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Journal of Surveying and Structural Engineering

Aims and Scope

Journal of Surveying and Structural Engineering is the major new peer-reviewed journal for building surveyors, structural engineers and other professionals concerned with building condition, defects, valuation, repair and maintenance. The Journal's scope encompasses the diverse range of concerns in the survey, appraisal and valuation of the built environment, including –

1. Building surveys
2. Structural surveys
3. Defect investigation
4. Instrumentation and its use
5. Valuation
6. Repairs and maintenance
7. Dilapidations
8. Fit out and refurbishment
9. Building control and building regulations
10. Party wall issues
11. Remedial works
12. Acquisition surveys
13. Insurance assessment and claims
14. Measured surveys
15. Project management and monitoring
16. Sustainable buildings
17. Dispute resolution
18. Professional liability

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Contents

Time Impact Analysis on Construction Projects

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A B S T R A C T

Time impact analysis (TIA) is a forward looking tool. This analysis takes into account a schedule that does not include a delay & one which includes delay. The difference between these two schedules is considered to be the impact of delay for time duration considerations. The research includes application of TIA on two construction projects and then finding the reasons for delays of those projects. Along with the learning's of case study, i.e. the discovered causes for delays & from the literature survey done, a questionnaire was prepared & questionnaire survey was carried out. A total of 28 causes were identified and classified under 8 major groups. The total numbers of respondents in this survey were 68, out of which 32 were clients, 12 were consultants & 24 were contractors. This questionnaire was circulated among the professionals in the industry to find the factor which contributes the most to the construction project delays. Top ten causes affecting delays the most were identified. This research would be helpful for the stakeholders to act on the critical causes & further reducing the delays.

Keywords: Forward looking tool, TIA, Stakeholders, Questionnaire

1. INTRODUCTION

Construction industry is a vast industry involving number of participants & varied products. So along with this vastness & variations come various problems. These problems may be faced before construction (planning), during construction (execution), & post construction (in the form of maintenance).The overall effect of all these problems is project delays which the Project Management Consultants (PMC) need to tackle with. These project delays gives rise to extra resources, extra project cost (cost overruns). The main participants of the project are owner (company), project management consultants, structural consultants & the contractors. These parties keep on blaming each other for the project delays which take place during the project. There are continuous disputes between the owner & the contractors, which the PMC needs to resolve. The time allotted for the project performance is equally important for the client contractor and the consultants.

A construction projects, unlike any other project, is expected to be completed in a certain time that is planned ahead of starting the physical task of the project during the early phases. A construction project involves a considerable amount of finance that goes to staff, machinery and the capital investment therefore any delay in the completion time will result in huge losses. The impact of delay is experienced

by all involved parties. Some of the main effects which occur due to the delays can be named as time overrun, cost overrun, and disputes between different parties, settlements, lawsuits, and total abandonment [9].

2. RESEARCH METHODOLOGY

The research methodology for this study contains two phases. The first phase includes collection of field data by actually being on the site. The collection of data has been done in following way- prepare schedule for the project using Microsoft Project, perform monitoring & application of TIA i.e. finding the difference between the prepared schedule & the actual tracked schedule for calculating the delays occurred. The difference represents the delay in the project. Then the activities in which delays have occurred were studied & the causes for these delays were found. Along with these causes other causes for construction project delays were also found from the literature survey done. Also responsibility analysis i.e. who was responsible for the delays in the project was found.

The second phase included the formulation of a questionnaire based on the causes found from the first phase. For this a total of 28 causes were identified & classified under 8 major groups. Then this questionnaire was circulated to the stakeholders of various projects & professionals in the industry & they were asked to rank these causes or factors in the questionnaire.

3. DATA COLLECTION

The first phase contains actual data collection from two construction sites & application of TIA i.e. difference between planned schedule & tracked schedule i.e. actual time required for the activities to complete.

3.1 Case Study 1

Project - Sugar factory expansion & construction of cogeneration plant (Boiler Section), Sangamner, Dist- Ahmednagar

Client - Sahakarmaharshi Bhausaheb Thorat Sahakari Sakhar Karkhana, Sangamner

Contractor - Pratibha Constructions, Kolhapur

This project included erection of a boiler & its other supporting machinery. Basically it was a work of industrial shed along with the erection of machinery. The project duration was of 6 months & project

cost went up to 1.5 Cr. Scheduling & tracking for the project was done using Microsoft Project. The tracked schedule showing delays in the activities marked as red bar is shown in fig 1 below:

- The delay occurred in following activities
  - Casting of the footings
  - Shuttering for the columns
  - Casting of the columns

The reasons & responsible factors for the delay were-

- The payment of contractor for concreting work was not done regularly so the casting work was stopped by the contractor. (Responsibility- Client)
- The surveyor has to perform quantity, billing works too, along with the survey works so there is delay from his side for marking of shuttering of the footing which further leads to delay in casting. (Responsibility- Contractor)
- Shuttering works for the column should have been started along with the completion of the footings, but it didn't happened so, shuttering for the columns were placed after all the footings were completed. (Responsibility- Contractor)

Total financial Impact due to delay

=8000 + 7200+ (10,750+3500)

=Rs 29,450 /-

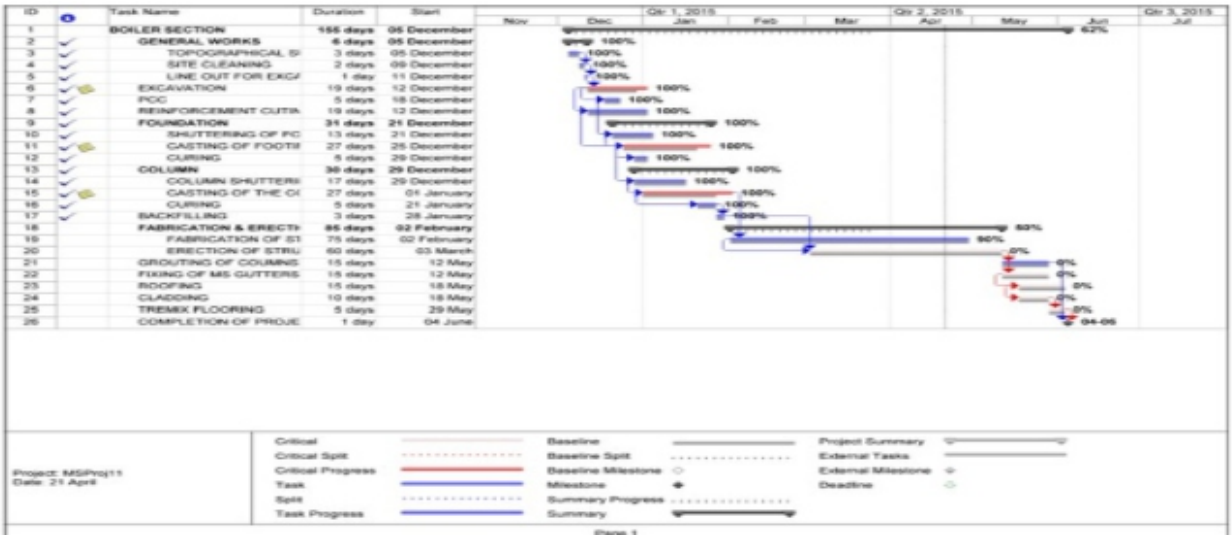

Figure 1: Tracked schedule of case study 1

3.2 Case Study 2

The reasons or responsible factors for the delay were:

Project – 84 m chimney for boiler of sugar factory.Sangamner, Dist- Ahmednagar

Client – Sahakarmaharshi Bhausaheb Thorat Sahakari Sakhar Karkhana, Sangamner

Contractor – Shree Ranga Engineers Pvt Ltd, Hyderabad

This project included construction of concrete chimney of 84 m height & 3.4 m diameter using slipform technique. The project duration was of 4 months & project cost went up to 1.5 Cr. Scheduling & tracking for the project was done using Microsoft Project. The tracked schedule showing delays in the activities marked as red bar is shown in fig 2 below.

Delay occurred in the following activities:

- Foundation of the chimney
- Setting up the slipform assembly
- Dismantling
- Mechanical ladder & platforms

- The material was supplied by the client, due shortage of 32 mm bar diameter with the suppliers, the client asked the structural designers to make changes in the design of foundation, this took time & hence a delay of 5 days occurred. (Responsibility- Client)
- RMC plant location was a bit far away on the site so the contractor was in search of miller/transit mixer for 3 days. (Responsibility- Contractor)
- Also separate electricity & water connections were not given near this chimney site by the client. (Responsibility- Client)
- There was shut down i.e. no electricity during the setting up of assembly for 2 days(Responsibility- Client)
- The wind velocity was very high which caused problems for the labours working at height for dismantling of the slipform assembly. (Responsibility- Natural)
- The client asked the contractor to keep curing the chimney continuously even when the dismantling & mechanical ladder fitting works were going on which posed problems for the labours & work has to be stopped for some time. (Responsibility- Client)

Calculations of time over-runs:

The project was to be completed on 24-03-2015, but it was completed on 7-04-2015 .There was a total delay of 10 days in the project

% time overrun = (Project delay / Original project duration) x100

% time overrun = (10/106) x 100 = 9.45 %

Total Impact= 10,000+11250+22750+21000+7000+2000

=Rs74,000

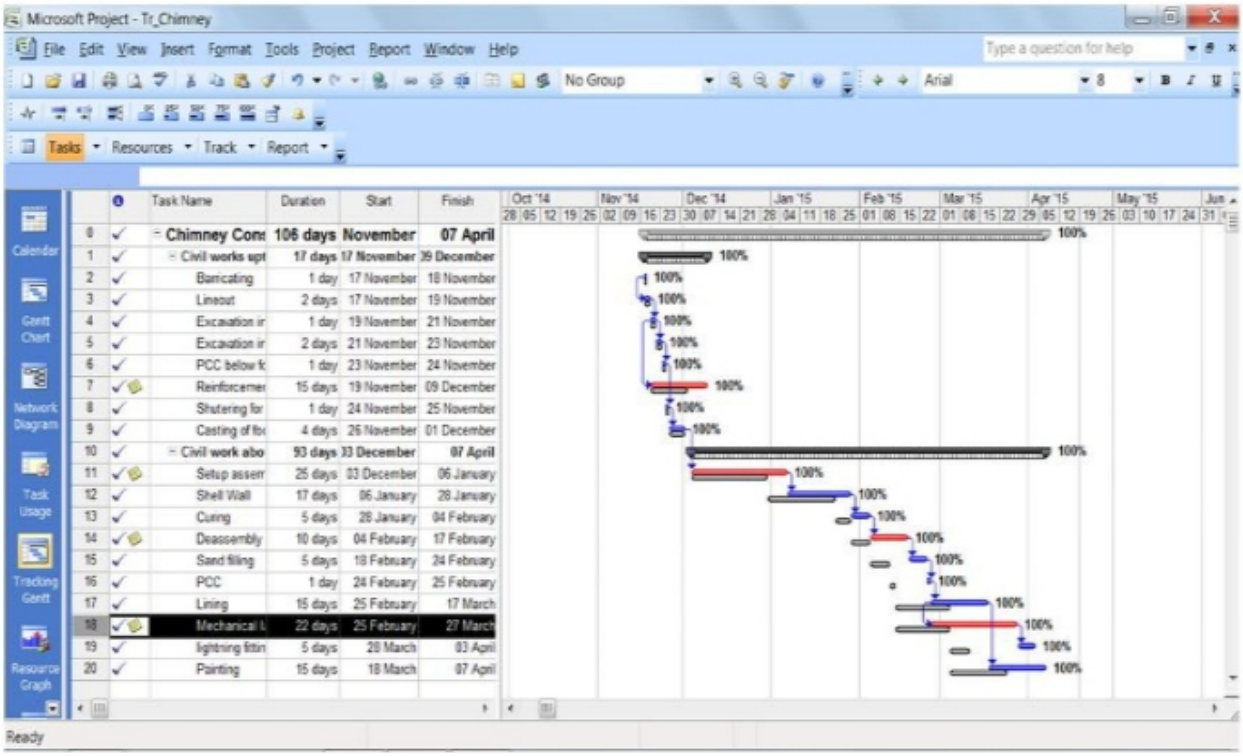

Figure 2: Tracked schedule of case study 2

4. FIELD OBSERVATIONS

From the above two case studies following observations were done.

General Causes of Delays on Construction Projects are-

1. Improper site layout (Responsibility- Contractor)
2. Excavated & demolished material was not properly dumped (Responsibility- Contractor)
3. Improper management of labour (Responsibility- Contractor)
4. Site supervisor or in charge was overloaded with extra work & had to look after number of nearby sites (Responsibility- Contractor)

5. Personnel's on site have to also perform works other than the work allotted to them(e.g.-surveyor) (Responsibility- Contractor)
6. Improper management of activities (Responsibility- Contractor)
7. If rules & regulation set by the client not followed by contractor(Safety) (Responsibility- Contractor)
8. Delay in material supply is a major cause too
(Responsibility- Contractor)
9. Change orders (Changes in design or any other specification changes by the client) (Responsibility- Client)
10. Improper maintenance & setup of equipments & plants(RMC) (Responsibility- Contractor)
11. Discontinuous & illegal supply of electricity(Responsibility- Client)
12. Shutdown (electricity or any other reason) (Responsibility- Client)
13. Delay in billing & payments of labour (Responsibility- Contractor)
14. Failure in investigation of type of strata before starting excavation (Responsibility- Contractor)
15. Fleet of equipments not managed properly(transit mixer) (Responsibility- Contractor)
16. Seasonal changes also affects the progress of the project (Environmental causes)
17. Heavy rains can stop the work completely (Environmental causes)
18. Cold weather hampered the setting of concrete & hence delay(Chimney site night shift) (Environmental causes)
19. Legal formalities & paperwork to be done for procuring materials (Responsibility- Client) (Responsibility- Client)
20. Failure of equipments (e.g. chimney site-mixer) (Responsibility- Contractor)
21. Slow decision making from client side (Responsibility- Client)
22. If timely promotions & increment of the employees is not done, they may be discouraged towards their work resulting in delays too. (Responsibility- Contractor)
23. Clearances not given from client side to start work e.g.- clearing power cables or underground conditions (Responsibility- Client)

1.3 Responsibility Analysis

The above causes were studied & analysis was done to find out who was responsible for the delays whether it was the client, contractor or environmental causes or others. Based upon the observation following analysis was done as shown in Figure 3.

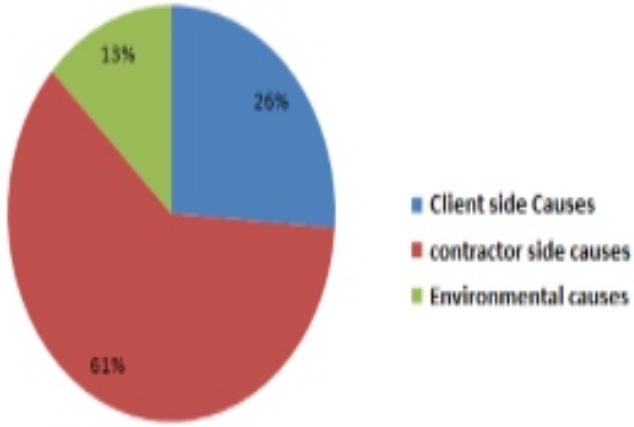

Figure 3: Pie diagram representing responsibility analysis

The results were as follows-

Client side causes - 26% +

Contractor side causes - 61%

Environmental & other causes -13%

5. QUESTIONNAIRE

Second phase consisted of preparation of questionnaire. By taking into consideration above 23 causes from on field observations & other causes identified from the literature survey done, a total of 28 causes were finalised & classified into 8 groups. The questionnaire was circulated to around 80 professionals from civil industry from the categories client, consultants, and contractors, out of which 68 professionals responded to the questionnaire. So the response rate is (68/80 * 100) 85 %, which is considered a good rate for such surveys.

1.3 Data Analysis Approach

The data analysis was carried out using Statistical Package for the Social Sciences (SPSS). SPSS was used to generate the frequency (fi) of the response category index for the delay causing factors. The relative importance index (RII) for each factor was calculated using the frequency data for each response categories generated from SPSS. The RII is the calculation of the mean frequency of each responses category index for the probability [5]. It is calculated using equation (1) given below:

$$RII = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \quad (1)$$

Where fi is the frequency of the i^{th} response and wi is the weight assigned to the i^{th} response.

6. RESULTS AND FINDINGS

After the analysis done using SPSS, ranking to the causes were given based responses given by the three categories i.e. client, contractor, consultant.

The top ten factors based on the RII by considering all the categories together are tabulated in Table no 1 below

Table 1: Ranking of all categories together

FACTORS /CAUSES	RII	RANK
DELAYED PAYMENTS & BILLS	0.782	1
POLITICAL ISSUES	0.776	2
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.767	3
LAND ACQUISITION	0.752	4
IMPROPER COMMUNICATION	0.747	5
BUILDING PERMITS & APPROVAL	0.717	6
SHOP DRAWING APPROVAL	0.691	7
MATERIAL PROCUREMENT & PRICE VARIATION	0.673	8
RAINS	0.652	9
CHANGE ORDERS	0.641	10

The top ten factors based on the RII by considering the responses of clients only, are tabulated in Table no 2 below.

Table 2: Ranking of factors by the clients

FACTORS /CAUSES	RII	RANK
POLITICAL ISSUES	0.775	1
LAND ACQUISITION	0.768	2
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.725	3
DELAYED PAYMENTS & BILLS	0.718	4
SHOP DRAWING APPROVAL	0.712	5
POOR FINANCIAL MANAGEMENT & CONTROL	0.706	6
BUILDING PERMITS & APPROVAL	0.693	7
IMPROPER COMMUNICATION	0.687	8
DECISION MAKING IN DEVELOPMENT STAGES	0.65	9
MATERIAL PROCUREMENT & PRICE VARIATION	0.606	10

The top ten factors based on the RII by considering the responses of contractors only, are tabulated in Table no 3 below.

Table 3: Ranking of factors by the contractors

FACTORS /CAUSES	*RII*	*RANK*
DELAYED PAYMENTS & BILLS	0.825	1
IMPROPER COMMUNICATION	0.775	2
CHANGE ORDERS	0.766	3
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.741	4
POLITICAL ISSUES	0.733	5
MATERIAL PROCUREMENT & PRICE VARIATION	0.708	6
BUILDING PERMITS & APPROVAL	0.7	7
LAND ACQUISITION	0.675	8
RAINS	0.666	9
SHOP DRAWING APPROVAL	0.641	10

The top ten factors based on the RII by considering the responses of consultants only, are tabulated in Table no 4 below.

Table 4: Ranking of factors by the consultants

FACTORS /CAUSES	RII	RANK
LAND ACQUISITION	0.866	1
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.85	2
DELAYED PAYMENTS & BILLS	0.816	3
POLITICAL ISSUES	0.8	4
IMPROPER COMMUNICATION	0.783	5
SITE LAYOUT CHANGES	0.75	6
BUILDING PERMITS & APPROVAL	0.75	7
CHANGE ORDERS	0.733	8
SHOP DRAWING APPROVAL	0.733	9
MATERIAL PROCUREMENT & PRICE VARIATION	0.733	10

7. SUMMARY OF FINDINGS

The objective of the research was to find the in general the causes & the responsible category for the delays of the construction projects. The results were as follows- Client side causes were 26% Contractor side causes were 61% Environmental & other causes were 13%. The top ten factors responsible for delays based on responses from all the categories of respondents were as follows - delayed payments & bills, political issues, lack of coordination in various departments, land acquisition, improper communication, building permits & approval, shop drawing approval, material procurement & price variation, rains & change orders.

8. REMEDIAL MEASURES

From the above analysis done, following are the measures which could be implemented to reduce the major delays:

I. There should be proper financial management, the contractors must submit the bill as suggested by the client & the client should see that the bills are cleared as early as possible once the bill is submitted.

ii. For proper coordination between various departments centrally located server with access to all departments as well to all the stakeholders of the project should be provided for smooth functioning.

iii. The policies for land acquisition should be such prepared that there is no injustice made to the land owners & they get proper values for their land. There should be proper negotiations between the stakeholders so the land acquisition becomes easy.

iv. The stakeholders should have clear idea about the project. Meetings & other modern communication tools like video conferencing, social networking sites should be used for improved communication.

v. The lengthy documentation process should either be reduced or digitalisation of this process should take place so a person need no to go the offices for approvals all the time.

vi. The shop drawing approvals should be fast, there should be proper communication between the contractor & the structural consultants so that the drawing is handed over to contractor on time.

vii. Inventory management should be followed along with application of techniques like ABC analysis for. The client should have an alternative material supplier for avoiding delays & price escalation.

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Cost Analysis of Green Building

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ABSTRACT

Now a days, due to effects of global warming, green building concept will be used to compensate or used to reduce the problems created from the increased temperature. The Green building is a system which deals with the various factors such as study of water conservation, study of energy conservation, reduction in the wastage, study of saving of materials etc. As well as "Green building" is defined as "a building constructed with design and construction processes which significantly reduce or eliminate negative impact of buildings on the environment and occupants." The green building is the building which uses less energy, less water and by using renewable resources energy is to be produced and it is utilize for the house. In this paper the comparison of green building with conventional building with respect to economy is studied with the help of suitable case study. It also includes study of existing green building, by carrying out survey with respect to energy saving, operating cost, saving in electricity water, to study of IEQ etc. This study also helpful to reduce the wastage, to maintain healthy and safe to the environment.

Keywords: Energy, Green Building, Saving, Material, Environment

1. INTRODUCTION

A "Green building" is defined as "a building constructed with design and construction processes which significantly reduce or eliminate negative impact of buildings on the environment and occupants." The term essentially refers to a building which is energy efficient and environment friendly in terms of minimal disturbance to environment during construction and service. It, therefore, encompasses the planning, construction processes and service performance aspects of the building. Green buildings result from integrated design and construction processes which reduce the negative impact of building on the environment and the occupants. Green Buildings are considered to be important component of any model for sustainable urban development.

Benefits of Green Building

- Reduces environmental impact through energy efficiency and waste recycling.
- Green buildings reduce construction waste by approximately 50% compared with that of similar conventional buildings.
- Helps in saving natural resources.

- Lower operational cost resulting from efficient resource use through reduction in energy and water requirements.
- Improves health through better indoor air quality.

Disadvantages of Green Building

- Initial cost of construction of a green building is high.
- No locally availability of materials.
- Requires advanced technology.
- Requirement of skilled labours.

Renewable Energy Sources

- Wind energy
- Solar hot water heating (also called solar thermal)
- Solar electricity
- Ground or air source heat pumps
- Biomass and Bio fuels

2. DETAILS OF CASE STUDY

Here we taken two case study which is Orange county phase 2 (Pune), Adwait House (Ahmednagar) .By taking out suitable case study the various parameters are to be studied.

Name of the project: Orange County, Phase 2. Location: Baner-Pashan Link Road, Pune.
Owner: 1) Mr. Sandip Sonigra
Purpose of project: Residential purpose. Consultant: Viraj Envirozing India Pvt Ltd. Total Area of construction: 21780 sq.ft.
Project highlights: 100% Green energy, STP Plant, Efficient natural light and ventilation.

3. FEATURES OF ORANGE COUNTY

- Innovative design
- Architectural planning

4. ANALYSIS OF CASE STUDY

1. Water Savings through: STP by Root Zone Cleaning System.
2. Energy Saving through:
    - Architectural Planning according to Sunlight and ventilation

- Hybrid Power System that includes two Wind Mill and 54Solar PV Panals.
- One Green Lift.
- Energy Efficient Fixtures.
- Solar Water Heating System.

Data Analysis

1. Hybrid Power Systems: The system has two wind mills and produces maximum 60 units per day.
2. Solar Water Heating System:

The maximum domestic electrical consumption is attributed to water heating. Therefore to minimize this consumption, Orange County has provided fully programmable solar water heating system of 5000 LPD i.e. Thus the "Solar Water Heating" System will save at least 7.2 units/flat/day for average 300 days. i.e. 7.2×27×300+8.7×09×300=81000 units yearly.

3. STP by Root Zone Cleaning System.

The Orange County has this RZCS STP of capacity 35, 000 liters.

Daily they get treated water of approximately 20, 000 liters without any electricity.

Total Energy Produced and Saved Yearly:

For Green Building:

- Solar wind hybrid production system- 60×300=18000 Units.
- Energy saving using Solar water heating system-81000 Units. But it is consider that 20% people may use other sources of heating water or cold water for bathing
- Therefore, only 80% should be considered.
- Therefore energy required for water heating is, 81000x0.80=64800 units.
- Energy consumption using efficient fixtures such as

o T5 Tub Lights -212Nos×28W×6Hrs×365 days=12999Units.
o CFL-162Nos×9W×2Hrs×365days=1064 Units.
o Power saver fans -117nos×50W×6Hrs×365 days = 12811 Units.
o Green lift – 5KW×60%×5Hrs×365 days = 5475 Units.
o Thus total energy saved =12999+1064+12811+5475=32349 units.

For Conventional Building:

- Production of Electricity within the building- Zero Units.
- Energy consumption required for water heating- 81000 Units.

- **Fixtures:-**
  - Fluorescent Tube Lights- 212Nos×48W×6Hrs×365days=22285 Units.
  - CFL Bulbs- 162Nos×40W×2Hrs.×365days=4730 Units.
  - Normal Fans- 117nos×80W×6Hrs.×365 days=20498Units.
  - Lift- 5KW×5Hrs×365 days =9125 Units.
  - Total energy consumed due to Fixtures-56278 Units.

Savings:

Saving by energy fixtures: 56278 - 32349 = 23929 Units.

Energy saving in terms of money: 23929 x 6.05 =Rs144700.45

Electricity dependency = consumption using fixtures – electricity production

=32349 – 18000 = 14349`~14350units.

5. RESULT

Total saving of energy at the site=106729 units.

Amount of coal used to generate 1 unit of electricity =0.00052 Tonne.

Total saving of coal=106729x0.00052=55.50 Tonne.

Saving in CO2 emission=106729x0.085=90 Tonne/year.

Analysis of Result

Sr. No	*Parameters*	*Green Building*	*Conventional Building*
1	Energy production using Wind & Solar energy	18000 Units	------
2	Saving due to Water Heating System	64800 Units.	------
3	Consumption using Fixtures.	32349 Units.	56278 Units
4	Saving by Energy Fixtures	23929 Units.	NA
5	Electricity dependency.	14350 Units.	139078 Units
6	Total energy saved at site	106729 Units.	NA
7	Total Saving of Coal.	55.50 Tonne	NA
8	Saving in CO2 Emission	90Tonne/year	NA

5. CASE STUDY -2 –"ADWAIT HOUSE"

To make the study of economical aspects and environmental friendly features, here project name as "Adwait" which is residential project is taken as a second case study.

Informatics of the project:

- Name of the project: Adwait House.
- Location: Gulmohar road, Savedi, Ahmednagar.
- Owner: Mr. Karandikar Ravindra V.
- Purpose of project: Residential purpose.
- Architect:-Mr. Ashok Joshi, Nagpur .

Total plot area:-276m2. Total built up area:- 183m^2

Cost of the project: - 11.5 Lakh

Salient Features of Case Study:

Inverted Saucer Foundation.

Cavity wall.Narrow and extra large windows.

Brick -jali Filler Slab.

Biogas

For finding out the total quantity of material required, here we use the comparison by using filler slab and concrete RCC slab. And find out the total quantity of material is to be saved.

RCC Slab:

In our case study the area of ground floor as well as the area of first floor is same, the room sizes are as follows,

Living Room-4.24x3.10m, Kitchen-4.24x3.10m, BED1- 4.22x3.10m, . BED2-4.29x3.10m

Firstly we have to calculate the total quantity of concrete required for slab without using filler materials.

For ground floor - The total quantity is to be found out by, 2(4.24 x3.10 x0.1)+(4.22 x 3.10 x0.1)+(4.29x3.10 x0.1)=5.96 m^3.

Grade of concrete M20=1:2:4

The total quantity should be found out by, 5.96 ÷ (1+2+4)=0.851m3.

Now, Cement 0.851x35=30Bags

Fine Aggregates 0.851x2=1.7÷2m^3=1.702 2.76=0.6Brass Coursed Aggre÷ates=0.851x4=3.404m^3=

3.404 2.76 = 1.2 Brass.

Therefore, (30 x380Rs/bag) + (0.6 x4000 Rs/brass) + (1.2 x3750 Rs/brass) =18, 300 Rs.

Therefore the total quantity of concrete required for Normal RCC slab =18, 300 Rs.

Now we have to find out the quantity of concrete required by using filler material.

➢ **Filler Slab:-**

In this case study of Adwait house we use the filler slab instead of RCC slab. By using the filler slab concept we can reduce the weight of the slab and cost of the project.

The size of Kitchen=4.24x3.1=13.144 m^2 .The size of one filler block=345x225x70mm.And in one filler block 3 Number of bricks are to be placed.

The area of filler used for kitchen=1.995x2.42=4.82 m^2 . The total quantity of concrete required for filler =2.14 m^3.

Now find out the quantity of concrete required for joining of filler slab. (Ground floor)

Kitchen:-The size of filler slab used=1.995x2.42m The filler is having Width of filler is 0.07m. And the thickness of the concrete to join the filler is o.1m. There is the arrangement of the filler is - 6 number of filler is in length and 5 number of filler is in its width of area of the filler slab. That is the arrangement is 6 x 5

we have, 1.995 x 0.07 x 0.1=0.014m3.As there are the 6 No. of filler used in the length of the filler slab, 0.014 x 6=0.084m3.And also 2.42x0.07x0.1=0.016m^3.

As there are the 5 No. of filler used in the width of filler slab, 0.016x5=0.084m^3. The total quantity of concrete required of filler for kitchen is 0.084+0.084=0.168m^3.

Another 3 room having same dimension approximately, therefore we can write it as 0.168 x 3=0.50m^3.

-Total quantity of concrete for all rooms for joining of filler =0.5m^3.

- For finding out the total quantity of concrete required for slab by using filler is to be calculated by, Total concrete required for all rooms without using filler -Total quantity of concrete for filler +Total quantity of concrete required for joining of the fillers.

Total concrete required for all rooms without using filler =5.96m^3.

Total quantity of concrete for filler=2.14m^3

Total quantity of concrete required for joining of filler =0.5m^3

So, 5.96-2.14+0.5= 4.32m^3.

Actual saving by using filler slab= Total quantity of concrete required without using filler slab –Total quantity of concrete required with filler slab.

Therefore we have, 5.96-4.32=1.64m3. Now total quantity should be find out by,

1.64 ÷ (1+2+4)=0.22m^3., Now, Cement 0.22x35=8Bags.

Fine Aggregates 0.22xx2=0.44m3=0.15Brass.

Coursed Aggregates=0.22x4=0.88m3=0.30Brass.

- **The total quantity of concrete required by using filler slab =4765 Rs. And that of concrete required for the slab without using the filler slab=18, 300 Rs**.

- **The total saving in case of slab in ground floor =18300- 4765=13, 535 Rs.**

1	Ground floor slab	4765 Rs	18, 300 Rs.
2	Saving by fiiler slab	13, 535 Rs.	NA
The material saving for ground floor is, 13, 535 Rs.			

Analysis of Adwait house.

5. CONCLUSION

Building an energy efficient home requires dozens of decisions by home designers, builders, and subcontractors. Many decisions affect the cost of construction and the profitability of the project. While energy efficiency requires careful planning and attention to details throughout the construction process, it offers substantial benefits to building professionals.

Economical benefits:

Studies show that installing green building technologies can be cost-efficient in the long run .It can create jobs and expand the local tax base to create economically competitive communities.

Social benefits:

Improving indoor environmental quality creates a healthier environment for the occupants of a building, which may help increase their productivity. Stronger neighborhoods that create a greater sense of community.

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A Review of Different Blade Design Methods for Radial Flow Centrifugal Pump

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A B S T R A C T

Centrifugal pumps are widely used for pumping water over short to medium distance through pipeline where moderate head and discharge are required. For optimum performance of pump the vanes should be properly designed. As there are very few papers that explain the radial type vane profile design procedure, therefore it becomes very difficult for designers to design a vane and they are forced to reverse engineer the vane profiles popularly available in the market. This paper is an effort to give a step by step guidance to design a radial type vane profile based on the fundamental understanding of published procedures.

Keyword: CFD, Design, Impeller, Pump, Radial Flow, Vane.

1. INTRODUCTION

Radial flow centrifugal pumps are widely used where head and discharge required are moderate. In radial type vanes, the vane profile is a curve that connects the inlet and outlet diameter of the impeller. Infinite number of curves can be drawn between two points, the length of the vane and hence the passage length can be different for same diameter D1 and D2 and same blade angle β1 and β2. Hence, it is necessary to define the shape of the vanes. If the length of the passage is short, the divergence angle may increase gradually which will result in separation of flow and formation of eddies. In a longer passage frictional loss will be more. Only an appropriate passage length will give minimum losses. For designing an efficient blade profile an appropriate blade design method should be selected [1].

point method. The investigation was carried out in Computational Fluid Dynamic commercial package solid works flow simulation (SWFS). The vane profile with forward and backward curves were analysed and the results showed that maximum efficiency was obtained with backward curved circular arc method [7].

2. METHODOLOGY

General methods available to design radial flow impeller vanes are simple arc method, double arc method, concentric circular arc method and point by point method. Each of these methods are discussed here in detail along with the calculations of blade design with concentric circular arc method and point by point method. The details of pump which are used for calculation are shown in table- 1.

Different researchers have studied the effect of blade design method on the efficiency of pump like Anagnostopoulos et. al.(2006) performed CFD analysis and design effects in a radial pump impeller. CFD software was used for computations of the steady flow field in the impeller and the characteristic performance curves were constructed. The results showed that hydraulic efficiency of pump can be increased by modifying the impeller geometry [3]. Kyparissis et. al.(2009) conducted parametric study on performance of a centrifugal pump based on simple and double-arc blade design methods-1,2 and 3. They found that when pump was operated at nominal flow rate simple arc method and double arc method-3, models gave best efficiency but when the pump was operated below nominal flow rate double arc method-3, caused a significant improvement of the hydraulic efficiency. On the other hand for flow rates greater than nominal simple arc method analysis gave higher hydraulic efficiency [5]. A simplified 3d model approach in constructing the plain vane profile of a radial type submersible pump impeller using 3D CAD software was developed by Gundale et.al.(2013). The impeller of a radial flow centrifugal pump was developed with different blade generation method and it was concluded that concentric circular arc method is the most simple method to generate a blade profile [6]. Singh and Natraj (2014) investigated the performance of impeller by developing the vane profile with circular arc method and point by

Table 1: Design parameters of the impeller used to construct the blade profile

S.No	*Description*	*Values*
1	Impeller inlet diameter (D_1)	66 mm
2	Impeller outlet diameter (D_2)	173 mm
3	Vane inlet angle (β_1)	23°
4	Vane outlet angle (β_2)	29^o
5	Number of blades (Z)	7
6	Vane or blade thickness	5 mm
7	Shaft diameter (D_{sh})	25 mm
8	Blade inlet height (B_1)	15 mm
9	Blade outlet height (B_2)	6 mm
10	Mass flow rate (Q)	7.4 kg/s
11	Head (H)	30 m
12	Rotation (N)	2870 RPM

2.1 Simple Arc Method

According to Pfleiderer's analytical method as discussed by Kyparissis et. al.(2009), in simple arc method the blade mean line is drawn with a single curve. The blade mean line AC is drawn from centre of curvature E with radius of arc R. To draw the blade mean line first an auxiliary circle Ca is drawn concentric with suction and pressure side of the impeller with diameter d_1 given by

$$d_1=D_1\sin\beta_1$$

The centre of curvature E is defined at the tangent of the auxiliary circle Ca which starts from A and point E is at a distance equal to the radius R of the blade mean curve from point A.

$$R = \frac{\frac{1}{2}\left(\frac{D_2^2}{2} - \frac{D_1^2}{2}\right)}{\frac{D_2}{2}\cos\beta_2 - \frac{D_1}{2}\cos\beta_1}$$

Where D_1 and D_2 are impeller diameters at suction and pressure side respectively and β_1 and β_2 are vane angles at leading and trailing edge respectively [5]. Fiigure 1 shows blade mean line generated using simple arc method

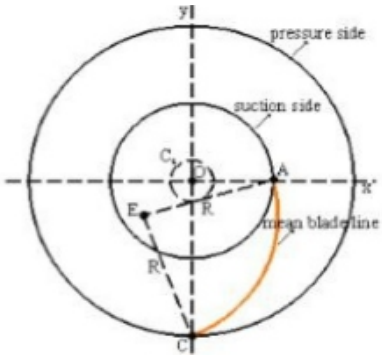


Figure 1: Blade mean line drawn using SAM (Simple Arc Method)

2.2 Double Arc Method

In double arc method the blade mean line is determined by construction of two curves. Pfleiderer has given three types of double arc method namely DAM1, DAM2 and DAM3 explained in Kyparissis et. al.(2009). DAM 1 (Double Arc Method-1) is considered as the poorest continuity of two curves to the connection point B as shown in Figure 2.

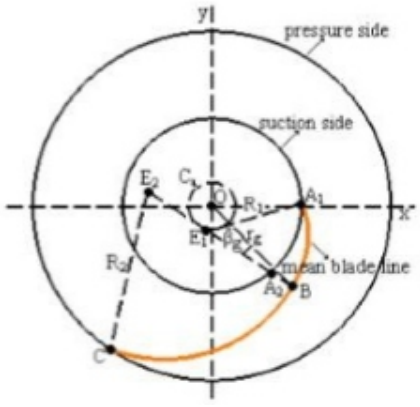


Figure 2: Blade mean line drawn using DAM1

The blade mean line consists of two arcs A1B and BC with E1 and R1 as centre of curvature and the radius of arc A1B respectively. In the same manner E2 and R2 are centre of curvature and radius of arc

BC respectively. The auxiliary circle Ca is drawn in the same manner as drawn in Single arc method. The periphery of suction side is divided into equal parts, just as the no of blades. The tangent of the auxiliary circle from points A1 and A2 intersects at point E1. The point B is end of first arc and it is defined at the extension of the line that connects the point E1 and A2 at a distance R1, equal to the distance between points E1 and A1. The radius of second arc BC i.e. R2 is defined as

$$R_2 = \frac{\frac{1}{2}\frac{D_2}{2}^2 - r_g^2}{\frac{D_2}{2}\cos\beta_2 - r_g\cos\beta_g}$$

Where r_g is equal to OB and β_g is the angle between E1B and OB as shown in Figure 2.

In DAM 2 (Double Arc Method-2) keeping the initial point A1 fixed the arc length A_1B is changed and the formula used for new arc length A_1B is given as

$$A_1B_{DAM2}=0.75A_1B_{DAM1}$$

As a result of this centre of curvature E_2 for second arc BC shifts downwards and the arc length of the blade decreases while the magnitude of E_1, R_1 and R_2 remains unchanged. In DAM3 (Double Arc Method-3) the radius R1 is kept 20% bigger than the radius of DAM1 i.e.

$$R_{1DAM3}=1.2\ R_{1DAM1}$$

As a result of this the centre of curvature E_1 shifts to left and E_2 moves downward while radius R_2 remains constant. It is obvious that the shift of E_2 in DAM3 is greater when compared to DAM2. Thus, the arc length of blade DAM3 becomes shorter than the corresponding of DAM2 [5].

2.3 Circular Arc Method

In circular arc method the diameter of the impeller is divided into a number of concentric circular rings not necessarily equally spaced. The value of radius of circular arc R for any two consecutive concentric circular rings is calculated using the equation and vane shape is plotted which is actually an arc tangent to both the rings.

$$R = \frac{\frac{1}{2}\frac{D_2}{2}^2 - \frac{D_1}{2}^2}{\frac{D_2}{2}\cos\beta_2 - \frac{D_1}{2}\cos\beta_1}$$

Where D_1 and D_2 are impeller diameters at suction and pressure side respectively and β_1 and β_2 are vane angles at leading and trailing edge respectively.

The radius of inner diameter and outer diameter are R_1 and R_2 respectively. The radius of intermediate rings can be obtained by adding the term $(R_2-R_1)/n$ to the radius of preceding ring. Similarly, the corresponding value of β can be obtained by establishing a straight line relationship between β and R [7]. The blade mean line drawn using concentric circular arc method is shown in figure 3.

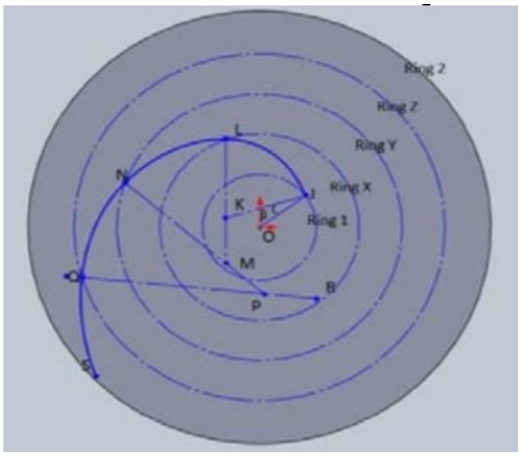
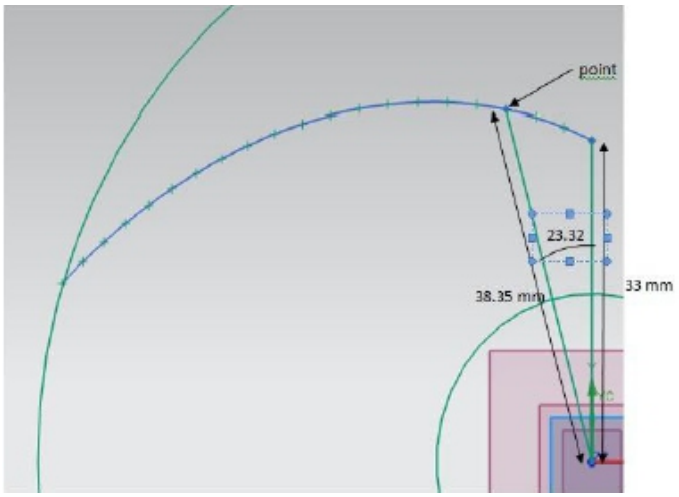


Figure 3: Blade mean line drawn using concentric circular arc method

2.4 Point By Point Method

In point by point method the blade mean line is drawn by determining number of intermediate points between the inner and outer diameter of the impeller and the final blade profile is obtained by drawing a smooth curve through these points joining the inner and outer diameter of the impeller. We know that, to specify a point here we need two parameters radius R and angle θ [1]. Figure 4 show the representation of blade mean line using point by point method.



3. RESULTS

On the basis of blade design methods discussed, calculations for concentric circular arc method and point by point method for the pump parameters are given where table-2 and table-3 shows the calculation for concentric circular arc method and point by point method respectively based on the procedure explained in this paper.

Table 2: Calculated values for R_1, R_2, β_1, β_2 and R

R_1	R_2	$\hat{a}_1$	$\hat{a}_2$	R
33	37.86	23	23.55	39.77
37.86	42.72	23.55	24.09	45.62
42.72	47.58	24.09	24.64	51.65
47.58	52.44	24.64	25.18	57.74
52.44	57.3	25.18	25.73	64.08
57.3	62.16	25.73	26.27	70.44
62.16	67.02	26.27	26.82	77.12
67.02	71.88	26.82	27.36	83.78
71.88	76.74	27.36	27.91	90.86
76.74	81.6	27.91	28.45	97.87
81.6	86.5	28.45	29	105.35

Table 3: R and θ values calculated using point by point method

Pt.	R	dR	C_m	W	$\beta = sin^{-1}\frac{C_m}{W}$	$B = \frac{1}{R * tan\beta}$	$dA = dR * \frac{B_n + B_{n+1}}{2}$	ΣdA	$\theta = \frac{180}{\pi} * \Sigma dA$
1	33.00	5.35	3.40	8.70	23.00	0.071	0.353	0.353	20.23
2	38.35	5.35	3.31	8.36	23.32	0.061	0.302	0.655	37.55
3	43.70	5.35	3.23	8.01	23.78	0.052	0.260	0.915	52.42
4	49.05	5.35	3.15	7.67	24.25	0.045	0.227	1.142	65.45
5	54.40	5.35	3.06	7.32	24.71	0.040	0.203	1.346	77.10
6	59.75	5.35	2.98	6.98	25.27	0.036	0.182	1.528	87.52
7	65.10	5.35	2.89	6.64	25.80	0.032	0.161	1.688	96.72
8	70.45	5.35	2.81	6.29	26.54	0.028	0.145	1.833	105.00
9	75.80	5.35	2.72	5.95	27.20	0.026	0.131	1.964	112.51
10	81.15	5.35	2.64	5.60	28.13	0.023	0.118	2.081	119.25
11	86.50	5.35	2.55	5.26	29.00	0.021	0.112	2.194	125.69

4. CONCLUSIONS

This paper thus presents description of various blade design methods and the calculations required, on the basis of which designers can design a blade mean line joining the inlet and outlet diameters of the pump impeller. Further modelling of pump impeller with these methods and CFD analysis can be carried out to obtain the performance curve for comparing the efficiency and head obtained with different blade design method at various discharge conditions.

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Elimination of the Structural Failure and the Placement of Chemical Explosives Options, for the Infrasonic Weapon Option as the Cause of the Synagogue (SCOAN) Building Collapse

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A B S T R A C T

On the 12th of September 2014, a guest complex of 6 storeys on the premises of the Synagogue church of all Nations (SCOAN) located at Ikotun in Lagos State South West Nigeria suddenly collapsed. The collapse was captured on closed circuit camera from 2 different angles. Different postulations have been put forward as to the cause of collapse including Structural failure and explosives attack in an act of sabotage. However having analyzed the CCTV footage and personally visiting the scene and made critical observations. I am convinced of an entirely new cause of collapse, which is, an exotic kind of weapon employing the infrasonic characteristic was used to cause the collapse of the building.

Keywords: CCTV footage, Infrasound, SCOAN, Infrasonic Weapon, Frequency, Resonance and Infrasonic Generator

1. INTRODUCTION

On the 12th of September 2014, a six story building suddenly collapsed in the premises of the Synagogue Church Of All Nations (SCOAN) located in Ikotun in Lagos state south west Nigeria. Many casualties were recorded, affecting mostly visiting South Africans who came to worship at the church. The death toll was so high that, the South African government got involved, visaviz the investigations as to why the building collapsed. Various reasons have been postulated as to why the building collapsed. This has also led to the Lagos state government to set up a judicial investigating panel, to find out the true cause of the collapse. Both the church and the Lagos state government has put forward different reason as to the cause of the collapse of the building.

The Lagos state government has been pushing the reason for collapse to be due to poor construction standards used by the church Engineers to construct the building. While the church has alluded the collapse to a terror attack/ sabotage by explosives and controlled demolition. Having looked at all the reasons adduced and personally visited the scene of the collapse and analyzed the video footage of the preceding moments, before the collapse of the structure [1] It was deduced that the collapse resulted

from a high energy infrasound absorption by the building leading to a high energy resonance of the constituents' atoms of the building.

This is even more accurate based on the fact that all other options being put forward were eliminated scientifically, creating what appears to be a mystery(due to limited knowledge) surrounding the collapse of the building. The Structural failure option cannot hold scientifically because, upon inspection of the foundation of the building, it was observed that the foundation columns are still intact, with no stress or cracks on the steel and concrete pillars protruding from the earth. This was also confirmed by the laboratory tests done by the Lagos state Materials Testing Laboratory.

And the CCTV footage showed a collapse that is not consistent with other known buildings that has collapsed as a result of structural failure. The controlled Demolition/placement of explosives cannot also hold because when the word controlled demolition is used, it elicits a set of known protocols which cannot be executed clandestinely. And analysis of the video footage of the collapse indicated the absence of any chemical explosives, due to the absence of a thermal shock wave and its attendant sudden rise in temperature. As evident in the absence of carbonization from expected combustion and burning of the structure and surrounding buildings and Tents [2] Consequently I am 100% certain that sample taken from the debris for chemical explosives residue analysis will return NEGATIVE.

2. INFRASOUND

Infrasound, sometimes referred to as low-frequency sound, is sound that is lower in frequency than 20 Hertz or cycles per second [3] Hearing becomes gradually less sensitive as frequency decreases, so for humans to perceive infrasound, the sound pressure must be sufficiently high. The ear is the primary organ for sensing infrasound, but at higher intensities it is possible to feel infrasound vibrations in various parts of the body. The study of such sound waves is referred to as INFRASONICS, covering sounds beneath 20 Hz down to 0.001 Hz. This frequency range is utilized for monitoring earthquakes, charting rock and petroleum formations below the earth, and also to study the mechanics of the heart. Infrasound is characterized by an ability to cover long distances and get around obstacles with little loss of energy and intensity [3]

One of the pioneers in infrasonic research was French scientist Vladimir Gavreau. His interest in infrasonic waves first came about in his laboratory during the 1960s, when he and his laboratory assistants experienced pain in the ear drums and shaking laboratory equipment, but no audible sound was picked up on his microphones. He concluded it was infrasound caused by a large fan and duct system and soon got to work preparing tests in the laboratories [3]

The possibility of a device that produces frequency that causes vibration of the eyeballs — and therefore distortion of vision — was apparently confirmed by the work of engineer Vic Tandy while attempting to demystify a “haunting phenomena” in his laboratory in Coventry England. It was characterized by a feeling of extreme discomfort and vague glimpses of a grey apparition. It was found that a newly installed extractor fan that, Tandy found, was generating infrasound of 18.9 Hz, 0.3 Hz, and 9 Hz [3]

In Military application, infrasound is being exploited for its weapon capabilities and was used by the Allies of World War I to locate artillery. When sound of any characteristic is being explored or deployed as a weapon to incapacitate, injure, kill or destroy, such a weapon is called an ACOUSTIC or SONIC weapon. In this case the infrasound properties are being deployed as an infrasonic weapon [4]

Infrasonic weapons produce both psychological and physical effects. They include highly directional devices which can transmit painful audible sound into an individual's ear at great distances and infrasonic generators which can shoot acoustic projectiles hundreds of meters causing a blunt impact upon a target. Infrasonic generators can cause negative emotions such as fear, anxiety, or depression, as well as biological symptoms like nausea, vomiting, organ damage, burns, or death—depending on the frequency and power level. Most of these weapons function between the frequency range of about 0.001 Hz to 30 KHz. These frequencies occur within the following waves: Extremely Low Frequency (ELF) 0.001 Hz to 30 Hz, Super Low Frequency (SLF) 30 Hz to 300 Hz, Ultra Low Frequency (ULF) 300 Hz to 3 kHz, and Very Low Frequency (VLF) 3 kHz to 30 kHz.[5]

High-intensity low-frequency sound may cause other organs to resonate, causing a number of physiological results, possibly including death. Acoustic weapons pose the hazard of being indiscriminate weapons, potentially imposing the same damage on friendly forces and noncombatants as on enemy combatants or other targets. Infrasound would be a powerful ultralow frequency (ULF) weapon that could be directional and tunable, penetrating buildings and vehicles. High Intensity infrasound could induce disorientation and reduced sensory motor functions. At higher levels of intensity, experiments have shown that animals may cease breathing temporarily. Diference Tones are more sophisticated arrays that project a sound to a specific location. The resulting sound can only be heard at that particular location as the result of interference patterns created by the interaction of sounds transmitted from multiple remote generators. A more potent weapon under development in Russia since the early 1990s is a high powered very low frequency (VLF) modulator. Operating at frequencies below 20 KHz, the device requires a 1-2 meter dish to project a so-called "acoustic bullet." The device was attractive because the power level is adjustable. At low power, the system would cause physical discomfort, while increasing the power could induce nausea, vomiting and abdominal pains. The highest levels can cause a person's bones to resonate, which can be quite painful.

3. Resonance

To understand how sound can become a deadly weapon of destruction; a review of the resonance principle was looked at. All of the chemical reactions in the cells of living organisms or in non living materials at the atomic level are caused by the electromagnetic oscillations, pulsations, and vibrations, which are collectively referred to as vibrational frequencies. All physical matter is vibrating at its own vibrational frequency.

Resonance occurs when a connection is made between a source and a target which are vibrating at the same frequency. When this happens, the materials become joined and are said to be resonating. Once resonance has been achieved, an energy exchange takes place on the surface of the membrane of each cell or atom. If the source of energy is more powerful, it directly impacts the targeted material resulting in a biological reaction or in this case a physical one. Resonance can be induced electromagnetically by an infrasonic pulse generator, which can establish a link, for instance, to a building like that of SCOAN that collapsed. Once this connection occurs, the power level of the generator can be increased, which would automatically transfer the energy to the building. If the power or intensity level is high or very high, the building can suffer a crumbling collapse.

Infrasonic and ultrasonic generators, also called emitters, and VLF modulators, are weaponized devices consisting of a directional antenna dish, or specially designed generators which can send acoustic pulses to a general or a specific area. In 1972 France was using infrasonic generators which operated at 7 Hz on its civilian population. And by 1973 the Squawk Box was used by the British Army in Northern Ireland. It was a directional weapon that could target specific individuals by producing audible sound at about 16 kHz, which turned into infrasound at 2 Hz when it coupled with the ears. In the early 1990s Russia had developed a 10 Hz VLF modulator capable of targeting individuals over hundreds of meters, causing pain, nausea, and vomiting. It was adjustable up to lethal levels. Since as far back as 1997, the US DOD has had an interest in creating generators in the infrasonic and ultrasonic ranges of 7 Hz and 20-35 kHz, respectively, which can cause these effects [6]

As at today, infrasonic weapons research has gone deeper underground which is inversely proportional to the advances made in production and testing with the consequent destruction like the type seen at the Synagogue Church of All Nations (SCOAN) building collapse.

3. CONCLUSION

As it is, it can be concluded scientifically that there was no explosives in the building when it collapsed upon the post blast analysis done. It can also be true to safely say the said building didn't come down as a

result of structural failure. Because its collapse was not consistent with known cases of building collapsing structurally. Coupled with the fact that the foundational pillars showed no sign of stress so far.

So, what caused the building to collapse? It's been known that Sonic and infrasonic weapons exists long before now as shown from the above literature. And it's also known in the weapons research community that certain Nations had taken it to the next level [6] How high that level is I do not know, but certainly our science tells us that infrasound weaponized with high enough intensity can cause vibrations to structures at the atomic level causing the kind of destruction we saw happened at the SCOAN premises.

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Experimental Investigation in Utilization of Basic Oxygen Furnace Steel Slag in Concrete

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A B S T R A C T

Construction in India is on rapid development which has caused massive depletion of scarce construction resources. Crushed limestone and sandstone aggregates used in bituminous mixes lack the desirable qualities for proper mix performance. On the other hand, large amounts of steel slag aggregates with good qualities are being produced and put to waste. To overcome from these crisis , we can partially replace the coarse aggregate by the by- product of the steel industries i.e steel slag. By this replacement, steel slag which is produced as a waste material in the steel industry and has a negative impact on environment hen disposed will not adverse effect. In this research we have taken M20 grade concrete with different replacement of 0%, 25%, 50%, 75% and 100% of steel slag for laboratory test such as compressive test, split tensile test and flexural test. The composition of 75% steel slag and 25% coarse aggregate gives the maximum strength results.

Keywords – Bofs Slag aggregate, cement, concrete

1. INTRODUCTION

Recent technological advances have led to an increase in the loads carried by road pavements, causing higher contact pressures at the pavement interface. These developments have led to premature failures in the pavements, affected by fatigue cracking and permanent deformation. In the present economic climate, it is becoming increasingly important to maximize the assets. The establishment of new industrial areas result in an increase in the production of by-products which are considered waste if they are not utilized subsequently. It is, therefore, imperative to reduce waste and preserve available natural resources. Further, the waste products have to be disposed off properly such that the environmental impact is minimum.. The proper disposal and handling of large quantities of waste material is expensive and will definitely have some environmental impact. In this project pozzonlanic material are used i.e steel slag to obtain the desired property. In this project we have replace coarse aggregate with steel slag at different proportion of 0%, 25%, 50%, 75% and 100%. The tests on hardened concrete are destructive test while the destructive test includes compressive test on concrete cube for size (150 x 150 x 150) mm, Flexural strength on concrete beam (700 x 150 x150) and split tensile strength on concrete cylinder (150 mm ø x 300mm) as per IS: 516 – 1959, IS: 5816 – 1999 respectively. The work presented in this project reports is an investigation in utilization of basic oxygen furnace steel slag in Concrete.

2. MATERIALS AND METHODS

2.1. Steel slag

It is obtained from Factor Steels Ltd. 46, A&B MIDC industrial Estate, hingna Road Nagpur. Extraction of 'iron' from ores is a complex process requiring a number of other materials which are added as flux or catalysts. After making steel these ingredients forming a matrix are to be periodically cleaned up. Removed in bulk, it is known as steel –slag. It consists of silicates and oxides. Modern integrated steel plants produce steel through basic oxygen process. Some steel plants use electric arc furnace smelting to their size. In the case of former using oxygen process, lime (CaO) and dolomite (CaO.Mgo) are charged into the converter or furnace as flux. Lowering the launce, injection of higher pressurized oxygen is accomplished. This oxygen combines with the impurities of the charge which are finally separated. The impurities are silicon, manganese, phosphorous, some liquid iron oxides and gases like CO2 and CO. Combined with lime and dolomite, they form steel slag. At the end of the operation liquid steel is poured into a ladle. The remaining slag in the vessel is transferred to a separate slag pot. For industrial use, different grades of steel are required. With varying grades of steel produced, the resulting slag's also assume various characteristics and hence strength properties. Grades of steel are classified from high to medium and low depending on their carbon content. Higher grades of steel have higher carbon contents. Low carbon steel is made by use of greater volume of oxygen so that good amount carbon goes into combination with oxygen in producing CO2 which escapes into atmosphere. This also necessitates use of higher amount of lime and dolomite as flux. These varying quantities of slag known as furnace slag or tap slag, raker slag, synthetic or ladle slag and pit or clean out slag. Fig.1 presents a flow chart for the operations required in steel and slag making.

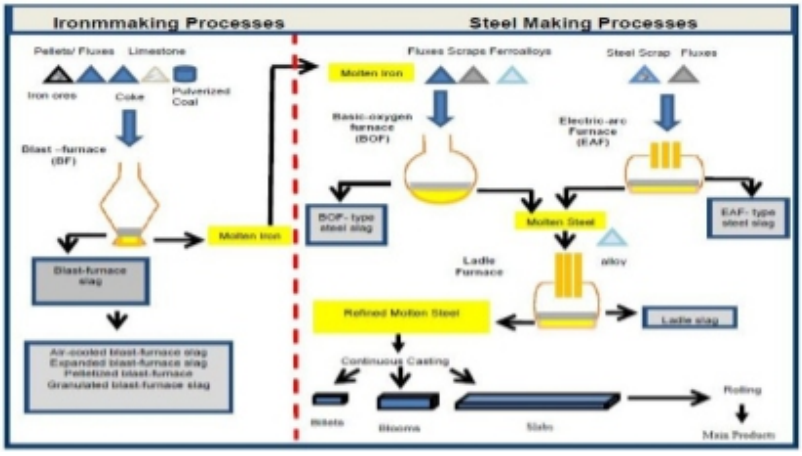

Fig. 1: Flowchart of iron and steel making processes (modified after Schoenberg 2001 ; http://www.emt-india.com/process_main.htm)

2.2 Production of Steel Slag

Steel slag is a byproduct from either the conversion of iron to steel in a BOF, or the melting of scrap to make steel in an EAF. In the BOF process, hot liquid metal from blast furnace, scrap, and fluxes, which consist of lime CaO and dolomite lime, are charged to a furnace. A lance is lowered into the converter and high-pressure oxygen is injected. The oxygen combines with and removes the impurities in the charge . These impurities consist of carbon as gaseous carbon monoxide, and silicon, manganese, phosphorus, and some iron as liquid oxides, which combine with lime and dolomite lime to form the steel slag. At the end of the refining operation, the liquid steel is tapped poured into a ladle while the steel slag is retained in the vessel and subsequently tapped into a separate slag pot. Unlike the BOF process, the EAF does not use hot metal, but uses ‘‘cold’’ steel scraps, which would otherwise be unsightly and environmentally damaging. It can be charged with limited amounts of iron scrap, pig iron, and direct reduced iron. The three graphite electrodes that heat the furnace pass through the lid. An electric current is passed through the electrodes to form an arc. The heat generated by this arc melts the scrap. During the melting process, other metals ferro–alloys are added to the steel to give it the required chemical composition. Also oxygen is blown in to the EAF to purify the steel. After samples have been taken to check the chemical composition of the steel, the EAF is tilted to allow the slag, which is floating on the surface of the molten steel, to be poured off. The EAF is then tilted in the other direction and the molten steel poured into a ladle. After being tapped from the furnace, the molten steel is transferred into a ladle for further refining to remove additional impurities still contained within the steel or to add alloys. This operation is called ladle refining because it is completed within the transfer ladle. During ladle refining, additional steel slag's are generated by again adding fluxes to the ladle to melt. These slag's are combined with any carryover of furnace slag and assist in absorbing de oxidation products inclusions heat insulation, and protection of ladle refractory's. The steel slag produced at this stage of steel making is generally referred to as ladle slag. Because the ladle refining stage usually involves the addition of different fluxes, the properties of these synthetic slag's are quite different from those of the furnace slag.

The two main types of steel slag are

1. Basic-oxygen-furnace (BOF) slag
2. Electric-arc-furnace-ladle (EAF(L)) slag

2.3 BOF Slag

Fig. 2: Samples

Fig. 3: Crusher

Mittal Steel, Indiana Harbour Works West Plan t, which is located in Highland, IN (east of Chicago, on the south shore of Michigan Lake), is the source plant for the BOF slag used in this research. This plant is one of the largest integrated steel mills of this region. Fig.1 shows the location of the source plant. At this plant, which has a gross annual capacity of 3.5 million tons, two basic-oxygen furnaces operate continuously to produce liquid steel. Lime is used as the fluxing agent in this plant, and the amount of slag generated is approximately 12% of the total steel output. BOF slag processing operations are performed by Multiservice Ltd., Harsco Corporation at Indiana Harbour Works West Plant. Multiservice has its own processing unit associated within this facility. BOF slag is cooled down slowly in the pits by spraying water. Next, the cooled BOF slag goes through metal recovery and screening processes, as detailed in Section 2. The processed steel slag is stockpiled in the processing plant according to three different particle size ranges.

5. RESULT AND DISCUSSION

5.1 Compressive Strength

Table 1 Comparison of Compressive Strength

Grade of Concrete	Replacem ent in %	Compressive Strength in (N/mm^2)		
		7 days	14 days	28 days
M20	0%	16.74	17.63	22.96
	25%	17.93	18.66	24.15
	50%	18.81	19.18	25.93
	75%	19.11	20.14	27.41
	100%	17.11	18.88	23.33

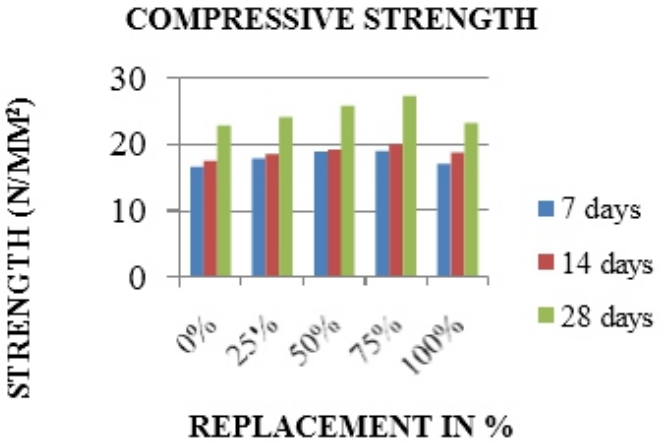

Fig. 4: Graph of compressive strength

- From bar chart it is observed that compressive strength of concrete for 7 days, 14 days, 28 days with replacement of 0%, 25%, 50%, 75% and 100% will increases with increase in percentage of replacement increases up to 75% but after that compressive strength will be reduces.
- From bar chart the maximum compressive strength is obtained at 28 days with 75% replacement with steel slag.

Table 2 Comparison of Flexural strength

Grade of Concrete	Replacement in %	Flexural Strength in (N/mm^2)		
		7 days	14 days	28 days
	0%	6.22	6.8	7.11
	25%	6.44	7.2	7.56
M20	50%	6.84	7.38	7.91
	75%	6.4	6.89	7.2
	100%	5.51	5.51	6.4

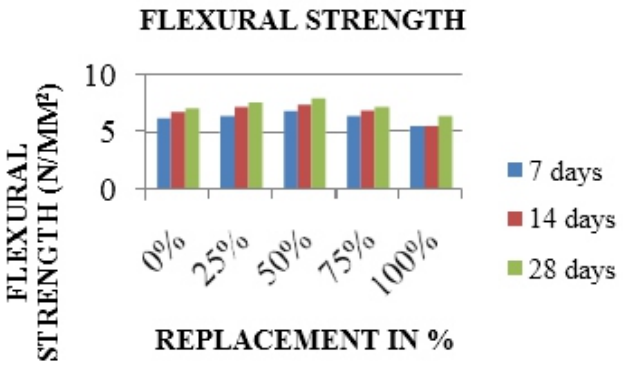

Fig. 5: Graph of Flexural Strength

• From bar chart it is observed that flexural strength of concrete for 7 days, 14 days, 28 days with replacement of 0%, 25%, 50%, 75% and 100% will increases with increase in percentage of replacement increases up to 50% but after that flexural strength reduces gradually.

Table 3 Comparison of Split Tensile strength

Grade of Concrete	Replace ment in %	Split Tensile Strength in (N/mm^2)		
		7 days	14 days	28 days
M20	0%	3.39	3.46	3.82
	25%	3.53	3.6	3.89
	50%	3.75	3.82	3.96
	75%	3.68	3.96	4.42
	100%	3.6	3.69	3.89

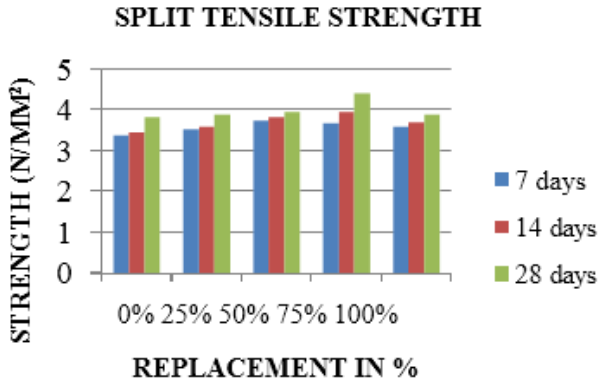

Fig. 6: Graph of Split Tensile Strength

• From bar chart the maximum flexural strength is obtained at 28 days with 50% replacement with steel slag.

• From bar chart it is observed that split tensile strength of concrete for 7 days, 14 days, 28 days with replacement of 0%, 25%, 50%, 75% and 100% will increases with increase in percentage of replacement increases up to75% but after that split tensile strength will be reduces.

• From bar chart the maximum split tensile strength is obtained at 28 days with 75% replacement with steel slag.

5. CONCLUSION

1. Steel slag meets the requirements to be used in concrete mixes, whether partly extended up to 50%.
2. The maximum compressive strength value occurs at 75% slag replacement and declines beyond the 75% slag replacement. This indicated the improvement of compressive strength for replacement slag of 25-75%
3. In all replacement ratios the flexural strength increases up to 50% it is linearly decreased after 50% by the increase in slag replacement.
4. From result, it is obtained that in the case of slag utilization, the compressive and split tensile correspond to each other but flexural strength do not correspond to each other.
5. The cost of slag is nearly 50% of that of natural aggregates hence it is economical to use the waste product of steel industry.

Hence it could be recommended that slag aggregate could be effectively utilized as course aggregate.

Further research work would be required to give a better understanding of the slag-concrete mechanical behaviour. The effect of slag to the bonding of steel reinforcements has to be investigated as an individual phenomenon.

The research studies confirmed good properties of slag as an alternative material and can definitely be considered an "encouragement" in initiating new research on the possibilities of the application of slag in construction.

Further research will be based on the utilization of the previously heated slag in concrete mixtures, in which better performance should be expected in the temperature range between 600°and 800°C.

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