01               | 4.67          |
|                          | After  | 5.05          | 4.90          | 6.08               | 5.10          |
| HOS Pressure             | Before | 3.97          | 3.85          | 4.10               | 3.95          |
|                          | After  | 4.25          | 4.10          | 4.25               | 4.15          |

**Table.3. Pressure for Machine after Improvement**

**2.4 Bending of Raw material sheet:**

Due to high load of the press machine raw material sheet is not coming properly from the feeder so bending of raw material sheet occurs. There were 8ft distance between feeder and machine, so due to impact of load vibration occurs in the sheet. So new servo feeder to machine is now assembled in order to decrease the vibration in raw material sheet.



**Fig.3. Bending of Raw Material**

Feeder Specifications:

|                            |                           |
|----------------------------|---------------------------|
| Type                       | Servo Driven Feeder Strip |
| Thickness                  | 3.5mm                     |
| Width                      | 400mm                     |
| 2 Main Roller Diameter     | 200mm                     |
| Supporting Roller Diameter | 200mm                     |

**Table.4. Feeder Specifications**



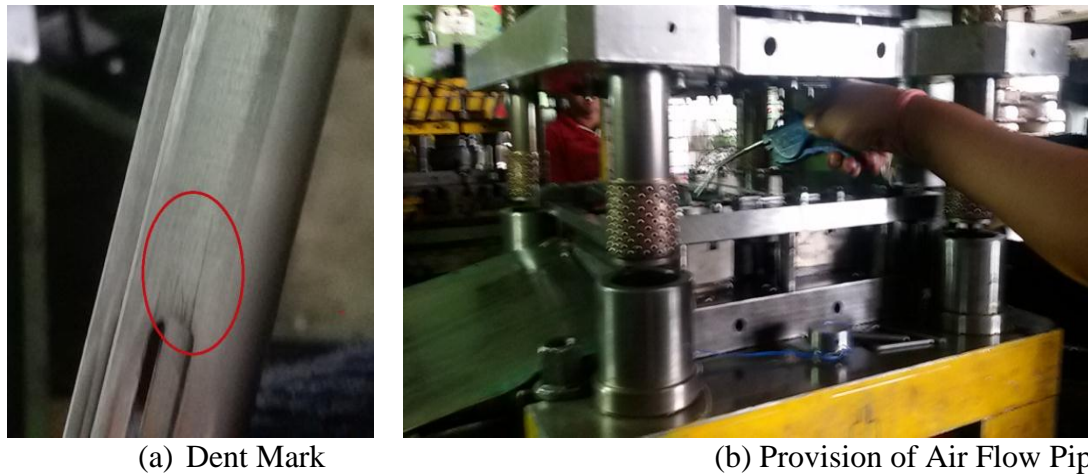
**Fig.4. New Servo Feeder**

### **2.5 Dent Mark:**

Introduction of the problem: When the final product is visually inspected, there are many linings on surface of final product called dent mark. So, produced part is not properly surface finished part. Due to not proper surface finish, on the final product is further more filing required.

Solution of problem: This problem occurs because of the strips located between the

stripper and cutting tool. Strips produced during operation remains between stripper and cutting tool. So, there is requirement of removal of strips properly. By providing air flow pipe, strips produced during operation can be removed properly in order to eliminate dent mark problem.



**Fig.5. Dent mark and its Solution**

## 2.6 Reduction in Manpower

Introduction: There is need of one operator to operate machine and one worker for the removal of the wastage or scrab. One can use conveyor for the removal of the wastage or scrab. Conveyor is used for convey the wastage or scrab of production. So after using conveyor, requirement of worker for removal of wastage and scrab is eliminated and that result in profit of the company.

Conveyor specification:

|                 |                                     |
|-----------------|-------------------------------------|
| Type            | Stainless Steel Strip Link Conveyor |
| Width           | 80 mm                               |
| Length          | 1 m                                 |
| Thickness       | 100 mm                              |
| Induction Motor | Induction Motor                     |

**Table.5. Conveyor Specifications**



**Fig.5. Provision of Conveyer for reduction in Man Power**

### 3. Result Analysis

Production rate analysis:

| Sr no. | Production before completing project (per hour) | Production after completing project (per hour) |
|--------|---|--|
| 1      | 274   | 437  |
| 2      | 321   | 492  |

**Table.6. Production Rate Analysis**

Quality Analysis:

| Sr. No                                   | 1   | 2   |
|--|-----|-----|
| Rejected piece (before) (per 1000 piece) | 116 | 125 |
| Rejected piece (after) (per 1000 piece)  | 80  | 76  |

**Table.7. Quality Analysis**

### 4. BENEFITS OF THE PROJECT

- I. Increase in productivity
- II. Increase in quality
- III. Reduction of manpower
- IV. Reduction in wastage of material
- V. Reduction in wastage of electricity
- VI. Reduction in cost of final product
- VII. Increase in profit

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# DESIGN AND MODELING OF STAIR CLIMBING TROLLEY

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## **Abstract:-**

The present paper describes the research and analysis of stair climbing trolley. Hand trolley is used to move heavy load from one place to another place. It is very common device used in large number of industry to move the physical product. Such kind of trolley does not move on stairs. To transfer heavy load or some object from bottom floor to the top floor is very difficult by using single wheel. In the industry the load is transfer by means of crane, lifting machine etc. But in civil construction site and also in home such kind of instrument is not used. So to transfer load to top floor is difficult. Such difficulty is eliminated by using stair wheels. The single wheel is replaced by means of stair wheels. Stair wheel is the combination of more than two wheels which works as single unit. Using such kind of stair wheels the load can be easily transferred from bottom floor to top floor by means of climbing the stairs or ladder step.

**Keywords:** *stair, hand-trolley, wheel-frame, shaft, gear, motor & battery*

## **1. INTRODUCTION:-**

A typical hand trolley is consisting of two wheels located at the bottom of trolley. The two handles are provided to support the frame and applied the human effort. Handles are used to push or pull the trolley. The size, shape, and position of handle are very according to requirement. Mostly shape of handle is l-shape. The wheels are mounting on shaft supported by bearing. The material used to make trolley is different according to the working load. To carry heavy load the trolley is made from stainless steel and to carry moderate load trolley made from mild steel. The load is mounting on top of the trolley. In some cases rectangular box is provided to carry the load. The material for rectangular box is very according to the working load. Sometimes holes, or square slot is provided to reduce the weight and such kind of trolley is used for light weight application. The types of trolley used are wheeled trolley, folding trolley, kitchen trolley, and motorized trolley.

Stair climbing trolley is designed to lift the high weight with less human effort. Conventional hand trolley is designed to movement on flat surface but it cannot move on irregular surface or on stair (step of ladder) [2] [3]. In stair climbing trolley more than two wheels are provided. These combinations of wheels are works as single unit. In stair climbing trolley three wheels are connected to the shaft by means of triangular plate or straight rod. Such kind of trolley is very useful in civil construction, transfer books in library and also used in home. When person are injured at that time to lift load by using such kind of trolley is very easy. The main component to design the motorized stair climbing trolley is wheel-frame, wheel, shaft, gear, motor, battery and bearing.

## 2. LOAD ANALYSIS OF STAIR CLIMBING TROLLEY

### 2.1 Weight calculation

- (1) Motor - 1kg
  - (2) Battery - 9 kg
  - (3) Container and frame - 16 kg (mild steel)
  - (4) Shaft - 1 kg (45c8)
  - (5) Gears - 1.3kg (cast steel)
- Total weight = 30 kg approx.

### 2.2 Shaft design

#### Shaft material – 40C8

From the space diagram shaft diameter is calculated as per combined twisting moment and bending moment [1].

Gear tangential force,

$$W_t = \frac{2T}{D} = 111.11 \cong 112 \text{ N}$$

Normal load acting on gear tooth,

$$W_c = \frac{W_t}{\cos 20} = \frac{112}{\cos 20} = 119.18 \cong 120 \text{ N}$$

Vertical component of  $W_c$ ,

$$W_{cv} = W_c \times \cos 20 = 112 \text{ N}$$

Horizontal component of  $W_c$ ,

$$W_{ch} = W_c \times \sin 20 = 41.04 \cong 42 \text{ N}$$

Reaction from trolley

Vertical load analysis,

$$R_{av} \times 520 = (500 \times 60) + (112 \times 60) + (500 \times 460)$$

$$R_{av} = 556 \text{ N}$$

$$R_{bv} = 556 \text{ N}$$

Horizontal load analysis,

$$R_{ah} \times 520 = 42 \times 260$$

$$R_{ah} = 21 \text{ N}$$

$$R_{bh} = 21 \text{ N}$$

Bending moment,

$$M_{dv} = R_{av} \times 60 = 33360 \text{ N mm},$$

$$W_{ev} = r_{bv} \times 60 = 33360 \text{ N mm},$$

$$M_{cv} = 112 \times 260 = 29120 \text{ N mm},$$

$$M_{ch} = 42 \times 260 = 10920 \text{ N mm},$$

$$M_c = \sqrt{(29120)^2 + (10920)^2} = 31100 \text{ N mm},$$

$$M_d = 33360 \text{ N mm},$$

$$M_e = 33360 \text{ N mm},$$

Equivalent twisting moment,

$$\begin{aligned} T_e &= \sqrt{M^2 + T^2} \\ &= \sqrt{(33360)^2 + (5000)^2} \\ &= 33732.61 \text{ N mm} \end{aligned}$$

Now,

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

$$33732.61 = 0.19625 \times 50 \times d^3$$

$$d^3 = 3435.9754$$

$$d = 15 \text{ mm}$$

## 2.2 Bearing Selection

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Selecting a ball bearing with minimum inner diameter of 30mm, minimum load carrying capacity of 50kg radially and speed greater than 100 r.p.m [7].

**Bearing selected - SKF 6006 open deep groove ball bearing**

15x30x13mm

Inside diameter: 15 mm

Outside diameter: 30 mm

Width: 13 mm

## 2.3 Motor Selection

Motor is used to convert the electric energy in to the mechanical energy.

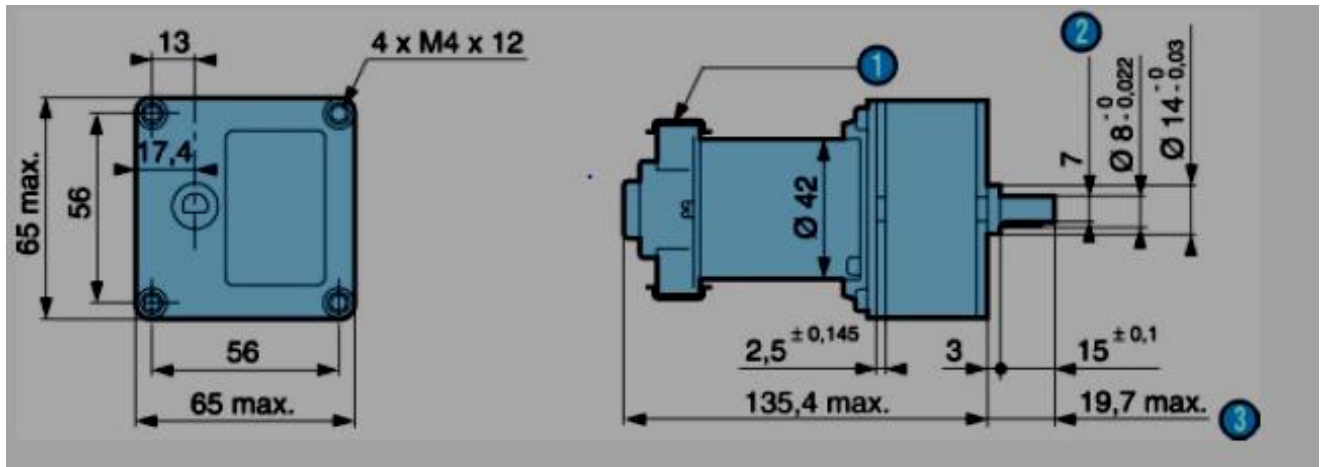
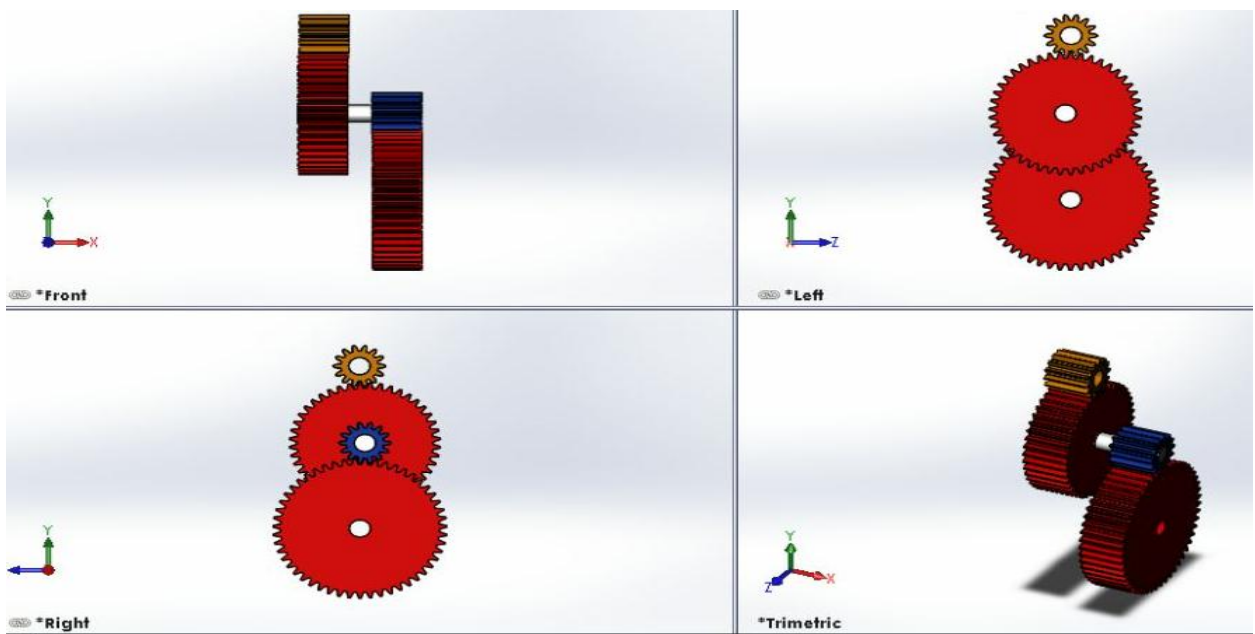


Fig.1. Motor Configuration

Motor type - Crouzet Motors of RC65  
 Power - 17 watt  
 Torque - 5 Nm  
 Weight - 0.8 kg  
 Voltage- 24 v  
 Speed - 200 RPM

## 2.4 Gear Train Calculation

Gear material - Cast Steel



**Fig.2. Gear Train**

**(1) Gear train 1:**

Where,  $n = \text{r.p.m}$

$t = \text{number of teeth}$

$d = \text{diameter of gear}$

$g = \text{gear ratio}$

Now,

$$N_1 = 200 \text{ r.p.m}$$

$$T_1 = 14$$

$$D_1 = 42 \text{ mm}$$

$$m = 3 \text{ mm}$$

$$N_2 = 40 \text{ r.p.m}$$

$$G_1 = \frac{N_1}{N_2} = \frac{200}{40} = 5$$

$$G_1 = \frac{T_2}{T_1} = 5 \Rightarrow T_2 = 5 \times T_1$$

$$= 5 \times 14$$

$$= 70 \cong 72$$

$$D_2 = m \times T_2$$

$$= 216 \text{ mm}$$

**(2) Gear train 2:**

Now,

$$N_3 = 40 \text{ r.p.m}$$

$$N_4 = 20 \text{ r.p.m}$$

$$G_2 = \frac{N_3}{N_4} = \frac{40}{20} = 2$$

$$G_2 = \frac{T_4}{T_3} = 2 \Rightarrow T_4 = 2 \times T_3$$

$$= 2 \times 14 = 28$$

$$D_3 = m \times T_3 = 3 \times 14 = 42 \text{ mm}$$

$$D_4 = m \times T_4 = 3 \times 28 = 84 \text{ mm}$$

### Checking gear train:

Here, gear and teeth are made from steel material whose permissible bending strength is  $540 \text{ N/mm}^2$ . Here gear and pinion both are made from same material so the pinion is weak. Here pressure angle is  $20^\circ$  full depth.

$$Y_{pp} = 0.484 - \frac{2.87}{T_1}$$

$$= 0.484 - \frac{2.87}{14} = 0.279$$

$$Y_{pg} = 0.484 - \frac{2.87}{72} = 0.444$$

$$\sigma_{bp} = \frac{540}{3} = 180 \text{ N/mm}^2$$

Now, bending strength of pinion is,

$$F_d = \sigma_{bp} \times Y_{pp} \times m \times b$$

$$= 180 \times 0.279 \times 3 \times 30$$

$$= 4519.8 \text{ N}$$

Velocity  $v$  is,

$$v = \frac{\pi DN}{60000} = \frac{3.14 \times 48 \times 200}{60000} = 0.5024 \text{ m/s}$$

Tangential force,

$$F_t = \frac{2 \times T}{D} = \frac{2 \times 5000}{48} = 208.33 \text{ N}$$

Dynamic load,

$$F_d = F_t + \frac{21 \times V (bC + F_t)}{(21 \times V + \sqrt{bC + F_t})}$$

$$= 208.33 + \frac{21 \times 0.5024 ((402.9 \times 30) + 208.33)}{((21 \times 0.5024) + \sqrt{(402.9 \times 30) + 208.33})} = 1276.60 \text{ N}$$

Now calculating factor of safety  $FOS = \frac{F_b}{F_d} = \frac{4519.8}{1276.60} = 3.54$

Here factor of safety is greater than 3 so our design is safe.

Similarly calculating for second gear train we get 10.41 factor of safety so it is also be a safe.

### 3. RESULT AND DISCUSSION

#### 3.1 front view and isometric view of stair climbing trolley

The fig shows the solid works model of stair climbing trolley. The fig 7 shows the wheel frame travel on the stair without interference. The fig 7 shows the actual working of the wheel frame.

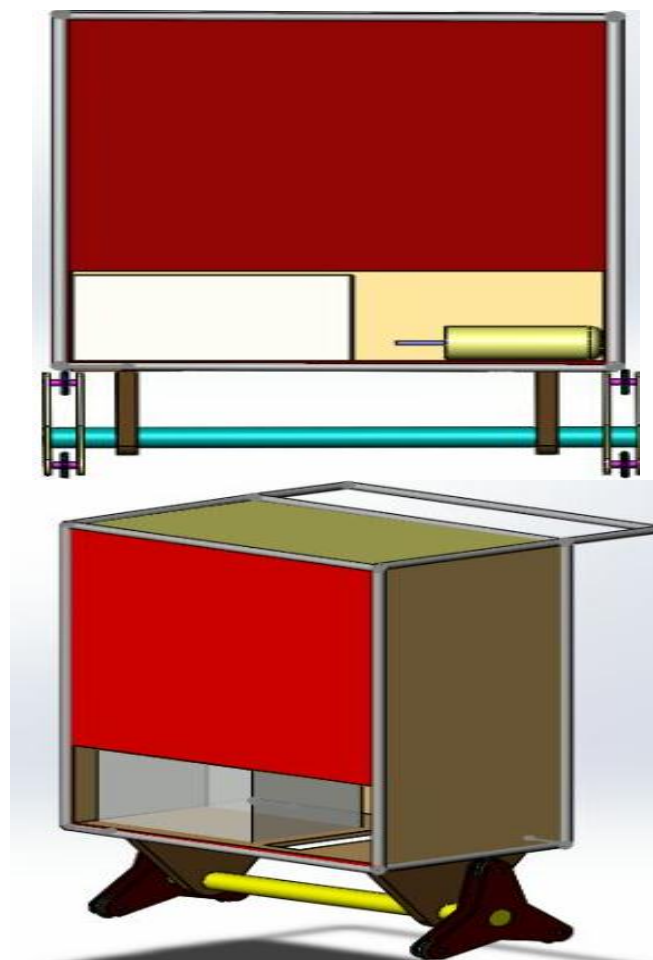


Figure.3. Front view and isometric view of stair climbing trolley

#### 4. CONCLUSION

Design has certain limitations such like high power consumption and produce high noise during the working. As far the commercial aspects of this product are concerned, if this product is fully automated and produced at a lower cost, the acceptance will be higher.

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# CUTTING MACHINE FOR RECYCLING PLASTIC STRIP

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## **Abstract:-**

The Present Paper Describe the Research and Analysis of cutting machine for the recycling plastic strip. In the plastic industry for making the plastic strip for packing material and box strapping the plastic pallets are used [5]. This type of plastic strip is made by using extruder machine but if there is any impurity in the plastic material then the plastic strip making process is cut-off and there is some waste of the plastic material in the form of strip. For recycling of the wastage plastic strip generally the melting process is used. But it is also economical and more time consuming process. The effort of the machine is to make pallets of the plastic from waste of plastic material in short span of time with less cost. In this type of machine by using pressure rollers and blades the wastage plastic strip can be easily transferred to the pallets. We decided to make this machine because plastic is not an environment free material and it is wasted more than enough. So with the help it can be minimized up to certain and specific limit.

**Keywords:** *Nut bolt, coupler, pressure roller, blades, Shaft, Gear, electric Motor.*

## **1. INTRODUCTION:**

In the most of the plastic industries which makes box stripping and packing material the plastic is used as a raw material. At the starting of the process the raw material is in the form of the bigger shape. Then by using grinding machine or mills the raw material is converted into small pallets and further process of mixing pallets with powder is taken place in the mixer machine. The mixing of pallets with the powder gives different types of colour to the end product. After mixing the material is inserted into the extruder machine and then by passing through the die and rollers the plastic strip forms. But if there is any impurity in the mixing material or due to power cut during the process then there is some wastage of plastic material.

If the production is 1000 kg per day then 100 kg is as wastage. Generally for recycling the waste material the recycling (melting) process is used. But it is very economical and time consuming process. The cost for recycling of the wastage caused by process is Rs.6.5 per kg. By using the strip cutting machine the waste strip can be recycled very easily and economically. If there is a use of automatic plastic strip cutting machine then its cost is only 0.5 Rs per kg electricity cost. So there is need to design some automatic machine for recycling the waste plastic. The main component to design the automatic plastic strip cutting machine is frame, nut bolt, flange coupling, pressure roller, blades, Shaft, Gear, electric Motor & power supply, and bearing.

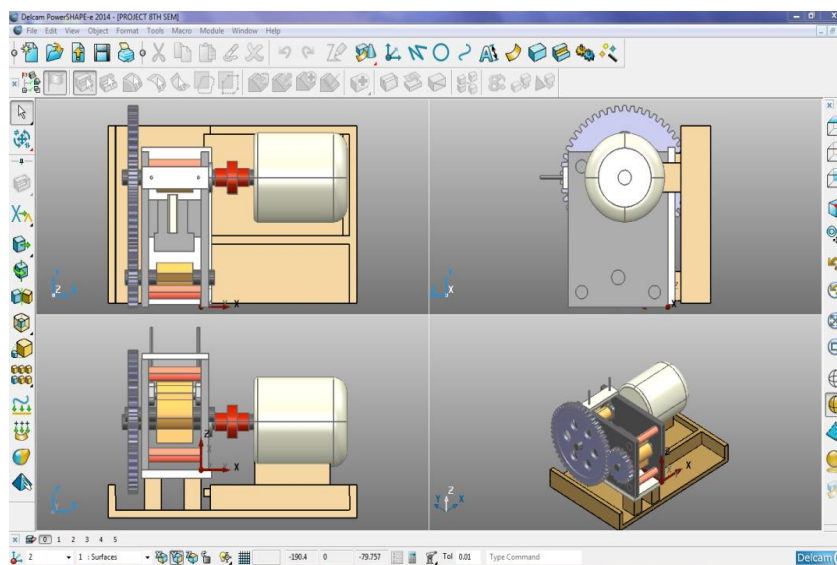
## **2. GENERAL ARRANGEMENT OF MACHINE:**

Different general arrangement designs were made after the brain storming session and the final proposed design is shown in Fig. 1. The solid model of the proposed design was made in Del Cam modelling software. Various components used in proposed design are mentioned in Table.1.

**Part List Table:**

| Sr. No | Part Name              | Material    |
|--------|------------------------|-------------|
| 1      | Blade                  | H.S/n-8     |
| 2      | Bearing                | White metal |
| 3      | Gear                   | FG 200      |
| 4      | Cutter Shaft           | 40C8        |
| 5      | Square Colum           | 40C8        |
| 6      | Couple                 | 40C8        |
| 7      | Pressure Roller        | 40C8        |
| 8      | Base Plate             | Cast iron   |
| 9      | Plate                  | 40C8        |
| 10     | Bolt (12 mm × 1.25 mm) | 40C8        |

**Table. 1 Part List Table**



**Fig. 1 General Arrangement Drawing of a Proposed Design in Del Cam software**

### **3. SELECTION OF DIFFERENT PARTS OF THE WASTE PLASTIC STRIP CUTTING MACHINE**

#### **3.1 Shaft selection**

Here the shaft is used to transmit the motion from the electric motor to the cutting blades. Generally the shaft Diameter is Calculated as per the Combined Twisting Moment and Bending Moment theory.

But in this machine the blades are used for cutting the plastic material and as we know that the plastic material is very easy to cut. So the stress value will not be that much higher and one can select the standard shaft which is easily available in the market.

Specifications of the shaft selected for this machine:

Diameter: 30 mm

Material: 40C8

#### **3.2 Electric motor selection**

Motor is connected to the shaft by means of a coupling. The selection of the electric motor depends upon the requirement of the output in the form of the pallets from strip. Depending up on the requirements flange mounted single phase motor with 0.5 hp rating and 2800 input RPM is selected.

#### **3.3 Gear selection**

Gear can be defined as the mechanical element used for transmitting power and rotary motion from one shaft to another shaft by means of progressive engagement of projection called teeth.

##### **Specifications:**

Diameter of bigger gear: 144mm

Diameter of smaller gear: 60mm

No. of teeth on bigger gear: 120

No. of smaller gear: 40

Material: FG 200

#### **3.4 Selection of blade**

Blade is defined as a sharpen edge plate which is used to cut some kind of material. In this cutting machine the use of the blade is to cut the waste plastic strip by means of shear. It is fitted on the shaft.

##### **Specifications:**

Length: 78mm

No. of blades: 4

Material: 18-4-1 High Speed Steel

#### **3.5 Bearing selection**

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is

stationary and the other is attached to the rotating assembly. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearing having minimum inner diameter of 20 mm, and speed greater than 2800 rpm is selected.

**Bearing Selected - SKF 6006-2Z [1] Open Deep Groove Ball Bearing**

$d = 30 \text{ mm}$

$D = 55 \text{ mm}$

$B = 13 \text{ mm}$

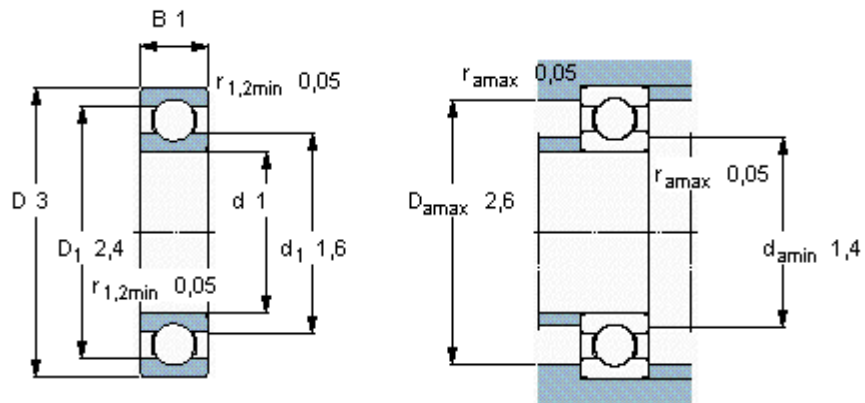
Dynamic load rating,  $C = 13.8 \text{ kN}$

Reference speed = 28000 RPM

Weight = 0.12 kg

Material of bearing: white metal

Here the white metal is selected for the bearing because it has high bending strength.



**Fig.2. Bearing Selection**

**4. ACTUAL MODEL**



**Fig.3. Working Machine**

**5. ADVANTAGES**

- I. Maintenance cost is low.

- II. Easy construction.
- III. Maximum capacity is 18 to 20 tonnes per month.
- IV. It requires less space.
- V. Worker with less skill can also handle this machine.
- VI. Transportation and erection is very easy.

## **6. FEATURES**

- I. Robust , simple and compact design
- II. Easy installation in production line
- III. Low noise level
- IV. Easy maintenance

## **7. CONCLUSION**

- I. The efficiency of a machine is based upon how much plastic waste is obtained in one hour.
- II. In this process plastic strip is converted into small strip by using this cutting machine.
- III. In this process one can avoid the melting process of plastic strip instead the plastic is used for recycling purpose.
- IV. Saving of minimum 3000 Rs per day by using this machine.

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## **RECENT TRENDS IN CYBER SECURITY: A COMPREHENSIVE SURVEY**

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**Abstract:** In the last four decades internet has caused a dramatic change. It has enabled flows of information including entertainment, news, financial or academic materials. It has brought people closer by introducing various means of communication like e-mails, instant messaging, social networking sites etc. It has also allowed consumers to purchase goods online like clothes, electronics, home appliances etc. with direct access to wide range of markets any time. The internet has helped people to grow faster with the resources and enrich their knowledge with the happenings in the world within seconds. In a very short period of time, it has become almost impossible for us to imagine a world without instant and continuous access to internet. But with this fast pace development, it leads to the so called 'Digital Divide' [18] which can be termed as the technological gap between the people. The paper discusses the current scenario of cyber security in India with statistics based on the report of IC3. The paper also highlights the survey on how people use their passwords and how much they are aware about the security.

*Keywords:* Cyber Security, Cyber Crimes, Passwords, Security

### **1. INTRODUCTION**

With the rapid growth in the number of computing devices and the corresponding increase of Internet use and online activities, many practices in everyday life tend to be computerized because of the considerable need it represents. However, activities such as online payments, money transfers and online communication can be subjected to different types of threats likely to impair the integrity, confidentiality or availability of information. And this can result in acts like forgery, computer fraud, illegal trade practices, pornography, offences related to content and offences related to intellectual property etc.

The internet crime complaint centre (IC3) has firmly established its role as a valuable resource for both victims of Internet crime and law enforcement agencies investigating and prosecuting these crimes. Here the figure below shows the top five countries that were ranked by the total number of complaints received by IC3 in 2013.

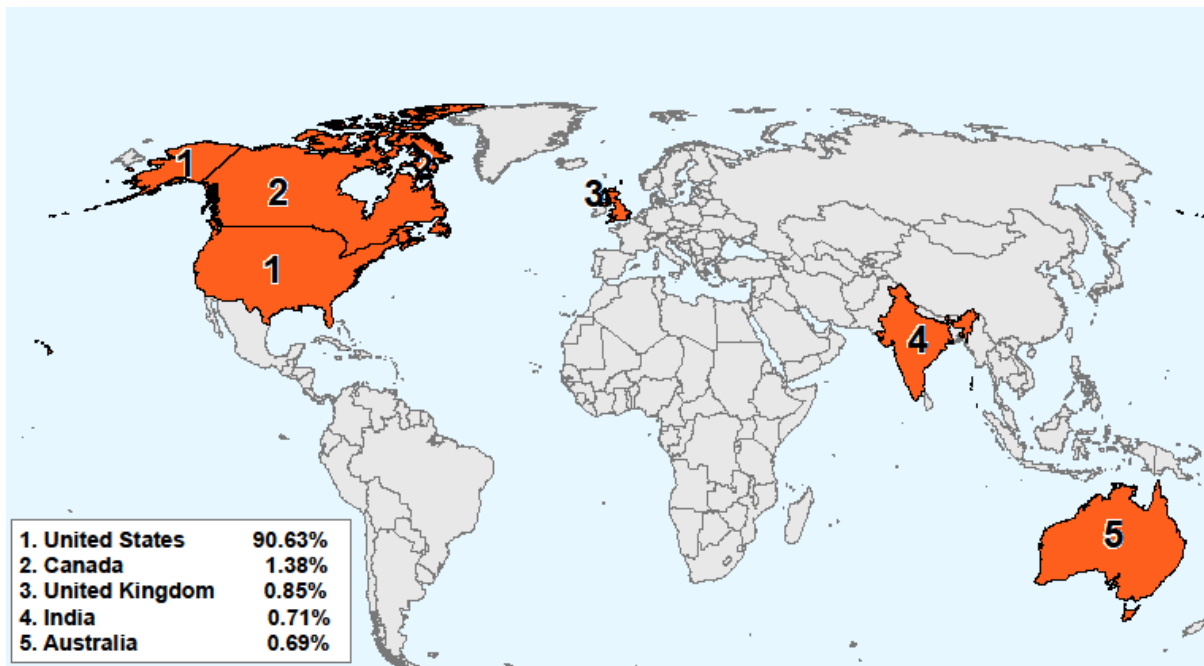


Fig 1: Top five countries ranked by the total number of complaints registered to IC3 in 2013.[17]

In an interview to NDTV in March 21, 2013, the Google Executive Chairman stated that there are estimated 600 million mobile users and 130 million internet users in India along with 20 million broadband users. Facebook in July, 2012 reported to Times of India stated that it has 50 million users in India, and most of them are accessing Internet through mobile phones.[[www.timesofindia.indiatimes.com/topic/facebook-in-july-2012/](http://www.timesofindia.indiatimes.com/topic/facebook-in-july-2012/)] In its 2013 report, Facebook further reported that as of December, 2012, it has 71 million users in India. These reports indicate how much the Indian youth has made internet communication mediums such as Google and Facebook part and parcel of their everyday affairs. It should also be noted that India has also shown sufficient growth towards e-governance and e-banking and this has been ensured by National Telecommunication Policy, [17] 2012. But at the same time, it also needs to be understood that millions of internet users in India are unaware of cyber safety and security essentials, netiquettes and proper forums for reporting crimes.[17]

For the law enforcement firms, IC3 serves as a conduit to receive internet related complaints, to conduct research related to them and to generate reports for the law firms nationally and internationally. Many countries like Canada, United States, Germany etc use the research made by IC3 as a model for similar cybercrime centres in the countries. Below the figure shows the complaints registered by IC3 yearly in thousands [17].

## IC3 Complaints by Year



Figure 2: IC3 complaints by year [17]

For the victims, IC3 provides a convenient and easy way to file complaints and report to the authorities about the suspected criminal activities. IC3 every year reports the complaints registered every year and presents demographics of the complaints registered by males and females and even people from different age groups. Here table below shows the demographics of 2013:

| Gender | Count   | Percentage |
|--------|---------|------------|
| Male   | 137,096 | 52.27%     |
| Female | 125,717 | 47.73%     |

| Age      | Count  | Percentage |
|----------|--------|------------|
| Under 20 | 8,796  | 3.4%       |
| 20 – 29  | 48,032 | 18.3%      |
| 30 – 39  | 54,780 | 20.8%      |
| 40 – 49  | 55,838 | 21.2%      |
| 50 – 59  | 55,459 | 21.1%      |
| Over 60  | 39,908 | 15.2%      |

Also, internet is global village; there is no restrictive boundary for any-one to access it. Whether it be school going children, college students, technological masters, corporate officials or retired personnel each and every one is over the web, it may be for official work or personal. Tata Consultancy Services had conducted survey “GenY 2012-13” whose main objective was to conduct a nationwide study that would capture the trends and pulse of the youth across the nation with a focus on technology. The study comprehended and compares the difference among the school students in metros and mini metros of India. The survey included 14 cities across India which had 17, 748 students from 1660 schools in the age group of 12-18 years. The survey consists of the exclusive study on the information access trends, social networking preferences, future education mind-sets, career interests and youth aspiration products.

| Questions Asked                                     | Categories Included  | Survey Insights  |
|---|--|--|
| 1. Most Favourite gadget used by the students?      | Mobile, MP3 Players, Tablet, Computer, Laptop, Gaming Console, Camera                    | Mobile emerged the principle device for students.  |
| 2. Most registered social networking site?          | Facebook, Twitter, Orkut, LinkedIn, Other  | Social Life is clearly lived online. And Facebook is the most used medium.                           |
| 3. Time spend by the students in a day on internet? | 1-2 hrs, 30-60 minutes, 2-3 hrs, 15-20 minutes, <15 minutes                              | One in four are online for 60+ minutes and 50% of them spend 30+ minutes.                            |
| 4. Purpose for accessing the internet?              | Movies, Listen/Download Music, Access Email, Chat/Connect/Blog, Research School Subjects | Project work and academic research for information is the highest followed by the social networking. |
| 5. Communicating mostly through which medium?       | Instant Messaging, Email, Voice call, SMS, Facebook                                      | Most used are facebook and instant messaging for communication.                                      |

Above are some of the results which says about the most favourite gadgets used by the students, what social networking sites they have registered with, how much time in a day they spend on accessing the internet, why do they access the internet and what all ways they use to communicate.

The results highlights that from all the gadgets given them as the category 30 % of the students chose mobile phones rather smart phone as their favourite gadget. Approximately 82% of the students were registered with facebook given linkedin, twitter, orkut etc in the category. Also, from instant messaging, SMS, emails etc facebook is the most used way of communication. And most students were found to spend 1-2 hrs daily on internet either for chatting, researching for their projects or for emails, out of which approximately 72% of the students switched to internet for researching for their projects.

Lastly, discussing the facts and figures from IC3 and the survey by TCS, the rest of the sections would discuss about the cyber security, current state of art in India, Issues in cyber security, survey on passwords, and some case studies regarding cybercrimes and cyber security.

## **2. STATE OF ART: CURRENT SCENARIO OF CYBER SECURITY IN INDIA**

Exploitation of cyber space is increasing world over and India too is facing problems in securing itself from the world of cybercrimes. Cyber Security in India is an alien concept for Indian Government for long. According to Praveen Dalal, managing partner of New Delhi ICT law firm Perry4Law and CEO of PTLB( Perry4Law's Techno Legal Base), "*India is a sitting duck in the cyberspace and civil liberties protection regime*"[15]. This is because Cyber security initiatives and projects in India are in numbers which are negligible. Even if some projects have been proposed, they have remained on papers only. Projects like National Cyber Coordination Centre (NCCC) of India[], National Critical Information Infrastructure Protection Centre (NCIIPC) of India etc have failed to materialise so far. The National Cyber Security Policy of India 2013 also failed to take off and even if it is implemented it is weak on numerous aspects like privacy violation in general and civil liberties infringement in

particular[15]. And it would not be wrong to mention that India is a sitting duck in cyberspace and civil liberties protection regime.

Trends in cyber reports show that maximum cases of cybercrimes in 2013 were of hacking the computer systems, transmission of obscene messages or images in electronic form came distant second in category. A total 2,516 cases were registered in 2013 for hacking with computer systems with 1,011 arrests. The numbers for "obscene publications/transmission in electronic form", stood at 1,203 cases registered, with 737 arrests. Offences under "hacking of computer systems" are calculated under the two subheads of "loss/damage to computer resources/ utility" and "hacking"[9].

The NCRB(National Crime Record Bureau) data shows that cybercrimes registered under the IT Act rose sharply by 51.5% from 2012 to 2013 and those registered under the Indian Penal Code, by 122.5% for the same time period. If taken together, they would constitute an increase of 63.73 % overall. According to the NCRB report, of the total 2,098 arrests made under the IT Act in 2013, 1,190 were between the ages of 18 and 30. 45 were below the age of 18. Advisor at the cybercrime cell, Gurgaon Police, said that this is largely a result of the younger generation lacking "cyberhygiene and cyberetiquette." [9].

Thus the emerging technologies are designed to engage users in an active and comfortable environment, thereby necessitating that technological competency demands skills in communication and collaboration. But more than to be competent socially, an individual must be competent personally by securing himself/herself, and this requires security awareness among the individuals. One of the famous Cyber-lawyer in Delhi has said that "We cannot "Enact laws" but we can use "Counter Technologies" to prevent illegal and unconstitutional e-surveillance and eavesdropping[15]. Self-defense and privacy protection in India must be ensured by us at our own level and for this awareness is must"[15].

### **3. ISSUES IN CYBER SECURITY**

Cyberspace is a part of everyone's life, every-day. We use internet at work, home, for entertainment and to connect to the close ones residing in any corner of the world. And with every comfort comes risk, and so with the increase in use of cyber its security comes in picture which is a big question to be answered. There are some issues which are to be considered while dealing with cyber security:

#### **A. Cybersecurity Landscape of India is changing**

The recent cybercrimes cases registered with cybercrime cell of India indicates that there has been an extraordinary surge in the cyber-attacks at the global level. Malware like Stuxnet, Flame, Blackshades, Finfisher etc have been messing up with computer systems located in the different parts of the world. For instance, Ebay faced sophisticated cyber-attacks and as a result of the same it is facing legal actions in United States and European countries. Similarly, the U.S. Department of Homeland Security (DHS) has reported that a hacking group had recently attacked a U.S. public utility and compromised its control system network [1]. India is also not safe from these cyber-attacks and thus cyber security awareness is needed at a global level.

#### **B. Cyber Security and International corporation**

Cyber-attacks have turned global in nature. Initially cyber-attacks were conducted just for fun, but now the scenario has become devastating as the cyber-attacks are now used to gain strategic and sensitive information for the country of interest. This gives rise to the need of international legal laws for the cybercrimes. Similarly the cyber security breaches in India would raise serious security issues in the near future. In order to effectively analyse and prevent future cyber-attacks, companies and individuals must adopt suitable cyber security breach notification to appropriate cyber authorities of India [15].

### C. Need of Mandatory Reporting mechanism

India is a very late starter as far as cyber security is concerned. The speed of cyber security initiative of India is still very slow. Further, there is no dedicated cyber security law of India that can be used in different cases of cybercrimes, cyber-attacks and cyber contraventions. The information technology act, 2000 is ill suited to take care of the cyber security related issues in India[15].The internet services providers (ISPs) are also not sharing information pertaining to cyber-attacks against their networks. As a result, a robust cyber security strategy to counter cyber-attacks cannot be formulated. Also various technological updates and different ways how the cybercrime is conducted need to be conveyed to the people using internet in their daily life. And to achieve this a dedicated system and proper laws are required.

### D. Cyber Security Education

Cyber Security in itself is a specialized field. There is no proper education given to the youth regarding the privacy policies and security for the technology they are using. A child is taught not to talk to strangers, keep the doors lock when alone at home but he is not taught how to keep himself/herself safe over the web by locking the email accounts and computers.

## 4. SURVEY ON PASSWORDS

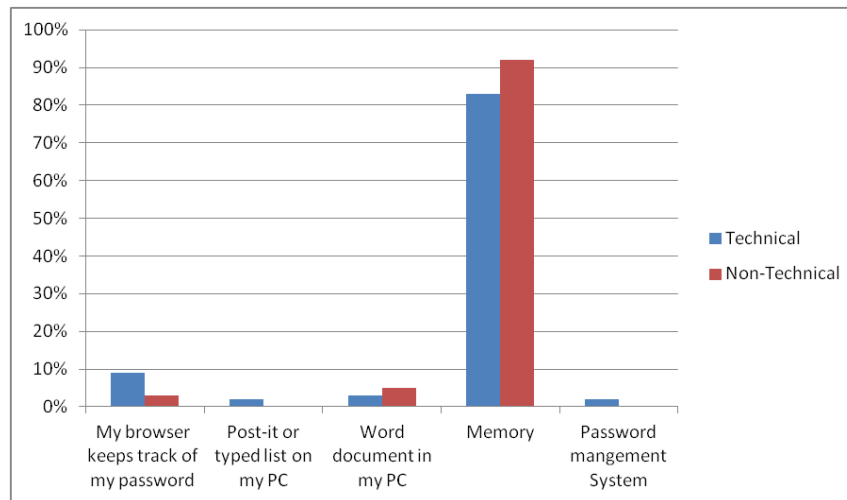
The latest data released by National Crime Records Bureau (NCRB)[9], showed that the cybercrimes registered under the IT act increased up to 50% across the country between 2012 and 2013. The government data shows that hacking forms close to 60% of all cyber offences (under IT Act) in India followed closely by obscene or derogatory postings (28%). The data indicate how deep internet has penetrated in India as only 45% of all hacking cases were reported from the 88 cities covered. Rest all came from small towns or rural areas. Even in the case of obscene/derogatory posts rural areas and small towns reported 60% of cases[9].

Hacking is compromising the computer systems and retrieving the information from the systems. This compromises the computer security which leads to many cybercrimes like gaining access to someone's personal information, confidential information and using this for illegal purposes. The basic step in securing computers or email accounts or personal accounts on internet is having secured passwords. Passwords are the only way, a user can authenticate himself/herself over the web. Passwords nowadays are required for each and every purpose like social networking sites, net banking, online shopping, emails etc. A survey was conducted to check the basic awareness regarding passwords among the technical and non-technical people. Below results shows the survey results which includes the question which

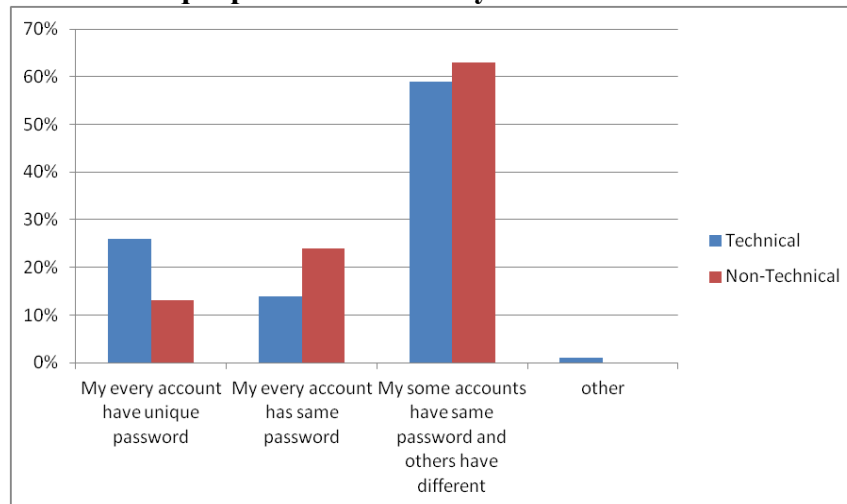
were asked, following by the categories which were included. Survey Insights highlights the category which was chosen by maximum number of the people.

## Survey Results

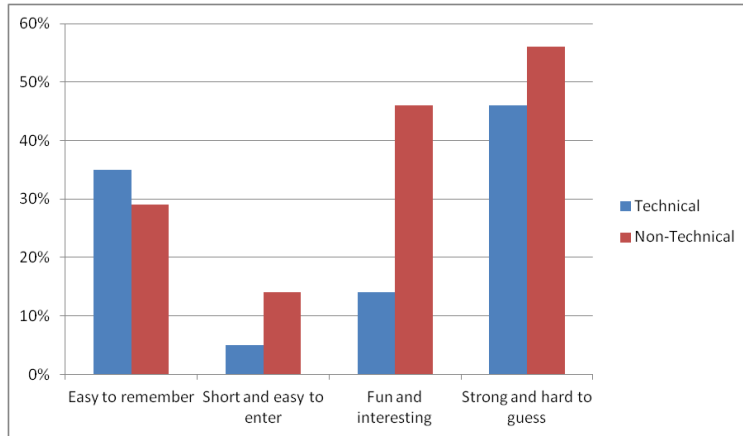
### 1. How do you remember your password?



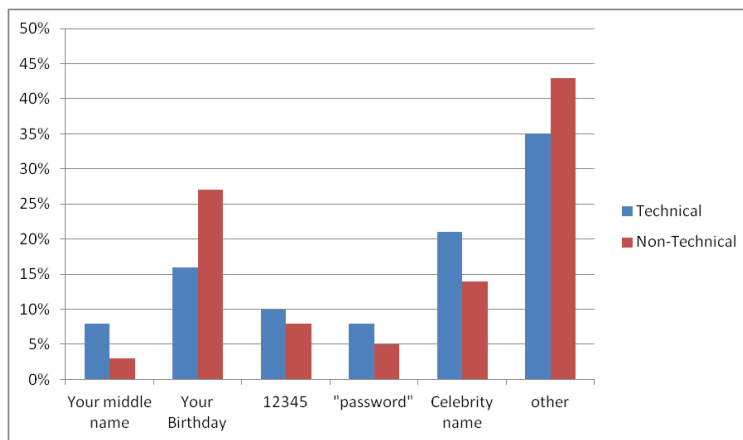
### 2. Do you have a unique password for every account?



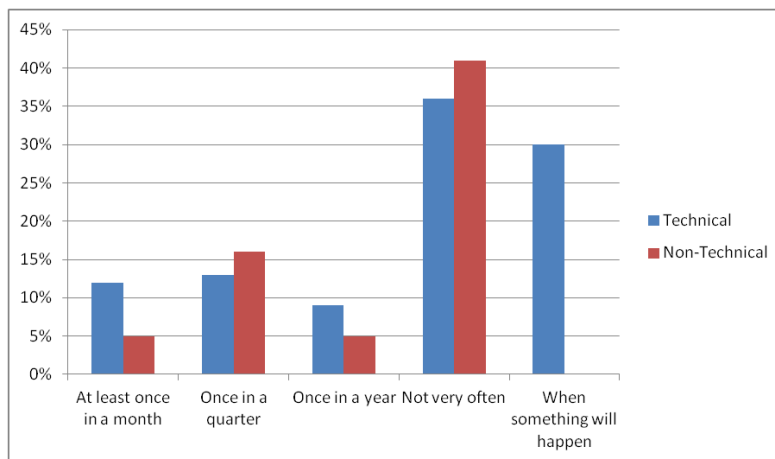
### 3. Which of the following are the most important factor while selecting a new password?



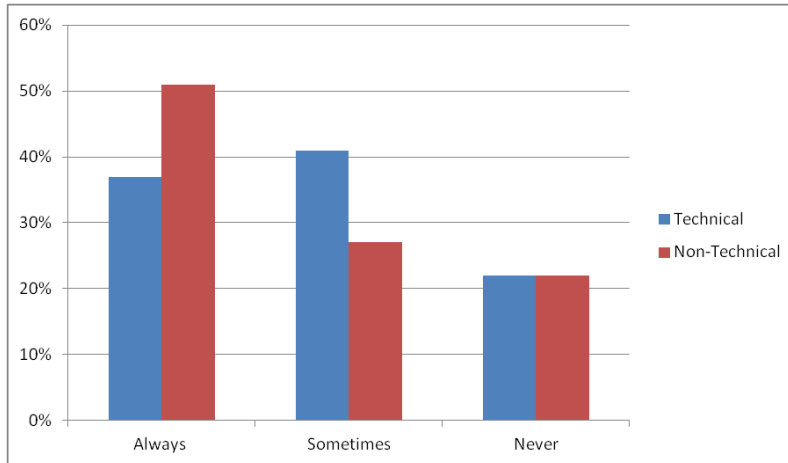
**4. Which of the following you have used for your password?**



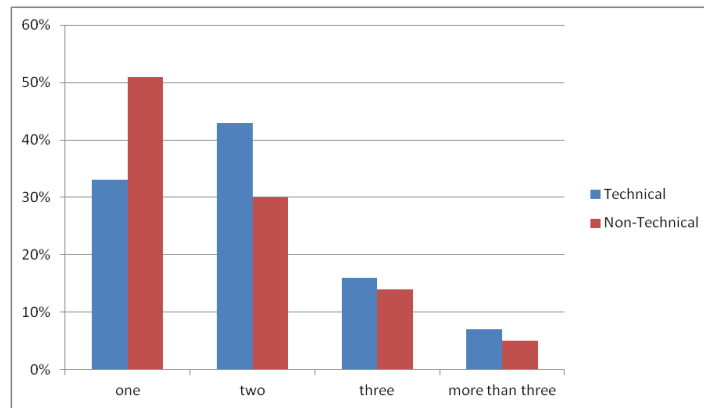
**5. How often do you change your password?**



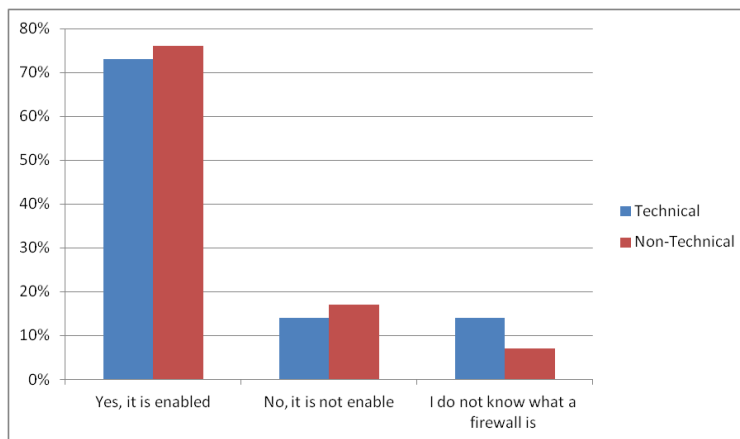
**6. Are your accounts always logged on in your phone or PC?**



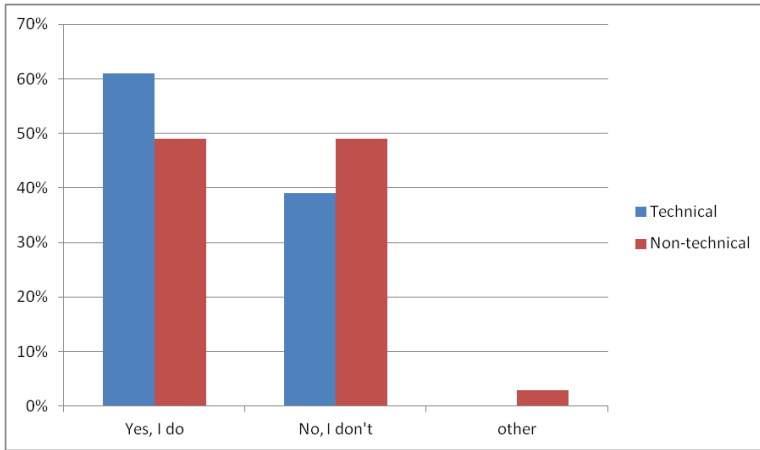
**7. How many browsers are you using?**



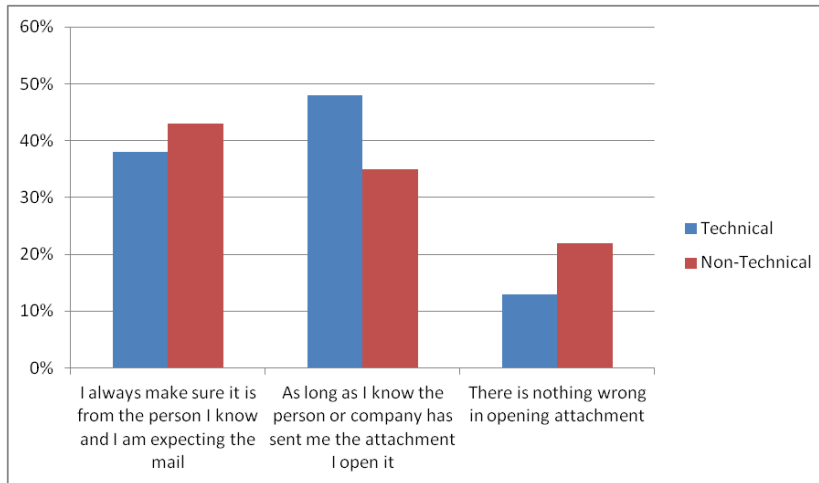
**8. Is the firewall on your computer enabled?**



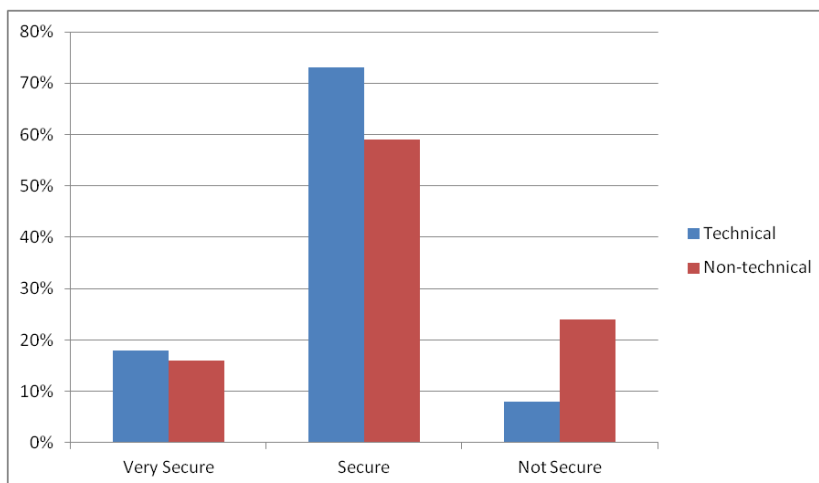
**9. Do you know what a phishing attack is?**



**10. How careful are you when you open an attachment in your email?**



**11. How secure you feel your computer is?**



**12. Do you know how to tell your computer is hacked or infected?**

The survey insights show that the basic need for security i.e. password has different perceptions for different people. How people remember their password, how frequently they change their password, what all things they keep in mind while choosing their password, whether they are aware of the different technical terms regarding attacks, attachments, hacking etc in which ways their system can be compromised and so on. Technical as well as non-technical people need to be aware of these various aspects which should be considered for securing themselves over the web.

Nowadays, to ensure security many banking firms have started using One Time Password (OTP) which is valid only for one time at the time we have logged in on the portal. Even at times session timeout concepts are also used along with the OTP, in which the password is valid only for a particular duration. Many educational websites have now added validation rules regarding the passwords which are chosen by the students for example including special characters, numbers, alphanumeric digits, capital letters etc. in the passwords. This in turn makes the passwords strong which cannot be encrypted easily.

## **5. CONCLUSION**

As we have seen the cybercrime rates which is increasing year by year, their rises the need for its awareness and more over how to tackle crimes which are committed in different ways every other day. The cybercrime officials should be taught the technology or new officials should be hired which are technology equipped. To add to this effort, the director general of police in Mumbai has sent 13 officers to an academy in US to undergo special training to tackle cybercrime cases.

Also Homeland Security, USA have taken an initiative to educate and engage people all over the country with goal of raising awareness about cyber-security and increasing the resiliency of the nation in an event of a cyber-incident[]. They have started a campaign “Stop, Think and Connect” by celebrating October 2014 as National Cyber Security Awareness Month in which they will promote online safety, they will discuss about the development of the IT products, critical infrastructure and Internet of Things, cyber security for small and medium sized businesses and cybercrime and law enforcement.

These kind of initiatives are required to engage public into the technology where they are safer and secure. This also helps in the development of the nation economically and technologically.

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# **DESIGN METHODOLOGY OF A LOW NOISE AMPLIFIER FOR WIRELESS COMMUNICATION**

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## **Abstract:-**

This paper presents the design methodology of a Low noise amplifier for wireless communication. The essential theory and practical consideration of Low noise amplifier are gathered and organized to a uniform presentation. This will be helpful to the circuit designer of low noise amplifier [1]. The design of an LNA in Radio Frequency (RF) circuits requires the trade-off of many importance parameters such as gain, noise figure (F), stability, power consumption and complexity. This situation forces designers to make choices in the design of RF circuits [2]. In LNA design, the most important factors are low noise, moderate gain, matching and stability. Besides those factors, power consumption and layout design size also need to be considered in designed works.

**Keywords:** Low noise amplifier, noise figure, Gain, Stability factor, Stability Circle, Bias Circuit

## **1. INTRODUCTION**

Amplification is the most basic circuit functions in modern RF and microwave system. To amplify the receive signal in a RF system, a low noise amplifier is required. Because any noise injected by the components in a system is amplified by later gain stage along with the signal [1]. It is essential that the signal be amplify early in the receiver chain while adding a little noise as possible. A Low noise amplifier plays a crucial role in overall performance of any receiver system. LNA is first block of the RF receiver and it has dominant effect on the overall noise performance of the receiver [1]. LNA Design presents considerable challenges because of its simultaneous requirement of the low noise figure, high gain, good input output matching network and unconditional stability at the lowest current drawn from the amplifier.

## **2. LNA DESIGN STEPS**

General Steps for microwave amplifier design

- On the basis of the application and S parameter select a suitable transistor
- Calculate the stability factor K
- If  $K > 1$ , then design input output matching networks.
- Plot input and output reflection coefficient and associated gain and noise and stability of the transistor
- If  $K < 1$ , then add some resistive components to stable the circuit on the entire range of the frequency at the expense of the gain. Do this step unless the circuit is stable over the entire range of the frequency.
- Perform the step 4
- Add DC biasing and again the stability of the transistor.
- Generate the layout of the circuit.

### **2.1. LNA Block Diagram**

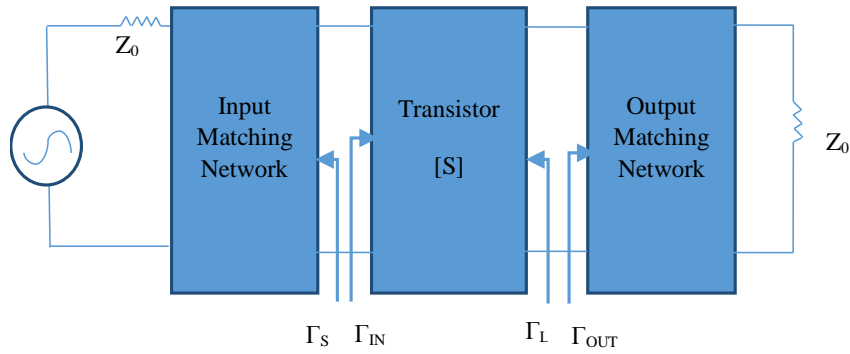


Figure 1 : General LNA Schematic<sup>[10]</sup>

## 2.2. SELECTION OF THE TRANSISTOR

Three types of the transistor that always are being used to design the low noise amplifier. The types of model are bipolar, FET and MMIC. The bipolar junction transistor was the first solid-state active device to provide practical gain and noise figure at microwave frequencies. In the seventies, breakthroughs in the development of Field Effect Transistors such as GaAs Metal Semiconductor Field Effect Transistor (MESFET) led to the higher gain and lower noise figure than bipolar transistors for the frequencies in the range of several gigahertz. Currently, advanced FETs and bipolar transistors still compete for lower noise figure and higher gain at frequencies in excess of 100 GHz. Examples are the High Electron Mobility Transistor (HEMTs), such as Pseudomorphic High Electron Mobility Transistors (pHEMTs), Metamorphic High Electron Mobility Transistor (MHEMTs), as well as Heterojunction Bipolar Transistors (HBTs), built using a variety of semiconductor materials likes GaAs, InP, Si, SiGe and many more [3]. The CMOS and MIMIC is the transistor that be used to design the low noise amplifier. Unfortunately, the cost to design the low noise amplifier using CMOS or MIMIC is very expensive.

## 2.3. STABILITY CONSIDERATION

Unconditionally stability of the circuit is the goal of LNA design. Unconditionally stable means that any load present at source and load the circuit will not oscillate. The way of determining the stability of the device is to calculate the Rollett's stability factor (K), which is calculated using a set of the parameters for a device at the frequency of the operation [4].

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|} \quad (1)$$

$$\Delta = S_{11}S_{22} - S_{12}S_{21} \quad (2)$$

$S_{11}$  = Input reflection coefficient

$S_{12}$  = Output reflection coefficient

$S_{21}$  = Reverse transmission gain

$S_{22}$  = Forward transmission gain

K &  $\Delta$  gives us to an indication whether the device is conditionally stable or unconditional stable. The parameter must satisfy the  $K > 1$  and  $\Delta < 1$  for the unconditional stable transistor. For the  $K < 1$ , so, transistor is conditional stable. That means for any load or source value transistor will oscillate. There are some different techniques to enhance the stability [4].

## 2.4. STABILIZATION TECHNIQUES

If a given transistor is unstable, it can be stabilized by inserting a series or parallel resistor connected either to its input or output of the terminal. To add stabilization a resistor to either the input or output of the transistor, the stability circles are drawn on the smith chart. The admittance circle that is tangent to input stability is used to determine the value of input parallel resistance. The impedance circle that is tangent to input stability is used to determine the value of input series resistance. Similar procedure can be used for output stability circle.

Input and output stability circles drawn on smith chart for finding the resistor value which make the transistor unconditional stable [5].

### 2.5. STABILITY CIRCLES

For the conditionally stable transistor, it is necessary to draw the input and output stability circle on smith chart to define the stable area region. These values of  $\Gamma_S$  and  $\Gamma_L$  lie in circles known as stability circles. The circles are defined by their radius and centre, which are found to be [6]

$\Gamma_S$  values for  $|\Gamma_{OUT}| = 1$  (Input Stability Circle)

$$r_S = \frac{|S_{12}S_{21}|}{||S_{11}|^2 - |\Delta|^2} \quad C_S = \frac{(S_{11} - S_{22}^* \Delta)^*}{|S_{11}|^2 - |\Delta|^2} \quad (3)$$

$\Gamma_L$  values for  $|\Gamma_{IN}| = 1$  (Output Stability Circle)

$$r_L = \frac{|S_{12}S_{21}|}{|S_{22}|^2 - |\Delta|^2} \quad C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2} \quad (4)$$

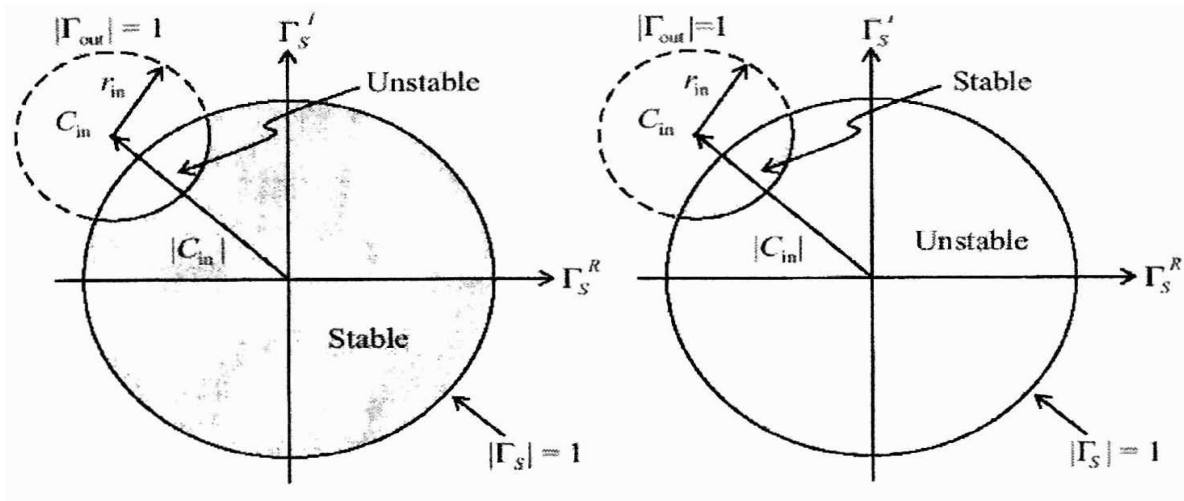


Figure 2: Input Stability Circle <sup>[10]</sup>

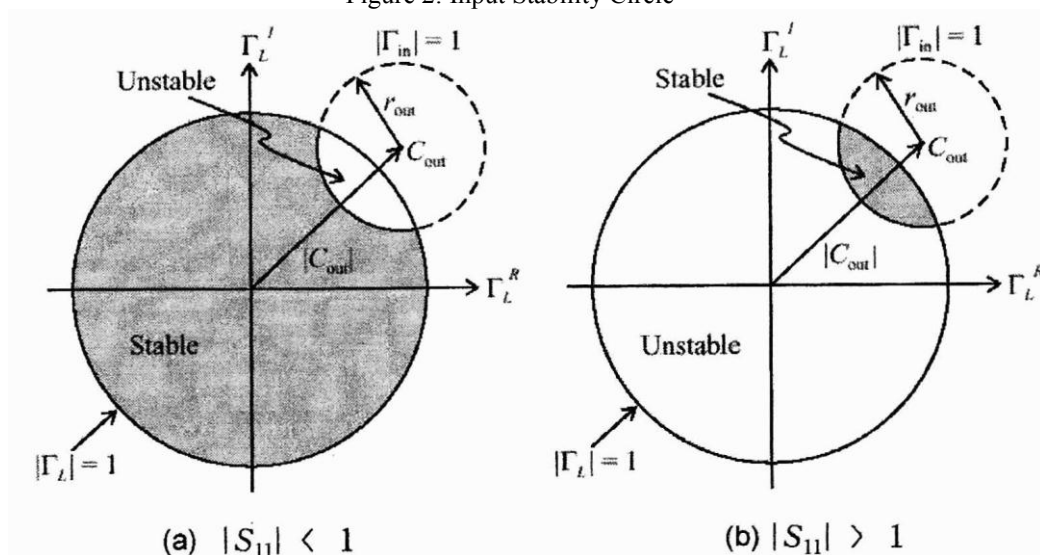


Figure 3: Output stability Circle <sup>[10]</sup>

### 2.6. UNILATERAL FIGURE OF MERIT, U.

If the signal flow in the reverse direction is much smaller than the flow in the forward direction then it's possible to make the simplification that the reverse flow is zero [10]. The

Unilateral Figure of Merit, U is a quick calculation that can be used to determine where this simplification can be made without significantly affecting the accuracy of the model. A transistor is said to be unilateral if the signal/power bounced back from the output to the source is equal to 0. This occurs if the reverse transmission coefficient,  $S_{12}$  or the reverse transducer power gain,  $|S_{12}|$  is equal to 0. In order to determine how close to ideal unilateral a network is, the Unilateral Figure of Merit, U has been defined as follows [7]:

$$U = \frac{|S_{12}||S_{21}||S_{11}||S_{22}|}{(1-|S_{11}|^2)(1-|S_{22}|^2)} \quad (5)$$

Error limits on unilateral calculations:

$$\frac{1}{(1-U)^2} < \frac{G_t}{G_{tu}} < \frac{1}{(1+U)^2} \quad (6)$$

This will decide whether to go for Unilateral and bilateral design.

## 2.7. CALCULATION OF $\Gamma_S$ & $\Gamma_L$

It is desired to conjugate match the amplifier to maximize the amplifier transducer gain.  $\Gamma_{in} = \Gamma_S^*$  will yield maximum power transfer from the input matching circuit to the transistor. Also, will provide maximum power transfer from the transistor to the output matching circuit [7]. Therefore, a simultaneously conjugate match requires  $\Gamma_{in} = \Gamma_S^*$  and  $\Gamma_{out} = \Gamma_L^*$

$$\Gamma_S = \frac{B1 \pm \sqrt{B1^2 - 4|c1|^2}}{2c1} \quad \Gamma_L = \frac{B2 \pm \sqrt{B2^2 - 4|c2|^2}}{2c2} \quad (7)$$

$$B1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 \quad (8)$$

$$B2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2 \quad (9)$$

$$C1 = S_{11} - \Delta S_{22}^* \quad (10)$$

$$C2 = S_{22} - \Delta S_{11}^* \quad (11)$$

$$\Gamma_{in} = \left| S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1-S_{22}\Gamma_L} \right| \quad \Gamma_{out} = \left| S_{22} + \frac{S_{12}S_{21}\Gamma_S}{1-S_{11}\Gamma_S} \right| \quad (12)$$

## 2.8. NOISE FIGURE

Signals and noises applied to the input port of amplifier were amplified by the gain of the amplifier and noise of amplifier itself is added to the output. Therefore, SNR (Signal to Noise Ratio) of the output port is smaller than that of the input port. The ratio of SNR of input port to that of output port is referred to as noise figure and is larger than 1 dB [8]. Typically, noise figure of 2-port transistor has a minimum value at the specified admittance given by formula:

$$F = F_{min} + \frac{R_N}{G_S} |Y_S - Y_{opt}|^2 \quad (13)$$

For low noise transistors, manufactures usually provide  $N_{opt}$ ,  $F$ ,  $R$ ,  $Y$  min by frequencies.  $N$  defined by formula for desired noise figure:

$$N = \frac{F - F_{min}}{4R_N/z_0} |1 + \Gamma_{opt}|^2 \quad (14)$$

## 2.9. NOISE PARAMETERS

To describe the characteristics of the noise, one must consider the following parameters:

1. NFmin

2.  $R_n$
3.  $\Gamma_{opt}$

These are the three basic parameters need to be considered.  $NF_{min}$ , is the minimum possible noise figure which a transistor can give;  $R_n$ , is the noise resistance of the transistor;  $\Gamma_{opt}$ , is the optimum reflection co-efficient. So, these are some of the terms to keep in mind before designing an amplifier.

## 2.10. CONDITION FOR MATCHING

The scattering coefficients of transistor were determined. The only flexibility permitted to the designer is the input/output matching circuit. The input circuit should match to the source and the output circuit should match to the load in order to deliver maximum power to the load [9]. After stability of active device is determined, input/output matching circuits should be designed so that reflection coefficient of each port can be correlated with conjugate complex number as given below.

$$\Gamma_{IN} = \Gamma_S^* = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1-S_{22}\Gamma_L} \quad (15)$$

$$\Gamma_{OUT} = \Gamma_L^* = S_{22} + \frac{S_{12}S_{21}\Gamma_S}{1-S_{11}\Gamma_S} \quad (16)$$

The noise figure of the first stage of the receiver overrules noise figure of the whole system. To get minimum noise figure using transistor, power reflection coefficient should match with  $\Gamma_{opt}$  load reflection coefficient should match with  $\Gamma_{out}^*$

$$\Gamma_S = \Gamma_{opt} \quad (17)$$

$$\Gamma_{OUT}^* = \Gamma_L = S_{22} + \frac{S_{12}S_{21}\Gamma_S}{1-S_{11}\Gamma_S} \quad (18)$$

Matching Network can be designed using the LC Component, Stub method and Quarter Wavelength Transformer depending upon the requirement.

## 2.11. POWER GAIN

Several power gains were defined in order to understand operation of super high frequency amplifier. Power gains of 2-port circuit network with power impedance or load impedance at power amplifier represented with scattering coefficient are classified into Operating Power Gain, Transducer Power Gain and Available Power Gain.

### OPERATING POWER GAIN

Operating power gain is the ratio of power delivered to the load to power supplied to 2- port network. Power delivered to the load is the difference between the power reflected at the output port and the input power, and power supplied to 2-port network is the difference between the input power at the input port and the reflected power. Therefore, Operating Power Gain is represented by

$$G_P = \frac{\text{Power delivered to the load}}{\text{power supplied to the amplifier}} \quad (19)$$

$$\frac{P_L}{P_{in}} = \frac{1}{1-|\Gamma_{in}|^2} |S_{21}|^2 \frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2} \quad (20)$$

where,  $\Gamma_{in}$  indicates reflection coefficient of load at the input port of 2-port network and  $\Gamma_s$  is reflection coefficient of power supplied to the input port.

### TRANSDUCER POWER GAIN

Transducer Power Gain is the ratio of maximum power available from source to power delivered to the load. As maximum power is obtained when input impedance of circuit network is equal to conjugate complex number of power impedance, if  $\Gamma_{in} = \Gamma_s$ , transducer power gain is represented by

$$G_T = \frac{\text{Power delivered to the load}}{\text{power available from the source}} \quad (21)$$

$$\frac{P_L}{P_{avs}} = \frac{|S_{21}|^2(1-|\Gamma_s|^2)(1-|\Gamma_L|^2)}{|(1-S_{11}\Gamma_s)(1-S_{22}\Gamma_L)-(S_{12}S_{21}\Gamma_s\Gamma_L)|^2} \quad (22)$$

### AVAILABLE POWER GAIN

Available Power Gain is the ratio of power available from the source to power available from 2-port network. It is given by

$$G_A = \frac{\text{Power available from the amplifier}}{\text{power available from the source}} \quad (23)$$

$$\frac{P_{avn}}{P_{avs}} = \frac{1}{|1-S_{22}\Gamma_L|^2} |S_{21}|^2 \frac{1-|\Gamma_s|^2}{|1-S_{11}\Gamma_s|^2} \quad (24)$$

### 3. CONCLUSION

In this paper I have demonstrated the systematic procedure of design methodology of the Low noise amplifier for the wireless communication.

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