

# COMPARATIVE STUDY OF DIVISIBILITY TEST FOR ALL INTEGERS USING REDUCIBLE CHAIN METHOD

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## ABSTRACT

Elementary number theory involves divisibility among integers. Testing a given number whether it is prime or not involves divisibility testing. Divisibility test for few numbers say 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 only are existing at present. In this paper, we have proposed a new method of divisibility test for all integers called Reducible Chain method which takes always less time for manual testing compared to the existing traditional division methods.

**Key Words:** Divisibility, Dividend, Divisor, Reducible Chain

## I. INTRODUCTION

Number theory is one of the branches of pure mathematics [2]. Elementary number theory involves divisibility among integers. In mathematics, there are few numbers say 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 only for which the testing procedures available. we have proposed a method of divisibility test for all integers as dividends using a method known as Reducible chain method.

A number chain is a sequence  $(a_0; a_1; \dots; a_n)$  where  $f(a_0)=a_1, f(a_1)=a_2, \dots, f(a_n)=a_{n+1}$ .

[3]Euler suggested a number chain created by continuously adding the square of the digits of a number to form a new number. For example selection of 44 as starting number the chain obtained is  $44 \rightarrow 32 \rightarrow 13 \rightarrow 10 \rightarrow 1$ .

Collatz formed the chain by multiplying the number by 3 and add 1 if the number is odd otherwise divide the number by 2 till the number obtained has been appeared earlier.

For example selecting the starting number as 15, the cycle obtained is  $15 \rightarrow 46 \rightarrow 23 \rightarrow 70 \rightarrow 35 \rightarrow 106 \rightarrow 53 \rightarrow 160 \rightarrow 80 \rightarrow 40 \rightarrow 20 \rightarrow 10 \rightarrow 5 \rightarrow 16 \rightarrow 8 \rightarrow 4 \rightarrow 2 \rightarrow 1$ .

In reducible chain method the chain is constructed by mapping  $10x+y$  to  $x+yc$  or  $2x+yc$  depending upon whether the unit digit is odd or even respectively. (the number is reduced by one digit in every map) where  $x+yc \geq 2$  or  $2x+yc \geq 2$  and  $c$  is a code number obtained by the result of the [1]Theorems provided in the mathematical model..

## II. MATHEMATICAL MODEL

The mapping process requires code number to be identified to the given divisor. The code number to the divisor depends on the unit digit of the divisor. The following theorems help to find the codes for the given divisor.

**Theorem 1 :** If  $10x \equiv -y \pmod{10n-9}$

Then  $x \equiv (n-1)y \pmod{10n-9}$  for  $n = 1, 2, 3, \dots$

**Proof:** Since  $10x \equiv -y \pmod{10n-9}$

\  $(10n-9)$  divides  $(10x+y)$

\  $10x+y = (10n-9)m$  where  $m$  is positive integer.

\  $y = (10n-9)m - 10x$

\  $x - (n-1)y = x - (n-1)\{(10n-9)m - 10x\}$   
 $= (10n-9)\{x - (n-1)m\}$

\  $x - (n-1)y$  containing a factor  $(10n-9)$

\  $x - (n-1)y$  is divisible by  $(10n-9)$

\  $x \equiv (n-1)y \pmod{10n-9}$

Hence theorem is proved.

The above theorem motivates to go for the divisibility test for a divisor having 1 as a unit digit. That is divisibility test of divisor like 11, 21, 31, 41, ... etc.

The table gives code number for divisor  $(10n-9)$  where  $n = 2, 3, \dots$  etc

Divisor	Code number
$(10n-9)$	$(1-n)$
11	-1
21	-2
31	-3
41	-4
51.	-5
etc	

**Theorem 2 :** If  $10x \equiv -y \pmod{10n-8}$

Then  $2x \equiv (n-1)y \pmod{10n-8}$  for  $n = 1, 2, 3, \dots$  etc.

The proof is similar to the theorem 1.

This result is applicable for the Divisibility Test for a divisor which has 2 as units digit. That is divisibility test for divisor like 2, 12, 22, 32, 42, ... etc

**Note:** The following table gives a code number for every divisor  $(10n-8)$  where  $n = 1, 2, 3, \dots$  etc

Divisor $(10n - 8)$	Code number $(1- n)$
2	0
12	-1
22	-2
32	-3
42.	-4
Etc	

The chain formed is  $228 \rightarrow 36 \rightarrow 0$

**Theorem 3 :** If  $10x^0 - y \pmod{10n - 7}$

Then  $x^0 (2 - 3n)y \pmod{10n - 7}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 3,13,23,33,43, ... etc.

**Theorem 4 :** If  $10x^0 - y \pmod{10n - 5}$

Then  $x^0 (1 - 3n)y \pmod{10n - 5}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 5,15,25,35, ... etc.

**Theorem 5 :** If  $10x^0 - y \pmod{10n - 3}$

Then  $x^0 (1-3n)y \pmod{10n - 3}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 7,17,27,37, ... etc.

**Theorem 6 :** If  $10x^0 - y \pmod{10n - 1}$

Then  $x^0 - ny \pmod{10n - 1}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 9,19,29,39,49, ... etc.

**Theorem7:** If  $10x^0 - y \pmod{10n - 6}$

Then  $2x^0 (1 - 2n)y \pmod{10n - 6}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 4,14,24,34,44, ... etc.

**Theorem 8 :** If  $10x^0 - y \pmod{10n - 4}$

Then  $2x^0 (1 - 3n)y \pmod{10n - 4}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 6,16,26,36,46, ... etc.

**Theorem 9 :** If  $10x^0 - y \pmod{10n - 2}$

Then  $2x^0 - ny \pmod{10n - 2}$  for  $n = 1, 2, 3, \dots$

This tests for divisor like 8,18,28,38,48, ... etc.

### III. ALGORITHM

Read dividend 'n' and divisor 'd'

Compute code 'c' depending on divisors unit digit

While(dividend  $\geq$  divisor)

Begin

Express dividend in the form of  $10x+y$  where 'y' is the unit digit of the dividend

If unit digit of the divisor is odd then compute  $x+yc$  otherwise compute  $2x+yc$

End

If new dividend = divisor or 0 then it is divisible, otherwise not divisible

**Example1.** Determine whether 3317 is divisible by 31 using Reducible chain method..

**Solution:**  $3317 = 331 \times 10 + 7$

here  $x = 331$ ,  $y = 7$   $c = -3$

where  $c = -3$  is code number for 31 by above table

$$\backslash \quad x + y(c) = 331 + 7(-3)$$

$$= 331 - 21$$

$$= 310$$

Now  $310 = 31 + 0(-3)$

$$= 31$$

Since 31 is divisible by 31

\ 3317 is divisible by 31.

The Reducible chain obtained for divisibility can be formed from the above steps will be

$3317 \rightarrow 310 \rightarrow 31$  which is divisible by 31

**Example2:** Determine whether 228 is divisible 12 using reducible chain method.

**Solution :**  $228 = 22 \times 10 + 8$

Here  $x = 22$ ,  $y = 8$ ,  $c = -1$

Where  $c = -1$  is a code for 12.

$$\backslash \quad 2x + y(c) = 2(22) + 8(-1)$$

$$= 44 - 8$$

$$= 36$$

Now  $36 = 2(3) + 6(-1)$

$$= 0$$

Since 0 is divisible by 12

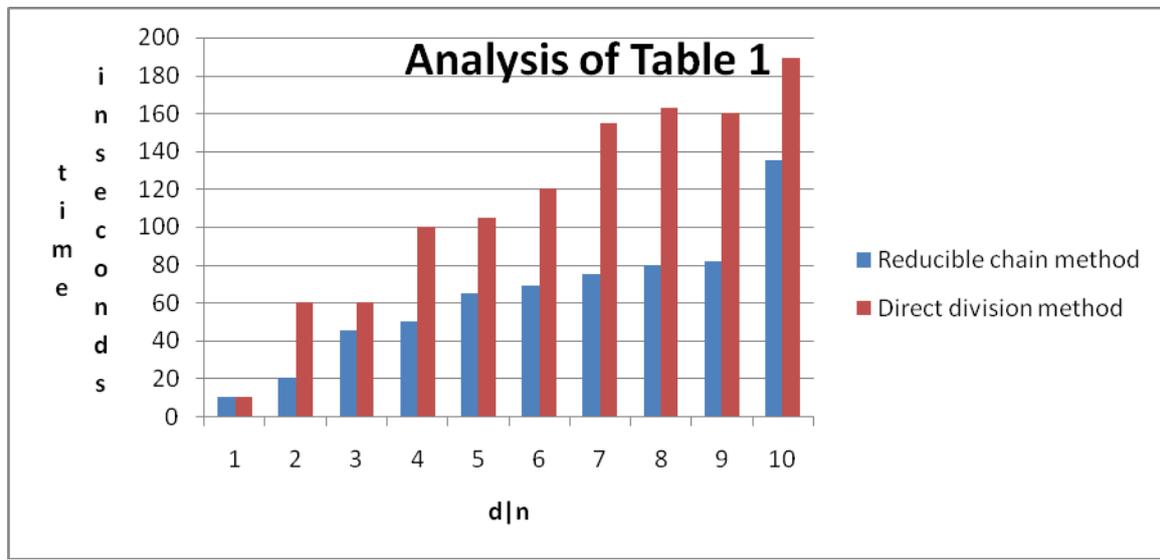
\ 228 is divisible by 12.

#### IV. EXPERIMENTAL WORK

The algorithm is tested with the student community on selection of 10 best, worst and average students. The average computation time obtained by Reducible chain method and direct division method is selected for the analysis which is summarised as given below.

Dividend 'n'	Devisor 'd'	Whether 'n' is divisible by 'd' or not	Time taken in Seconds by Reducible Chain method	Time taken in Seconds by direct division method
1859	13	Yes	10	10
1867591	41	Yes	20	60
12345678	27	No	45	60
123456789	23	No	50	100
1234567892	24	No	65	105
12345678957	29	No	69	120
123456789524	28	No	75	155
1234567890122	22	No	80	163
12345678912345	25	No	82	160
1234567895623538	26	No	135	189

Table 1



Graph1

#### V. RESULTS AND DISCUSSIONS

From the plotted graph it can concluded that most of the results using Reducible chain method has taken 50% less time than the Direct division method. The limitation of the Direct division method is that if the number of digits of the dividend is large there will be an enormous increase of time in direct division method.

## **VI. CONCLUSION**

The reducible chain divisibility method is a simple method of divisibility testing for all integer divisors. This method involves additions and subtractions rather than division with a big number. A number containing any number of digits can be tested for divisibility by hand computation faster than any existing method of testing.

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# SUSPENSION SYSTEM: REVIEW ABOUT COMPONENTS, PRINCIPAL AND CLASSIFICATION

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## ABSTRACT

Vehicle suspension is used to achieve good driving stability and passenger comfort regardless of road surface. The suspension system of an automobile or a vehicle is the arrangement or a device which not provide the cushioning but also prevents the vehicle's engine from the road surfaces by providing the sufficient desired distance. I this article it is discussed about the general review about the suspension system.

## I. INTRODUCTION

The automobile chassis is mounted on the axle, not directly but through some form of springs. This is done to isolate the vehicle body from the road shocks which may be in the form of bounce, pitch, roll or sway. All the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system [1].

It must also keep the tires in contact with the road, regardless of road surface. The suspension of modern vehicles needs to satisfy a number of requirements, whose aims partly conflict, because of different operating conditions [2]. However, in active suspension systems, which benefit from an active actuator, it is possible to attain acceptable ride comfort and safety simultaneously. In other words, an AS system is used to improve ride comfort without loss of controllability [3]. Human sensitivity to transmitted vibrations in the objective ride comfort evaluation is usually formulated as a standard Ride Index (RI) obtained by applying frequency filters to the transmitted vibrations and combining the weighted accelerations [4].

One of the performance requirements is advanced suspension systems which prevent the road disturbances to affect the passenger comfort while increasing riding capabilities and performing a smooth drive [5]. While the purpose of the suspension system is to provide a smooth ride in the car and to help maintain control of the vehicle over rough terrain or in case of sudden stops, increasing ride comfort results in larger suspension stroke and smaller damping in the wheel hop mode [6].



Fig.1 Schematic Quarter Car Model, [7]

Broadly speaking, suspension system consists of a spring and a damper. The energy of road shock causes the spring to oscillate. These oscillations are restricted to a reasonable level by the damper, which is more commonly called a shock absorber [1].

In this review, an automatic suspension system for a quarter car is explored to highlight the different technological processes used for suspension systems such as shown in Fig.1 [5].

## **II. CLASSIFICATION OF SUSPENSION SYSTEM**

Suspension systems are classified into three categories namely

1. Active suspensions,
2. Semi-active and
3. Passive [8].

### **2.1 Active Suspensions**

The active suspension systems are complex, bulky and expensive and therefore, they are not commonly used in commercial vehicles. Issues related to the design and control aspects in active suspension systems appear to be the real challenges. An excessive power is required that results in heavy loads on the engine[8]. An active suspension has an actuator that allows improve the passenger comfort due this element is placed in parallel with the damper and the spring between the car body (sprung mass) and the wheel (un-sprung mass). Typically, active suspension systems include actuators that supply additional force[9]. These additional forces are determined by a feedback control law using data from sensors attached to the vehicle. Various control strategies such as adaptive control presented by Nugroho et al. [10], fuzzy control in Ranjbar-Sabrine et al. [11] and optimal control developed by Paschedag et al. [12] have been proposed in the past years to control the active suspension system.

### **2.2 Semi Active**

A semi-active system has the ability to modulate the damping coefficient of damper but the direction of damping force is dependent on the relative velocity across the sprung and un-sprung masses [8].The system incorporates a damper that can modulate its damping coefficient. Semi-active systems are classified as systems where the characteristics can be changed rapidly (typically in less than 100 milliseconds) [13]. The development of electrorheological (ER) and magnetorheological (MR) fluids has boosted research in the field of semi-active suspensions [13]. Nowadays, the mentioned conflicting requirements cannot be met with passive suspension systems; therefore, the application of active and semi-active suspensions is mandatory [14]. It was in early 1970s that active vehicle suspension systems were developed focusing on the optimization of trade off between ride quality and road handling [15]. Semi-active suspension enables smooth changes of damper coefficient [16]. It can be nearly as effective as fully active suspension in improving ride quality [17]. Semi-active control devices potentially offer the reliability of passive devices, yet maintain the versatility and adaptability of fully active system [18]. Magnetorheological damper is a good example of device for semi-active suspension [19-20]. Active suspension contains the power controlled actuator located between the wheels and vehicle body, for instance linear electric motor or hydraulic servomechanism.

Compared with passive suspensions, active suspensions can improve the performance of the suspension system over a wide range of frequencies [19]. Semi-active suspension is a better choice than active suspension at the cost of ride comfort and road handling but there is not a significant degradation of the performance [15]. Semi-

active technology can materialize the variation of damping between the softer and harder limits in accordance with the situation as compared to the passive system [21].

### **2.3 Passive**

A passive system comprises a damper and a spring having fixed characteristics [8].

## **III. OBJECTIVE OF SUSPENSION**

The objectives of suspension system are as follows [1]:

- To prevent the road shocks from being transmitted to the vehicle components.
- To safeguard the occupants from road shocks.
- To preserve the stability of the vehicle in pitching or rolling, while in motion.

## **IV. BASIC CONSIDERATION**

There are various basis considerations and mainly of them are as follows [1]:

### **4.1 Vertical loading**

When the road wheels comes across a bump or pit on the road, it is subjected to vertical forces, tensile or compressive, depending upon the nature of the road irregularity. These are absorbed by the elastic compression, shear, bending or twisting of the spring.

### **4.2 Rolling**

The C.O.G. of the vehicles is considerably above the ground. Due to this reason, while taking the turns, the centrifugal force acts outwards on the C.O.G. of vehicle, while the road resistance acts inward at the wheels. This gives rise to a couple turning the vehicle about a longitudinal axis. This is called rolling.

### **4.3 Side Thrust**

Centrifugal force during cornering, cross-winds, cambering of the road etc., cause a side thrust to be applied to the vehicle. Such forces are usually absorbed by the rigidity of the leaf springs or by fitting panhard rods.

### **4.4 Road Holding**

The degree to which a vehicle maintains contact with the road surface in various types of directional changes, e.g. dip, squat, cornering, etc., and in a straight line motion is called road holding.

### **4.5 Ride and Handling**

Ride is the qualitative ability of a vehicle to provide a smooth, comfortable drive on a bumpy road. Handling is the ability of a vehicle to safety accelerate, brake and corner.

### **4.6 Unsprung Weight**

Unsprung weigh is the weight of the vehicle components between the suspension and the road surface. This includes rear axle assembly, steering knuckle, front axle in case of rear axle suspension, wheels, tyres and brakes. Thus it is seen that greater the weight of unsprung parts, greater will be the energy stored due to vibrations and consequently greater shocks.

## **V. COMPONENTS**

A suspension system mainly consists of

1. Springs.
2. Shock absorbers.

## 5.1 Springs

Springs are mechanical device, used for absorb the energy of shocks, vibrations of the irregularities present on the road surface.

### 5.1.1 Function of Suspension Springs

Springs are placed between the road wheels and the body. When the wheel comes across bump on the road, it rises and deflects the springs, thereby storing energy therein. On realising, due to the elasticity of the spring material, it rebounds thereby expanding the stored energy. In this way the spring starts vibrating, of course, with amplitude decreasing gradually on account of internal friction of the spring material and friction of the suspension joints, till vibrations die down [1].

### 5.1.2 Types of Suspension Springs

There are various suspension springs and the suspension spring mainly two types are used in vehicle as follows[1]:

#### 5.2.1.1 Leaf Spring

Semi elliptic leaf springs are almost universally used for suspension in light and heavy commercial vehicles. For car also, these are widely used for rear suspension. The spring consists of a number of leaves called blades. The blades vary in length and the longest blade has eyes on its ends, called as master leaf [1].

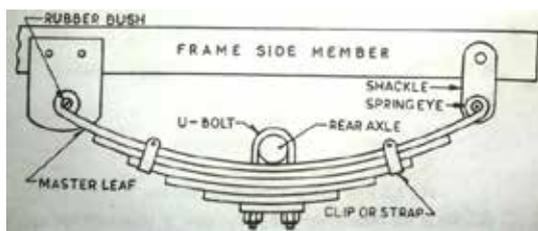


Fig. 2 Rear Leaf Spring [1]

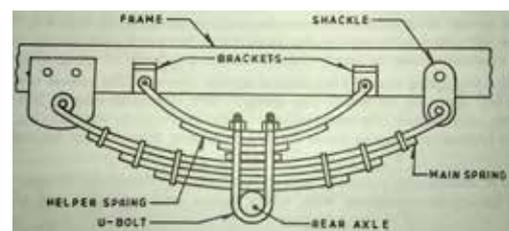


Fig. 3 Helper Spring [1]

Helper springs are provided on many commercial vehicles in addition to the main leaf springs. They allow for a wide range of loading [1].

#### 5.2.2.2 Coil Spring

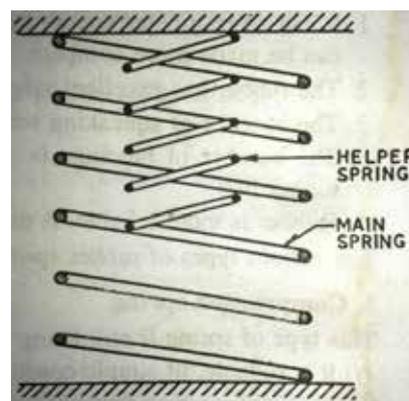
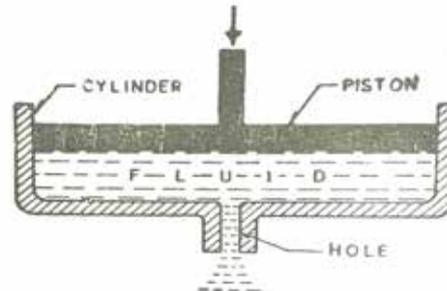


Fig. 4 Helper Coil Spring [1]

Mainly used with independent suspension system, as they can be well accommodated in restricted spaces. Coil springs don't have noise problems nor do they have static friction causing harshness of ride as in case of leaf springs. It takes the shear as well as bending stresses. A helper spring is also sometimes used to provide progressive stiffness against increasing load.

## 5.2 Shock Absorbers

1. A springing device must be compromise between flexibility and stiffness. If it is more rigid, it will not absorb road shocks efficiently and if is more flexible it will continue to vibrate even after bump has passed. So we must have a damping of the spring to prevent excessive flexing.

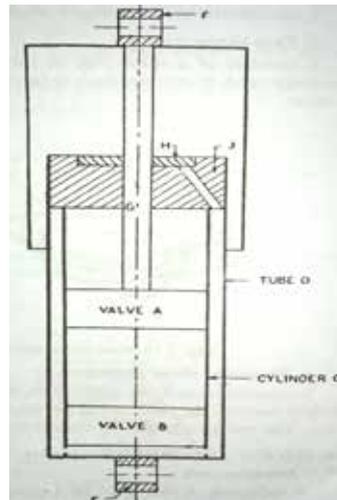


**Fig. 5 The Principle of Operation of Hydraulic Shock Absorber [1]**

### 5.2.2 Type of Shock Absorber

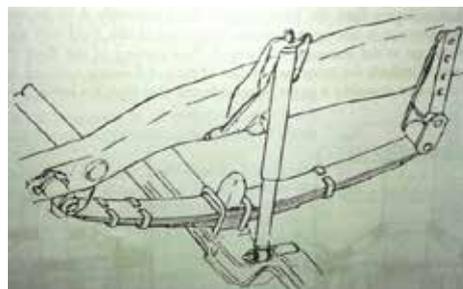
There are mainly two types of shock absorber are used, are as follows [1]:

#### 5.2.2.1 Telescopic Type Hydraulic Shock Absorber



**Fig.6 Telescopic Type Shock Absorber [1]**

The principle of operation of a hydraulic shock absorber is that when a piston forces the fluid in a cylinder to pass through some hole[fig. 5], a high resistance to the movement of piston is developed, which provides damping effect [1].

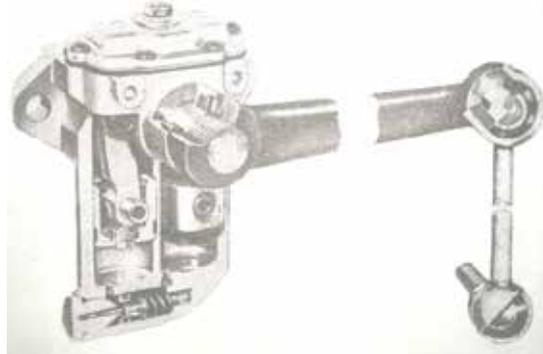


**Fig. 7 Telescopic Shock Absorber Mounted on Vehicle.**

(Courtesy-Swaraj Mazda Ltd., INDIA) [1]

This type has additional advantages that the damping is proportional to the square of the speed. In this type of shock absorber the tubular shape of early telescopes used in ancient times. Thus it is called as telescopic type shock absorber [1] .

#### 5.2.2.2 Lever Arm Type Shock Absorber



**Fig. 8 Lever Arm Type Shock Absorber**  
(Courtesy-Armstrong Patents Co. Td., England)

Lever arm type of shock absorber has also been employed in certain vehicles. The advantage is that the large deflections are possible. It consists of two pistons operating in two adjacent chambers filled with oil and connected through holes which are covered or uncovered by means of a valve. The up and down movement of the lever arm due to road shocks causes one piston to move up and the other down, thus causing the oil to flow through the oil holes, which absorbs the energy of vibrations and their damping [1] .

## VI. CONCLUSION

The suspension system provides the vehicle acts as a safety member by providing the desired height and the cushioning against the bumps or irregularities present on the road surface. The suspension system absorbs the energy generate due to road irregularities or bumps, pits etc., and these energy are transferred from the vehicle to the earth or road.

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# DISASTER MANAGEMENT OF GRID FAILURE

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## ABSTRACT

*It is on record that the past blackout suffered by many developed and developing countries of the world have rendered immense financial loss and became a major source of embarrassment. The recently July'12 Indian blackout has proved one of the world's biggest power disasters caused by the failure of Northern grid. This not only caused a national financial loss to of several hundreds of crores but also has become a major embarrassment for India raising doubts on India's ability to cope with the world's expectations to become a future world economic power The issue is grave and requires concerted and focused attentions from the academia, industry, government, professionals and all stakeholder to address to all aspects of this calamity so that any such future threats may be pre-empted. Present article is an attempt to analyze events and reasons which lead to this disaster and suggest measures which would be helpful in avoiding the reoccurrence of any such future event.*

**Keywords:** *Blackout, Grid, Black Start, Grid Indiscipline.*

## I. INTRODUCTION

India has recently witnessed one of its worst blackouts in the recent times. Twenty Indian states and two union territories faced a complete power blackout on 30 July 2012 triggered by the failure of Northern grid. This incidence not only left more than 300 million people powerless in New Delhi and much of northern India but also became a reason for a national financial loss and a cause of an international embarrassment. This, however, also highlighted the chronic infrastructure woes holding back Asia's third-largest economy. The lights in Delhi and seven other states went out in the early hours, could not be restored by the morning rush-hour, and bringing the life to standstill as entire communication network including that of rail road became virtually dead.

The outage forced the shutdown of hydroelectric plants in the Himalayan state of Himachal Pradesh and thermal power stations in the wheat belt of Punjab and Haryana. Fortunately, Air traffic was unaffected due to the adequate backup was unaffected. This black day ultimately proved to be a national nightmare.

India is boastfully among emerging BRIC economies. On way to its journey to become a matured world economy from the emerging one it has to establish a vigorous infrastructure driven by transport network and overcome all sorts of Power woes. Power shortages and a creaky road and rail network have weighed heavily on the country's efforts to industrialize. The underperformance of the country in the recent past on infrastructure development and power eventually may become major reasons for a slump in the economy. India recently scaled back a target to pump \$1 trillion into infrastructure over the next five years (1).

Blackouts lasting up to eight hours a day are frequent in much of the country and have sparked angry protests on the industrial fringes this summer, the hottest in years. Apart from the domestic implications, confidence of

international community and financial stakeholders on India's capability to handle high industrial growth has become critical.

Importantly, of all the infrastructural needs power is a critical pre-requisite. There is an urgent need to take all possible measures to pre-empt any such future power woes.

## **II. A RECALL OF MAJOR GRID FAILURES IN THE WORLD**

A review of account of major blackouts of the world (2) is an indicator of how the world tackled the important power issues which is the backbone of entire economic activity. It is evident from the chronology of events given below that post 20<sup>th</sup> century though the power demand increased in geometric terms no developed economy has a repeat power chaos Except India.

- Blackout on 09.11.1965, North-East of USA
- PJM blackout on 05.06.1967, USA
- New-York city blackout of 13.07.1977.
- Blackout on 04.08.1982 in Belgium
- Blackout on 14.12.1982 in Canada
- Blackout on 22.12.1982 (West coast power system USA)
- Blackout on 27.12.1983 in Sweden
- Blackout on 21.02.1995, USA
- Oswego (New-York district) blackout of 26.04.1995.
- Blackout on 02. and 03.07.1996 in the USA West coast power system
- Blackout on 10.08.1996 in the USA West coast power system
- Blackout on 25.06.1998, USA, north-west.
- Blackout on 11. 03.1999 in Brazil
- 19.blackout on 02.01.2001 Northern grid India
- Blackout in Croatia - Bosnia on 12.01.2003.
- Blackout of 14.03.2005 in Australia
- Blackout of 25. 05. 2005, Moscow
- Blackout of the European power system of 04.11.2006.
- Byelorussian event of 25.06.2008.
- Northern Grid failure on 30/07/2012 in India

Even later half of the first decade of 21<sup>st</sup> century is free from any power woes in most of the developed countries. If this has something to indicate it's high time that India should give a serious thrust on the future challenges and its management of all our power disasters. The analysis of past events of power sector disasters is the first and immediate need of the hour.

## **III. ANALYSIS**

A proper and efficient technical analysis is very important as such issues are very sensitive and become the subject of prolonged public debates which in turn affect the policymaking process. The Northern Grid failure that occurred on July 30 2012 occasioned a flood of comments in the print and electronic media; unfortunately, some

of these comments were ill-informed and misleading. This could lead to people losing faith in one of the finest institutions in the country. A well-informed approach is necessary to fully understand the events that unfolded on July 30 and 31.

The present article is an attempt to perform a critical technical analysis on every single event right from the pre-breakdown to the restoration. Before a detailed analysis is made it is apt present a precursor to the supply-demand dynamics which is the main valve to cope-up with the daily power demand variations.

### **3.1 Supply-Demand Dynamic**

The power demand systematically varies with the time of day — it is highest during evening peak hours (generally 6-10 p.m.) and lowest during the night hours (12 midnight-6 a.m.). This is because the commercial and institutional installations work on full load in day time whereas during night the main load comes from the domestic usage. In graphical terms the power demand variation may be called an S-curve.

During peak hours the demand is high and the power generators tend to slow down causing frequency to falls below 50 Hz. The frequency of 50 Hz corresponds to 3,000 rpm for a conventional two-pole generating set. During night (or off-peak hours), on the other hand, power system operators have to grapple with excess generation. Most power generators, therefore, reduce their generation off-peak hours to the extent possible to match the reduced demand. The nuclear and thermal power generators cannot reduce the generation below a technical lower limits called 'technical minimum' without a complete shutdown of unit. The restart of a thermal and nuclear power unit is a costly and a time consuming exercise. Hence, they are always reluctant to reduce generation below the technical minimum. Thus, when power generation exceeds demand, the generating sets speed up beyond 3,000 rpm and system frequency exceeds 50 Hz. Further, there is a frequency limit beyond which it is not advisable to run a generator, and the same will trip if that limit is crossed. That's what happened in the present case.

### **3.2 The Trigger of The Event And Its Culmination Into A Catastrophe**

On July 30, going by the statements made by Power Minister, first failure of the Northern Grid took place at 2.35 a.m. at the grid frequency of 50.46 Hz which is beyond the upper operating limit. During this time the load had dropped much below the generation and the frequency had already exceeded the upper operational limit of 50.2 Hz (3). Unfortunately no control mechanism was operational to tackle the grid over frequency .Thus, either or both the generators and States infringed upon the grid operating discipline.

Demand-supply mismatch is a common event. Going by the reports of hearings being conducted by the regulator on the subject of grid indiscipline. Another uneventful night would have passed, had it not been for a trigger — which in this case was the reported tripping of a loaded line (400 kV Bina/Agra/Gwalior). Further loss of load in a scenario where there already exists oversupply, over frequency, (and presumably over-voltage) proved to be the proverbial last straw. Frequency went beyond trip settings, resulting in a series of generator and line shutdowns, known as a cascade tripping, because each tripping worsens the operating parameters for the surviving plant and has a snowballing effect. In the present context the crisp and a simple summary of the reasons triggering the event may be as follows:

i) For a demand/supply mismatch resulting in a grid over frequency of 50.4 Hz it is certain that there was violation of grid discipline by some or all sections of the consumers/constituents (states), and/or failure of the NLDC/RLDCs to correct it in time.

ii) The July 30 event was a matter of ‘oversupply’ and not ‘overdrawal’, though the eventual outcome was the same — a grid collapse.

iii) The July 31 event, evidently and naturally, became a case of excess drawal. It is, although, difficult to piece together with any degree of exactitude the events leading to this failure, but one thing is clear — there was excess drawal vis-a-vis schedule by certain constituents that too at a time when the grid was in a fragile condition, and a trigger event like a line/equipment tripping took place, thus exacerbating an existing demand-supply mismatch. Both these events of 30-31 July indicate a blatant lack of grid discipline, dilapidated health of under/over frequency relays and impediments to speedy restoration of the system.

iv) The inaction of the NLDC/RLDCs is the next contributory factor, and all these combined to produce catastrophic failure when a crucial line trips due possibly to poor maintenance, or some other random cause.

The precedence of this catastrophes should be, therefore, be regarded an opportunity to identify remedial measures for pre-emption of any future repeat of such event. It is desirable that LDCs should come out of their akin to a dormant role. Firstly, persistent underdrawal or overdraw in disregard of LDC instructions amounts to grid indiscipline and needs to be firmly dealt with. Likewise, oversupply by generators, or failure to meet schedules also amounts to failure of grid discipline. Secondly the grid maintenance and its health audit should be strictly performed as per the laid down procedures. Therefore, State and generator discipline, and grid maintenance and operation all need more attention. All this is well within the competence of our power sector professionals and regulators, provided, of course, that they are not subjected to political interference.

#### **IV.REMEDIAL MEASURES**

The intent of the Electricity Act, 2003, is quite clearly to distance the Government from day-to-day operations of the power sector. A beginning can be made by further empowering the LDCs and making them independent of respective State governments. Responsible professional from relevant bodies like those from Power grid can be fully relied upon to take care of the grid and ensure reliable power supply, as they have done for the past 11 years (i.e. the previous grid collapse event). Thus, a three pronged remedial procedure could be proposed as per the following details so that any future recurrence of such catastrophes may be dealt with.

##### **4.1 Avoidance of Blackout Due To Grid Failure**

1. Implementing Under-frequency load shedding automatics ( AUFLS).
2. Maintaining grid discipline.
3. Use of micro grids which may take power from local nonconventional energy sources after ascertaining power quality. States may be allowed to buy renewable energy certificates Encouraging rural power producers to reduce grid load.

4. Distribution generation, disturbances in a transmission grid could reduce the excessive withdrawal from the grid.
5. Proper coordination between RLDC and SRLDC's

#### 4.2 Post Emergency Frequency Recovery

The post emergency frequency recovery is system recharge strategy which shows the technical prudence in the system at time of dismay. In the past many such events were tackled with utmost efficiency. As depicted in section II above the October, 1965 event was self-liquidated automatically within 100 seconds. In 1967, a series of four emergency events in the Latvian PS occurred in one day; each of them required 100 seconds for self-liquidation. This in itself indicates that the frequency avalanche disturbance transformed into an unnoticeable transient process, which could be exploited not only in its direct form but also as the inverted process .

One of the prime-most action points in such situations are that under-frequency load shedding (AUFLS1) is to be complemented with the following three elements:

- i) Slow-acting under-frequency load shedding automatics (AUFLS2) for restoring the frequency, consisting of several stages with various time delay settings (e.g. 8-10, 15, 20, 25 s, and so on) and with a high setting for start (similar to the first stage setting of the fast-acting AUFLS), which serves for adjusting the retiming setting to the rated frequency after the start. The slow-acting AUFLS2 begins its operation of restoring the frequency up to the normal level after the fast AUFLS1 has been completed its operation (Fig. [2]).
- ii) Automatic re-integration of split parts of a power system at a minor difference between their frequencies, using the available on all lines synchronism-check relays of automatic re-closing (ARC) devices;
- iii) Automatic re-closing of consumers' lines by the normal frequency, exerting the control over frequency variations.

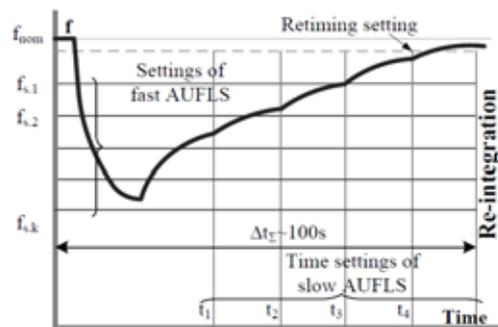


Figure-1: Reintegration of grid using AUFLS

#### 4.3 Control Over A Power System In View of Its Security

From the viewpoint of security, the operational conditions of a power system can be classified as follows

- (i) normal
- (ii) pre-emergency
- (iii) emergency

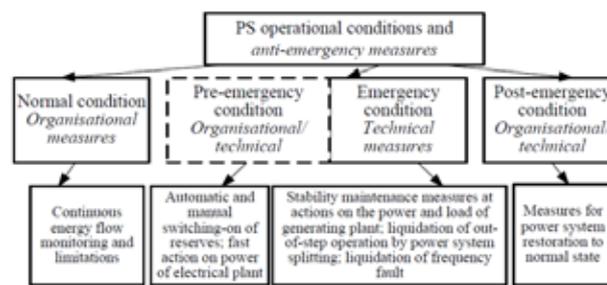
For normal operating conditions the mandatory security standards already exist along with power limitations in order to maintain voltage and frequency in the allowable margins [7]. Usually, this concerns observance of the

(n-1) criterion, which means that at emergency tripping of one important element of a power system it is kept normally operating thus preventing the development of a cascading emergency. A power system operator has to perform non-stop monitoring the security criteria and ensuring the availability of power reserves needed for frequency and voltage control. A definite reserve must also be provided to secure the allowable power exchange in transmission lines.

A pre-emergency condition is imminent when on normal running, an element of a power system is tripped which disturbs its operation. In this case, the emergency condition, though, has not yet begun but the security criteria are not observed any more, and the development of an emergency process can start any time if there is enhancement of operational condition severity [3]. This is a critical phase and needs careful attention by the operators and all other professionals working on the power system. This situation should immediately be normalized by mobilizing the capacities and reserves.

Once the emergency condition has taken place, the process develops in a fast cascading manner and the situation eventually goes out of controls from the hands of the personnel managing it. In such condition a blackout can only be prevented by the fast-acting automatic protection means which should be unified and most simple.

To manage the emergency condition as mentioned above the measures shown in Fig. 2 [2] should be applied.



**Figure 2: Classification of the anti-emergency measures by operating condition of a power system**

Organizational measures as represented in the Fig 2 are associated with the attentive and alert timely action by the staff professional which must be taken in strict compliance to the written or electronic instructions. These measures should correspond to the human abilities to act and make decisions fast. To provide higher security, there is an urgent need for execution of instructions be made automatic. At normal operation these are applied in a usual order; however, in the pre-emergency condition special programs should be in place which would provide instructions for urgent actions in a changed situation.

Technical measures are unavoidable during emergency, in which case the events develop too fast for a manual action, and the blackout can only be prevented with fast acting technical means. In these cases the staff should be involved in the post-emergency stage.

## V. CONCLUSION

Primary cause of PS blackouts is the transmission grid overload that triggers the development of cascading processes. A protection complex against blackouts is needed that momentarily removes the overload and automatically restores the normal system operation.

The Grid discipline along with the fast acting under frequency relay protection with backup protection with full automation is essential in the present case of blackout on 30 July 2012.

A proper coordination between the SDLC and RLDC and imposing the penalty on the persons responsible for overdrawing the power may also prevent the Disaster to reoccur.

The scheme of connecting the local micro grids to the grid which takes power from non conventional energy sources power producers after due verification of power quality meets the excess demand and reduces the possibility of the blackout

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# APPLICATIONS OF GRAPH THEORY IN COMPUTER SCIENCE ENGINEERING

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## **ABSTRACT**

The field of mathematics plays vital role in various fields. One of the important areas in mathematics is graph theory which is used in structural models. This structural arrangements of various objects or technologies lead to new inventions and modifications in the existing environment for enhancement in those fields. The field graph theory started its journey from the problem of Konigsberg bridge in 1735. This paper gives an overview of the applications of graph theory in heterogeneous fields to some extent but mainly focuses on the computer science applications that uses graph theoretical concepts. Various papers based on graph theory have been studied related to scheduling concepts, computer science applications and an overview has been presented here. The Field of Graph Theory plays vital role in various fields. One of the important areas in graph theory is Graph Labeling used in many applications like coding, x-ray crystallography, radar astronomy, circuit design, communication network addressing, data base management. This paper gives an overview of labeling of graphs in heterogeneous fields to some extent but mainly focuses on the communication networks. Communication network has two types 'wiredcommunication' and wireless communication'. Day by day wireless networks have been developed to ease communication between any systems, results more efficient communication. This paper also explored role of labeling in expanding the utility of this channel assignment process in communication networks. Various papers based on graph labeling have been observed, and identified its usage towards communication networks. This paper addresses how the concept of graph labeling can be applied to network security, network addressing, channel assignment process, social networks.

**Keywords:** *Bipartite graph, Ad-hoc networks, Geometric spanner, Median graph, Verona graph.  
Applications of Graph; Graph Theory*

## **I. INTRODUCTION**

Graph theoretical ideas are highly utilized by computer science applications. Especially in research areas of computer science such data mining, image segmentation, clustering, image capturing, networking etc., For example a data structure can be designed in the form of tree which in turn utilized vertices and edges. Similarly modeling of network topologies can be done using graph concepts. In the same way the most important concept of graph coloring is utilized in resource allocation, scheduling. Also, paths, walks and circuits in graph theory are used in tremendous

applications say traveling salesman problem, database design concepts, resource networking. This leads to the development of new algorithms and new theorems that can be used in tremendous applications. This paper has been divided into two sections. First section gives the historical background of graph theory and some

applications in scheduling. Second section emphasizes how graph theory is utilized in various computer applications.

A graph is a pair  $G = (V, E)$ ; where  $V$  is the set of all vertices and  $E$  the set of all edges; and the elements of  $E$  are subsets of  $V$  containing exactly 2 elements' is called a labeled graph if each edge  $e=UV$  is given the value  $f(UV) = f(u)*f(v)$ , where  $*$  is a binary operation. In literature one can find  $*$  to be either addition, multiplication, modulo addition or absolute difference, modulo subtraction or symmetric difference. Network representations play an important role in many domains of computer science, ranging from data structures and graph algorithms, to parallel and distributed computing, and communication networks Traditional network representations are usually global in nature. That is, in order to retrieve useful information, one must access a global data structure representing the entire network. Massive graphs are every where, from social and communication networks to the World Wide Web. The geometric representation of the graph structure imposed on these data sets provides a powerful aid to visualizing and understanding the data.

## **II. HISTORY OF GRAPH THEORY**

The origin of graph theory started with the problem of Konigsbergbridge, in 1735. This problem lead to the concept of Eulerian Graph. Euler studied the problem of Konigsberg bridge and constructed a structure to solve the problem called Eulerian graph. In 1840, A.F Mobius gave the idea of complete graph and bipartite graph and Kuratowski proved that they are planar by means of recreational problems. The concept of tree, (a connected graph without cycles was implemented by Gustav Kirchhoff in 1845, and he employed graph theoretical ideas in the calculation of currents in electrical networks or circuits. In 1852, Thomas Guthrie found the famous four color problem. Then in 1856, Thomas. P. Kirkman and William Hamilton studied cycles on polyhedral and invented the concept called Hamiltonian graph by studying trips that visited certain sites exactly once. In 1913, H.Dudeney mentioned a puzzle problem. Even though the four color problem was invented it was solved only after a century by Kenneth Apple and Wolfgang Haken. This time is considered as the birth of Graph Theory.

## **III. APPLICATIONS OF GRAPH THEORY**

Graph theoretical concepts are widely used to study and model various applications, in different areas. They include, study of molecules, construction of bonds in chemistry and the study of atoms. Similarly, graph theory is used in sociology for example to measure actors prestige or to explore diffusion mechanisms. Graph theory is used in biology and conservation efforts where a vertex represents regions where certain species exist and the edges represent migration path or movement between the regions. This information is important when looking at breeding patterns or tracking the spread of disease, parasites and to study the impact of migration that affect other species. Graph theoretical concepts are widely used in Operations Research. For example, the traveling salesman problem, the shortest spanning tree in a weighted graph, obtaining an optimal match of jobs and men and locating the shortest path between two vertices in a graph. It is also used in modeling transport networks, activity networks and theory of games. The network activity is used to solve large number of combinatorial problems. The most popular and successful applications of networks in OR is the planning and scheduling of large complicated projects. The best well known problems are PERT(Project Evaluation Review Technique) and CPM (Critical Path Method). Next, Game theory is applied to the problems in engineering, economics and war science to find optimal way to perform certain tasks in competitive environments. To represent the method of finite game a digraph is used. Here, the vertices represent the positions and the edges represent the moves. Graphs in Chemistry: Graphs are used in the field of chemistry to model chemical compounds. In computational

biochemistry some sequences of cell samples have to be excluded to resolve the conflicts between two sequences. This is modeled in the form of graph where the vertices represent the sequences in the sample. An edge will be drawn between two vertices if and only if there is a conflict between the corresponding sequences. The aim is to remove possible vertices, (sequences) to eliminate all conflicts. In brief, graph theory has its unique impact in various fields and is growing large now a days. The subsequent section analyses the applications of graph theory especially in computer science.

#### **IV. ALGORITHMS AND GRAPH THEORY**

The major role of graph theory in computer applications is the development of graph algorithms. Numerous algorithms are used to solve problems that are modeled in the form of graphs. These algorithms are used to solve the graph theoretical concepts which intern used to solve the corresponding computer science application problems.

Some algorithms are as follows:

1. Shortest path algorithm in a network
2. Finding a minimum spanning tree
3. Finding graph planarity
4. Algorithms to find adjacency matrices.
5. Algorithms to find the connectedness
6. Algorithms to find the cycles in a graph
7. Algorithms for searching an element in a data structure (DFS, BFS) and so on.

Various computer languages are used to support the graph theory concepts. The main goal of such languages is to enable the user to formulate operations on graphs in a compact and natural manner

Some graph theoretic languages are

1. SPANTREE – To find a spanning tree in the given graph.
2. GTPL – Graph Theoretic Language
3. GASP – Graph Algorithm Software Package
4. HINT – Extension of LISP
5. GRASPE – Extension of LISP
6. IGTS – Extension of FORTRAN
7. GEA – Graphic Extended ALGOL (Extension of ALGOL)
8. AMBIT – To manipulate digraphs
9. GIRL – Graph Information Retrieval Language
10. FGRAAL – FORTRAN Extended Graph Algorithmic Language

#### **V. USE OF GRAPH ENUMERATION TECHNIQUES:**

Graph enumeration technique is used to identify the computerized chemical identification. The list of all distinct chemical structures will be generated based on the given chemical formula and the valence rules for any new substance. To identify the chemical compounds automatically, a computer language called DENDRAL has been developed.

#### **VI. GRAPH THEORY IN OR**

Graph theory is a very natural and powerful tool in combinatorial operations research. Some important OR problems that can be solved using graphs are given here. A network called transport network where a graph is

used to model the transportation of commodity from one place to another. The objective is to maximize the flow or minimize the cost within the prescribed flow. The graph theoretic approach is found more efficient for these types of problems though they have more constraints. The field of Graph Theory plays vital role in various fields. One of the important areas in graph theory is Graph Labeling used in many applications like coding theory, x-ray crystallography, radar, astronomy, circuit design, communication network addressing, data base management.

This paper gives an overview of labeling of graphs in heterogeneous fields to some extent but mainly focuses on the communication networks. Communication network has two types 'Wired communication' and 'wireless communication'. Day by day wireless networks have been developed to ease communication between any two systems, results more efficient communication. This paper also explored role of labeling in expanding the utility of this channel assignment process in communication networks. Various papers based on graph labeling have been observed, and identified its usage towards communication networks. This paper addresses how the concept of graph labeling can be applied to network security, network addressing, channel assignment process, social networks.

## **VII. GRAPH COLORING**

Graph coloring is one of the most important concepts in graph theory and is used in many real time applications in computer science. Various coloring methods are available and can be used on requirement basis. The proper coloring of a graph is the coloring of the vertices and edges with minimal number of colors such that no two vertices should have the same color. The minimum number of colors is called as the chromatic number and the graph is called properly colored graph.

## **VIII. GRAPH LABELING IN COMMUNICATION RELEVANT TO ADHOC NETWORKS**

Graph labeling can also use for issues in Mobile Adhoc Networks (MANETS). In Adhoc networks, issues such as connectivity, scalability, routing, modeling the network and simulation are to be considered. Since a network can be modeled as a graph, the model can be used to analyze these issues. Graphs can be algebraically represented as matrices. Also, networks can be automated by means of algorithms. The issues such as node density, mobility among the nodes, link formation between the nodes and packet routing have to be simulated. To simulate these concepts random graph theory is used. Various algorithms are also available to analyze the congestion in MANET's where these networks are modeled based on graph theoretical ideas.

## **IX. EFFECTIVE COMMUNICATION IN SOCIAL NETWORKS BY USING GRAPHS**

Social networks are the communication networks that are built around people. Traditional social networks and modern social networks are two such kind.

## **X. TRADITIONAL SOCIAL NETWORKS**

Long before the Internet started to play a role in many people's lives, sociologists and other researchers from the humanities have been looking at the structure of groups of people. In most cases, relatively small groups were considered, necessarily because analysis of large groups was often not feasible. The traditional networks are used for identifying importance of people or groups.

A person having many connections to other people may be considered relatively important. Likewise, a person at the center of a network would seem to be more influential than someone at the edge is the disadvantage of

thesenetworks. To overcome the drawbacks of traditional social networks modern social networks are introducedasonline communities.

## **XI. ONLINE COMMUNITIES**

Internet has been the ability to allow people to exchange information with each other by means of userto- user messaging systems. The best known of these systems is e-mail, which has been around ever since the Internet came to life. Another well-known example is network news, through which users can post messages at electronic bulletin boards, and to which others may subsequently react, leading to discussion threads of all sorts and lengths. More recently instant messaging systems have become popular, allowing users to directly and interactively exchange messages with each other, possibly enhanced with information on various states of presence. Now a day's almost 2 million e-mail messages were sent every second, by a total of more than 1 billion users are used.

An important contribution to social network analysis came from sociograms. A sociogram can be seen as a graphical representation of a network: people are represented by dots (called vertices) and their relationships by lines connecting those dots (called edges).

It is interesting to see what these communication facilities do to the people who use them. Online communities are used by people who have never met each other physically are sharing ideas, opinions, feelings, and so on. Online community which is dealing here is known as a small world. A small world is characterized by the fact that every two people can reach each other through a chain of just a handful of messages. It is the phenomenon of messages traveling through a network of e-mail users. Users are linked by virtue of knowing each other, and the resulting network exhibits properties of small worlds, effectively connecting every person to the others through relatively small chains of such links. Describing and characterizing these and other networks forms the essence of network science.

## **XII. SECURE COMMUNICATION IN GRAPHS**

Secure communication in an open and dynamic network in the presence of a malicious adversary can only be achieved when the messages are authenticated. For this purpose authentication channels are used. There are several ways to establish such channels. For example, dedicated communication lines in the network are used here With shared secret keys or public keys.

## **XIII. BY USING CERTIFICATES**

The graph with vertices the processors in the network and edges the authentication channels is called a trust graph. If the sender is connected to the receiver by an edge in this graph then the messages can be authenticated through the corresponding channel. Otherwise authentication paths are used through intermediary processors in the trust graph.

Consider the problem of secure communication in a network with malicious faults for which the trust graph, with vertices the processors and edges corresponding to certified public keys, is not known except possibly to the adversary. This scenario occurs in several models. For example, in survivability models in which certifying authorities may be corrupted, or in networks which are being constructed in a decentralized way. A protocol, with which secure communication can be achieved in this case, is provided for the trust graph if sufficiently connected.

#### **XIV. BY USING KEY GRAPHS**

Securing group communications, i.e., providing confidentiality, authenticity, and integrity of messages delivered between group members, will become a critical networking issue. The key graphs are used to specify secure groups. For a special class of key graphs, three strategies for securely distributing rekey messages are provided here after a join/leave and specify protocols for joining and leaving a secure group. The three strategies are a set of users, a set of keys held by the users, and a user-key relation. By using any of the three rekeying strategies, is scalable to large groups with frequent joins and leaves. In particular, the average measured processing time per join/leave increases linearly with the logarithm of group size.

#### **XV. IDENTIFICATION OF ROUTING ALGORITHM WITH SHORT LABEL NAMES**

Informative labeling schemes consist in labeling the nodes of graphs so that queries regarding any two nodes (e.g., whether the two nodes adjacent or not) can be answered by inspecting merely the labels of the corresponding node labels. The main goal of such schemes is to minimize the label size, that is, the maximum number of bits stored in a label. Probabilistic labeling schemes are used to construct various probabilistic one-sided error schemes for the adjacency and ancestry problems on trees. Some of the schemes are significantly improve the bound on the label size of the corresponding deterministic schemes, while the others are matched with appropriate lower bounds showing that, for the resulting guarantees of success, one cannot expect to do much better in term of label size.

#### **XVI. AUTOMATIC ROUTING WITH LABELING**

In any traditional network if it can be represented with a specific kind of graph topology, then labeling applied may automatically detects route with any additional information.

Here the Graph structure can be anything like cycle, wheel, fan graph, friend graph etc but should be fixed. Now magic labeling can be applied to the network for a magic constant which is public to network. Now the router automatically detects the next node to be reached by using the magic constant, its own label and labels assigned to channels.

#### **XVII. CONCLUSION**

The main aim of this paper is to explore role of Graph Labeling in Communication field. Graph Labeling is powerful tool that makes things ease in various fields of networking as said above. An overview is presented especially to project the idea of Graph Labeling. Researches may get some information related to graph labeling and its applications in communication field and can get some ideas related to their field of research.

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# COMPARATIVE STUDY OF MOBILE AD-HOC NETWORKS IN REACTIVE ROUTING PROTOCOLS DSR AND TORA

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## ABSTRACT

*A Mobile Ad hoc network (MANET) is self-configurable network systems of mobile nodes is connected by wireless links. These nodes infrastructure less (ad hoc) network and there is no centralized control. Each node operates not only as an end system. Every node participates in routing by forwarding data for other nodes dynamically on the basis of network connectivity. MANETs nodes are changed position frequently in case may be broken down due to mobility and dynamic infrastructure. Hence routing becomes a critical issue that needs to be addressed for smooth transmission. Number of protocols is proposed by many authors due to the wide application of MANETs. The objective of this paper is to survey and compare DSR and TORA routing protocols in Reactive routing protocols in the MANET routing protocols are discussed in details.*

**Keywords:** *DSR, MANET, TORA, Wireless Networks*

## I. INTRODUCTION

Discrimination geographic position of a wireless network, which will allow users to access electronic services and information, is an emerging new technology. Wireless networks can be classified into two types: infrastructure and infrastructure-less (ad hoc) networks -Infrastructure network consists of a network of fixed and wired gateways. Technician in a mobile network with wireless mobile computers (or nodes) is a group; Ad hoc network of mobile nodes dynamically "on the fly" to create their own network routing and install it themselves. Direct wireless transmission range of the nodes which allow them to collaborate with each other by sending packets. Mobile technology network that can communicate with each other via radio waves is a collection of independent mobile nodes. Intermediate nodes to route packets to other nodes in the assistance they need, while the mobile nodes communicate with each other directly to those nodes that are in the radio range. This fully distributed networks, and can work in any place without the help of any infrastructure. This property is very strong for these networks. These ad hoc networks, routing protocols discussed in this paper comparative study. Explored how and when the routes based on demand driven routing table: The routing protocol is divided into two sections. When desired by the source host to the table-driven routing protocols, consistent and on-demand routing information to all nodes is maintained by each node routes, whereas the Marxists Reactive routing protocol DSR and TORA .

## II.CHARACTERISTICS OF MANET

### 2.1 Distributed Operation

The backbone network is the central control of network operations, distributed among the nodes of a control on the Internet. Cooperate with each other in a constant communication nodes communicate among themselves and to carry out certain functions, such as routing and security, will be required for each node acts as a relay.

### 2.2 Multi-Hop Routing

In its communication range of a node, which is trying to send a message to other nodes, the packet must be submitted through one or more intermediate nodes.

### 2.3 Autonomous Terminal

Unchanged, and two of each mobile node can act as a host, it is an independent node is a router.

### 2.4 Dynamic Topology

Nodes are free to move independently at different speeds; thus, the network switches randomly and at unexpected times. They establish themselves as dynamic routing nodes unchanged establishing a network of their own, the whole journey.

### 2.5 Light Weight Terminals

In most cases unchanged edged lower CPU performance, low-power mobile storage and small memory size.

### 2.6 Shared Physical Medium

Wireless communication medium that is accessible to any entity for which equipment and adequate resources accordingly, controlled access channel.

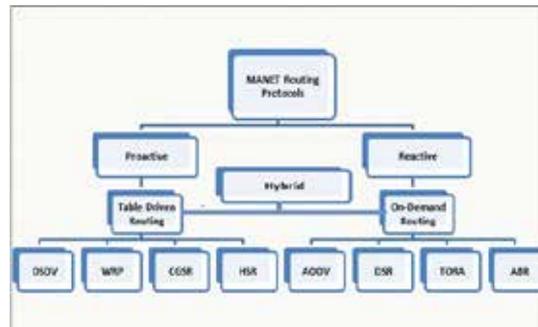
## III.ROUTING PROTOCOLS IN MOBILE ADHOC NETWORKS

### 3.1 Pro-Active / Table Driven Routing Protocols

Pro-active routing protocols in the form of tables and store information during the conversion of any type of network, each node receives the data in these tables will improve. At any time when they most needed information on the way the information node topology changes. Innovation is the path to finding a new way of getting late. Pro-active routing protocols as a reaction to the fixed cost that is usually higher than the build. Pro-active routing protocols traditional occasional high-level distributed algorithms based on the shortest route [3]

#### Protocols Include

1. Destination-Sequenced Distance Vector (DSDV)
2. The Wireless Routing Protocol (WRP)
3. Cluster-head Gateway Switch Routing Protocol (CGSR)
4. Hierarchical State Routing(HSR)
5. Global State Routing (GSP)
6. Fisheye State Routing (FSR)



**Fig.3 Classification of Routing Protocols**

### 3.2 Reactive (On Demand) Protocols

A Reactive Protocols is On-Demand Routing Protocols take a lazy approach: Mobile nodes- Notebooks, Palmtops or mobile phones usually forming wireless ad-hoc networks. This is an important issue for portability with movement. This is an important issue in ad-hoc networks. The movement of the nodes of the network topology changes constantly. Re-active routing protocol developed for this kind of environment. Changing lanes. When a node needs a route to a specific target, instead, it is a way to find out. fly initiates a route discovery process [1]. Begin to set standards for the reaction pathways. When looking to start any node to communicate with another node routing protocol, which is the way it is presented in such a way to try to establish. Usually this kind of request via protocols (RREQ) and route reply (RRP) found along the path from the source to the target node request message mutivu messages with the help of the network is based on the flood; And the destination node of the path that has been established to ensure that a RREQ news RRP send a message. The protocol is very useful in this kind of networks are usually the same rate. It reduces the number of hops is usually chosen route. However, multi-rate, the number of hops in a certain way [2] can be obtained, so that the throughput is not as critical.

#### Driven By Re-Active On Demand For Different Types Of Protocols:

1. Ad hoc On Demand Distance Vector (AODV)
2. Dynamic Source routing protocol (DSR)
3. Temporally ordered routing algorithm (TORA)
4. Associativity Based routing (ABR)
5. Signal Stability-Based Adaptive Routing (SSA)
6. Location-Aided Routing Protocol (LAR)

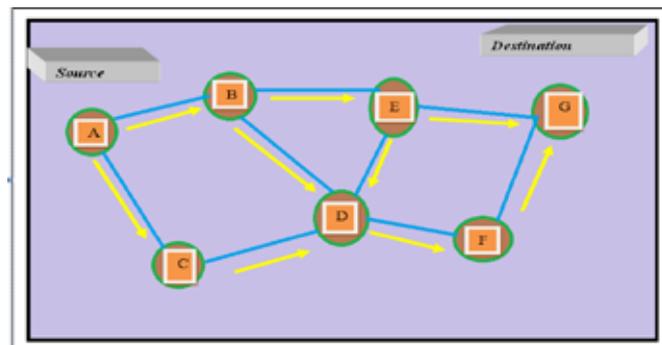
### 3.3 Description of Reactive Protocols Conditions

All of this, it is only when you need to create pathways, protocols, because the reaction was identified as in need of regulation. As the name suggests is required, the source begins. A source node needs a route to a destination; a route in the network discovery process begins. Once this process is completed, there is a path or route measured permutations. Remove and wrong ways to keep the valid paths is practically a routine maintenance various reactive routing protocols are explained below

## IV. COMPARION OF DSR AND TORA

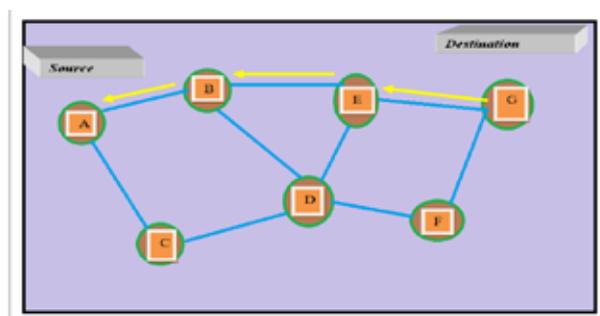
### 4.1 Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is used to perform a routing protocol Wireless mesh networks. It is similar to the AODV in that a connection establishes a route on-demand when a data transmitting request to one mobile node. However, it uses source routing Instead of relying on the routing table at each intermediate Device [5] mainly On-demand source routing protocol is one of Dynamic Source Routing protocol (DSR) its perform routing every time mobile nodes information (regularly updated) maintains in DSR. Dynamic Source Routing allows the network to be fully without the need for self-organizing and self-configuring, which one of the network infrastructure or administration. The algorithm (protocols) is composed of two main methods "Route Discovery" and "Route Maintenance" which works The ends together to find and maintain Ways to arbitrary locations in the network technician These and other in-demand among Ad-hoc It is the beacon-less routing protocols, so that it No need for periodic hello packets A node (the lighthouse) transactions, To inform its neighbors of its existence. Basic On the stage of development is the ethical approach Request packets to a path on the way from the flood Network. One way to get the target node, Request packet, responds by changing the way the answer Sources in the back pocket of the source, with the route Route Request packets received through. A Request packet to route through a network, as shown on the registration form in to Routing Network node pass data packets.



**Fig.4.1 (A) Propagation of Request (PREQ) Packet**

If the answers are generated on the target and puts it on the path from register in response to the request packet to packet. On the other hand, if the nozzle is forming on the answer its goal is to post it on the demand on the secondary node on the handwriting of savings Response packet and parcel of the way places.



**Fig. 4.1 (B) Path selected by the Route Reply (RREP) Packet**

Shows the packet is sent on the answer destination. To send the response packet, the source node is responding to a path. If the source path is a path to the cache, it can be used in that way. If the route can be used to reverse

the record supports symmetric links. In case you do not support symmetric connections, the start node in response to the discovery of the source and the new route to piggyback on request.

#### 4.1.1 DSRP Route Packets Use Two Types of Care

Dynamic Source Routing Protocols (DSRP) Perrutarutal route packet error. The data link layer is a tip, when you meet a fatal transmission problem; it creates a route error packet data. When a node receives a route error packet data, it removes the path from cache error hop. Error hops point that all the routes is limited. Acknowledgment packets are used to verify the proper operation of road links. It also sent a packet to the next hop on the way to the edge of the gate which includes passive acknowledgment.

#### 4.1.2 Advantage and Disadvantage

Periodic Table of the DSR is a table-driven approach, which eliminates the need for the update messages flooding the network using a reactive approach [6]. Intermediate nodes to efficiently reduce the burden of regulation on the use of information in the cache. The disadvantage of the DSR route maintenance mechanism is in place that can fix a broken down connection. Connection setup delay is greater than the table- driven algorithms. Although the protocol is stable and works well in environments with limited mobility, Performance degrades rapidly increasing mobility. Also, due to the considerable overhead routing source routing mechanism is involved in the work of the DSR.

### 4.2 Temporary Ordered Routing Algorithm (TORA)

A Temporary Ordered Routing Algorithm (TORA) for a more efficient, adaptive and scalable distributed routing algorithm based on attachment theory reversal. TORA is proposed highly dynamic mobile, multi-hop self-configuring wireless networks. It is a source start on-demand routing protocol. From a source node to a destination node it finds many ways. TORA is the main feature that Control Change messages a topological a very small set of nodes in the vicinity of the event. To achieve this, nodes maintain routing information about adjacent nodes. The algorithm has three Basic functions: root formation, root maintenance, and destruction of the way. Each node has a quintuple associated with it: Logical time of a link failure and the unique id of the node that defined the new reference level a reflection indicator bit and a propagation ordering parameter. The unique id of the node.[4]The first three components are collectively represented by the reference position. Due to the failure of a link to a new reference to a node loses its last downstream link is defined for each method. Last two values that define a delta with respect to the reference position. Route creation is done using QRY and UPD packets. On the formation of scalable algorithms (i.e. undefined), set the destination of 0 null a set (widely quintuple ordering parameter) and all other node starts height. It is the source of the destination node ID Broadcasts a QRY pocket. Its destination it was at the height of a non-NULL packet responds to a UPD. a node receiving a UPD.[4] A UPD packet that generated more than node sets its height. Upstream and downstream node is considered the height of the height of a node. In this way a directed acyclic graph is constructed from the original target.

It has already been shown in figure 4.2 (A), node B to node E QRY not campaign and G.

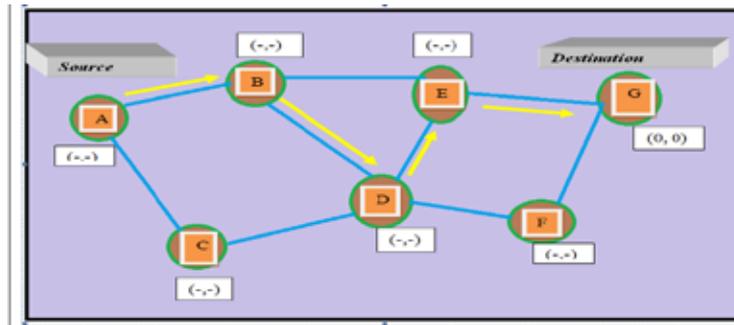


Fig.4.2 (A) Propagations of QRY message through the network

The number of node B-D-E QRY news from the campaign, the source (i.e. node A) received a UPD D gives the low height of the tip of the tip of each node B or D, but it keeps the height.

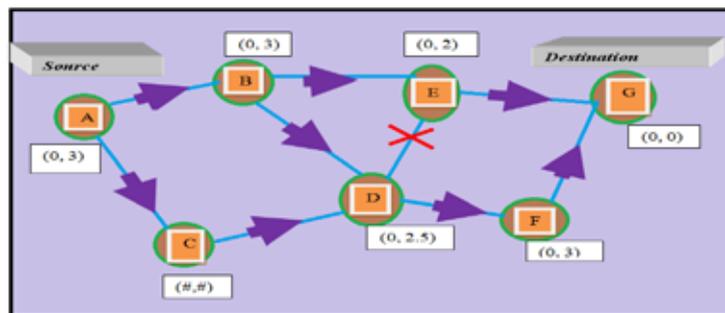


Fig.4.2 (B) Height of each Node Updated as a result of UPD messages

When moving a node DAG path is broken, and the maintenance required for the formation of a DAG back for the same destination. when the down-stream connection to a node, it creates a new reference level. Neighboring nodes, as shown in figure 4.2(C). Note that the condition results in Adapting to the new reference level can be reversed to reflect the change. This has the same effect when a node has no downstream links and reversing the direction of one or more links. On the point of destruction, TORA destroy false paths throughout the network broadcast package to clear (CLR) flood. Integration of multiple sets of nodes, routes simultaneously erasing diagnostic partitions, and each other, especially when building new routes based on the TORA, there is a potential cause oscillation.

TORA uses integration, because of such oscillations convergences temporary and occurs at the end of the path, the instability problem, distance-vector routing protocols, the "count-to-infinity" problem is similar.

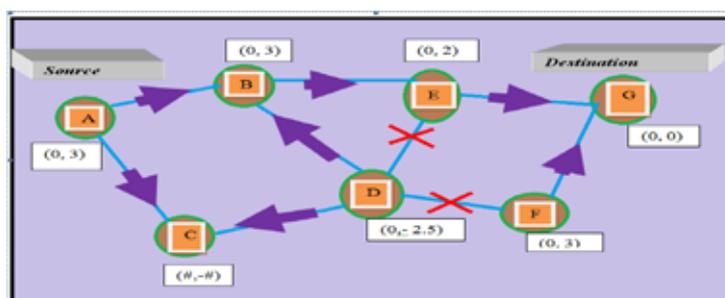


Fig.4.2 (C) Re-connection Establishing Route on Failure of Link D—F and the new reference level is node B-E-G.

Advantages	Disadvantages
1. That of an on-demand routing protocol – create a DAG only when necessary.	1. Same as on-demand routing protocols.
2. Multiple paths created.	2. Not much used since DSR and AODV outperform TORA.
3. Good in dense networks.□	3. Not scalable by any means.

Table4.2.1 TORA Advantage and Disadvantages

## V.COMPARISON FOR REACTIVE ROUTING PROTOCOL DSR and TORA

Parameters	DSR□	TORA
Route Selection	Shortest and Updated Path□	Shortest and Neighbours Node Selected Height Path
Route Computation	Broadcast□	Broadcast and limited source
Route□	Multiple□	Available no of Nodes s Selected Path
Topology Structure	Flat□	Reduced
Broadcast□	Full□	Local
Source Routing□	Yes	No
Update□	Event driven□	Event driven
Update Information	Route Error□	Route Error, Nodes height
Method□	Unicast□	Broadcast
Beacon□	No□	Yes
Loop Free□	Yes□	No
Route Reconfiguration	Erase Route, Notify Source	Clear packet, Erase□invalid routes

Table: 5 COMPARISONS FOR REACTIVE ROUTING PROTOCOL DSR and TORA

## VI. CONCLUSION

A comparison between TORA and DSR routing of the reactive protocols. This paper was MANET's protocol. We should undertake more in-depth study of the reactive routing can prove beneficial to the some set of Conditions Changes in the performance of these protocols. It is Recommend that you start with the most basic building Each of these modules to see how these protocols blocks How to take care of each other, thereby to communicate more effectively coordinated Infrastructure leading paper, the description is based on the increase in performance differentials. This TORA and comparison of the DSR protocol, and protocols. A TORA, highly adaptive distributed routing algorithm this is in accordance with the operation of a mobile networking Environment. Its design, the ability to make a shortest- Route calculation, the high efficiency of routing sacrifice Limit the scope of the control

message (link failures adding a small set of nodes in the vicinity of and change). As seen from the paper that the requirements and General requirements for temporary ordered routing protocols Routing protocol is very unique compared to networks Infrastructure near networks. TORA event messages Topology a very small set of nodes that change control is the main feature. Is a sum of the TORA Yet it maintains the routing tables to achieve the required routing protocol, routing information about nodes near nodes. This Behavior, scalable, adaptive, and a well-suited Dynamic low bandwidth mobile network. We cannot say that it is driven by two table features Reactive routing protocol. Only one of which is an input Source / destination pair, it is a resort on the invention, therefore, And more often than any of the DSR routing Do not use DSR.A Tables. Instead, it can be more than one path Source / destination pair. It makes complete use of raw Routing, the raw material or data Launcher Is to determine the complete hop-by-hop route to the packet Destination. TORA is directly applicable to the tactical networking Environment, and can provide either an internetwork routing Multi-hop wireless LAN routing solution.

We final conclusion is that we include in our comparative study can be summarized:

1. This leads to an increase in the density of nodes increases the average end-end delay.
2. Increase decrease time to pause the decision means-end delay.
3. Increase the number of nodes increases Average time for loop detection.

In short, the best all-round performance with the DSR. Of the DSR Suitable for moderate mobility rate networks. It has that makes it suitable for low bandwidth and low overhead Low power network. Whereas suitable for TORA Densely populated major mobile networks operated Nodes. The big advantage is its excellent support Many paths and multicasting.

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# DESIGN OF STORAGE AND MATERIAL HANDLING SYSTEM FOR PIPE INDUSTRY – A CASE STUDY

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## ABSTRACT

*Manufacturers need to implement system which reduces production time & cost to improve production efficiency & product quality to withstand in today's globalization world. Material handling is the movement and storage of material at the lowest possible cost through the use of proper method and equipment. This paper discuss the concept of implementing material handling system in small scale industries which has raw material as pipes at lowest cost .*

**Keywords: Design, Material Handling System, Movable Support, Pipes, Storage Rack.**

## I. INTRODUCTION

In small scale industries the material handling is generally done manually. Regarding pipes handling is very difficult. The precaution is taken that there is no damage to the pipes. Whenever, the specific pipe is required for the manufacturing of product then that pipes is carried by labors up to the cutting machine. Due to the manual material handling a lots of time is consummated. So the cycle time of production increases which decreases productivity of the plant, also increases cost per unit product.

## II. PROBLEM STATEMENT

The problem faced by small scale industries in material handling is time and labor consumption. In our case study we had found that around 3 to 4 hours are required to unloading the truck as well as 6 labors are required for manual transfer of pipes. As no of worker engaged in transferring the raw material towards cutting machine is large and also the time for transferring is more. It results into more working cost. To minimize this cost & time we are going to design the system which has inbuilt material handling system & storage rack.

## III. METHODOLOGY TO ADDRESS PROBLEM

### 3.1 Industrial Survey of Manufacturing Plant

The survey consists of total consumption per month of raw material in the plant. Also getting information about the various types of pipes required for manufacturing, Depending upon the consumption of various types of pipes, the position of that pipes in the rack is decided.

### 3.2 Deciding Parameters of Production Design

Depending upon the human comfort and quick accesses of regularly required raw materials the design of rack and MHS is based. Maximum amount of raw material is stored into the rack.

### 3.3 Design of Actual System

By Calculating the load, moment which are acting on the system we had find out the actual dimension on the system

## IV. INDUSTRIAL SURVEY

When the truck of raw material is comes in plant, two labors are required to unload the truck. These two people travels the distance of 15 m to store the pipe in storage rack whose position is fixed near the wall. To unload the Truck of 3 ton two people requires 3 hrs. When the pipe of particular size is required for manufacturing, two labors are required to carry the pipes from storage rack to machine through the distance of 15 m. After that two more labors are required for perfect aligning of pipes with pipe cutting machine. Total 1 hour is required to carry the pipes from storage rack up to the So the total 6 labors are required to unloading the pipes from the truck up to its loading to the machine. 6 labors are required for the unloading and loading of the pipes they requires 4 hours to unload the 3 ton pipes per day. The salary of each worker is 200 /-daily that is half of the shift is going to waste on the material handling that is 600Rs are waste on material handling. The plant is semi automated only 14 workers are working in the plant. If out of these 14 workers, 6 workers are busy for loading and unloading. Then it also affects on production of the plant. so maximum 2 workers will be forwards the loading and unloading section. So it is desired to implement low budget material handling system in SSI.

## V. DESIGN PROCEDURE

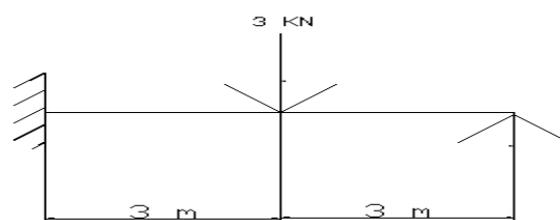


Fig. 1

The diagram shows the force acting on the single rack. We had total 7 racks and at the top, one gantry crane.

Total load =  $(7 \times 3000 \text{ N})$  + wt of material handling system

$$= (7 \times 3000) + 2000 \text{ N} = 23,000 \text{ N}$$

The moment at the end of single rack is given as {Moment =  $(\frac{3}{16}) \times W \times L$ }<sup>[5]</sup>

where,  $W=3000 \text{ N}$ ,  $L=6 \text{ m}$

Moment of the each cantilever at the end of each rack, =  $(\frac{3}{16}) \times W \times L = (\frac{3}{16}) \times 3000 \times 6 = 3375 \text{ Nm}$

Total moment due to 7 rack is given as  $7 \times 3375 = 23,625 \text{ Nm}$

Now, There is a moment due to material handling system.

When the load is at extreme condition and it is given as, moment =  $3000 \times 6 = 18,000 \text{ Nm}$

Due to the weight of MHS the moment is given as,

wt. of material handling system = 2000N

It is acted at the centre of span, & it is given as =  $2000 \times 3 = 6000 \text{ Nm}$

Total moment acting on the column is the summation of above mentioned equations

Total moment =  $23,625 + 18,000 + 6000 = 47625$

Total moment = 48,000Nm

### 5.1 Design of Column (Material = Yst 310 Grade)<sup>[10]</sup>

By assuming hollow column section that is of internal diameter 250mm and thickness 8mm.

The properties are as follows.

$A_{cs} = 66.63 \times 10^2 \text{ mm}^2$ ,  $Z = 428.87 \times 10^3 \text{ mm}^3$ ,  $K = 0.0937 \text{ m}$

Now, direct stress,  $f_a = \frac{(2000 \times 1.5)}{(66.63 \times 10^2)}$ , = 5.175 N/mm<sup>2</sup>

Bending stress,  $f_b = \frac{(48000 \times 10^3 \times 1.5)}{(428.87 \times 10^3)}$  = 167.88 N/mm<sup>2</sup>

Slenderness ratio =  $\frac{L}{R} = \frac{3}{0.0937} = 32.01$

The compressive stresses are, (30 = 178 N/mm<sup>2</sup>)<sup>[10]</sup>, (40 = 169 N/mm<sup>2</sup>)<sup>[10]</sup>

, For, slenderness ratio of 32.01. The compressive stresses are 176.2 N/mm<sup>2</sup>. The bending stresses are 205 N/mm<sup>2</sup>

$F_a = 176.2 \text{ N/mm}^2$ ,  $F_b = 205 \text{ N/mm}^2$

By similarly checking for stresses,

$$\left\{ \left( \frac{f_a}{F_a} \right) + \left( \frac{f_b}{F_b} \right) < 1 \right\}^{[5]}$$

$$\left( \frac{5.175}{176.2} \right) + \left( \frac{167.88}{205} \right) = 0.84$$

Therefore the design is safe .

The column selected is of

I.D = 250mm, O.D =  $250 + (2 \times 8) = 266 \text{ mm}$

### 5.2 Design of Rectangular Section<sup>[10][5]</sup>

choosing the cross section of (80 × 40)

Therefore properties of section are,

thickness = 4mm,

$Z_{xx} = 16.20 \text{ cm}^3$

=  $16.20 \times 10^3 \text{ mm}^3$

Moment will be the same

i.e.  $M = 2250000 \text{ Nm}$

The induced stresses are calculated as

$$\sigma_{\text{max}} = \frac{M}{Z} = 138.88 \text{ N/mm}^2$$

Therefore the induced stresses are less than allowable stresses. Therefore design is safe. By selecting the cross section  $80 \times 40$  for the rectangular section.

### 5.3 Weld Design 1<sup>[6][8]</sup>

Welding design between circular section and rectangular section

Considering fillet weld

We provide circular angle at a distance of 1m. internal therefore load on each angle is  $3000/6 = 500\text{N}$ .

By taking factor of safety as 2

Therefore ,total load  $500 \times 2 = 1000\text{N}$

Primary stresses are given as,  $\tau_1 = \frac{P}{A}$

by selecting the circular section of 15mm diameter

$$\tau_1 = \frac{1000}{\pi \times 15 \times t} = 21.22/t \quad \text{N/mm}^2$$

Now the moment of inertia of weld is given as

$$I_{xx} = \pi \times t \times r^3 = \pi \times t \times 7.5^3 = 1325.35 \times t \quad \text{mm}^4$$

Now bending stress is given as

$$\sigma_b = \frac{M_b \times Y}{I_{xx}} = \frac{1000 \times 137.5 \times 7.5}{1325.35 \times t} = 778.09 / t \quad \text{N/mm}^2$$

From the maximum shear stress theory

$$\tau = \sqrt{(\sigma_b / 2)^2 + \tau_1^2} = \sqrt{((778.09/2 \times t)^2 + (21.22 / t)^2)} = \sqrt{\frac{151256.072}{t^2} + \frac{450.28}{t^2}} = 389.62/t$$

N/mm<sup>2</sup>

For fillet welds, Permissible shear stress  $= (95 \text{ N/mm}^2)^{[4]}$

From equation 1

$$95 = \frac{389.62}{t}, t = 4.1 \text{ mm}, t = h \cos 45^\circ, h = \frac{4.1}{\cos 45^\circ}, h = 5.8 = 6 \text{ mm}$$

### 5.4 Weld Design 2<sup>[6][8]</sup>

Design between bush and rectangular lever<sup>[8]</sup>

The cross section of lever are  $80 \times 40$

$$A = 2(80t + 40t)$$

$$= 240t$$

Primary shear stress

$$\tau_1 = P/A = 3000/240t = 12.5/t$$

$$I_{xx} = t \left[ \frac{bd^2}{2} + \frac{d^3}{6} \right] = t \times 74.666 \times 10^3 \quad \text{mm}^4$$

$$\sigma_b = \frac{M_b \times Y}{I_{xx}} = \frac{3000 \times 3000 \times 20}{t \times 74.66 \times 10^3} = \frac{241 \times 10^3}{t}$$

Now From the maximum shear stress theory

$$\tau = \sqrt{(\sigma_b / 2)^2 + \tau_1^2} = \sqrt{(2.41 \times 10^3 / 2 \times t)^2 + (12.5 / t)^2} = 1205.06 / t$$

Now,  $(\tau = 95 \text{ N/mm}^2)^{[4]} 95 = 1205.06 / t, t = 12.68 \text{ mm}, t = h \cos 45^\circ, h = 12.68 / \cos 45^\circ, h = 17.94 \text{ mm}$

### 5.5 Design of Pin

By selecting the material as steel of C45<sup>[6]</sup>,  $\sigma_{ut} = 600 \text{ N/mm}^2$ ,  $\tau = 300 \text{ N/mm}^2$

by using factor of safety 2

The pin is in shear and the load of 3000 N is acted on it

$$\text{Shearing area} = (\pi / 4) \times d_1^2$$

$$d_1 = \text{diameter of pin, } P = (\pi / 4) \times d_1^2 \times \tau$$

$$\text{assuming the diameter of pin as 20mm, } 3000 = \pi / 4 \times 20 \times \tau, \tau = 9.54 \text{ N/mm}^2$$

which is less than allowable stress there for design is safe

$$\text{pin diameter} = 20 \text{ mm, clearance} = 3 \text{ mm on both side, internal diameter of bush + circular part} \\ = 20 + 2 \times 3 = 26$$

Considering  $d_2 = 1.5 d_1$ ,  $d_2 = \text{outer diameter of circular part, } d_2 = 40 \text{ mm, } d_1 = 26 \text{ mm}$

### 5.6 Design of Circular Bush

By using theory of knuckle joint<sup>[9]</sup>

$$1. \text{design for tension, } P = (d_2 - d_1) \times t \times \sigma_t, 3000 = (40 - 26) \times 100 \times \sigma_t, \sigma_t = 2.14 \text{ N/mm}^2$$

induced stress is less than allowable stress

$$2. \text{In shearing, } P = (d_2 - d_1) \times t \times \tau, 3000 = (40 - 26) \times 100 \times \tau, \tau = 2.14 \text{ N/mm}^2$$

$$3. \text{design in crushing, } P = d_1 \times t \times \sigma_c, 3000 = 26 \times 100 \times \sigma_c, \sigma_c = 1.15 \text{ N/mm}^2$$

### 5.7 Design For Circular Support on Coloumn

$$1. \text{For tension, } P = (d_2 - d_1) \times t \times \tau, 3000 = 44 \times 60 \times \tau, \tau = 1.13 \text{ N/mm}^2,$$

$$2. \text{for shearing, } P = (d_2 - d_1) \times t \times \tau, 3000 = 60 \times 600 \times \tau, \tau = 1.13 \text{ N/mm}^2$$

$$3. \text{for crushing } P = d_1 \times t \times \sigma_c, 3000 = 60 \times 600 \times \sigma_c, \sigma_c = 0.18 \text{ N/mm}^2, \text{ design is safe}$$

### 5.8 Design of Movable Support

As this is the case of propped cantilever the reaction of movable support

$$R = \frac{5}{16} \times W = \frac{5}{16} \times 3000 = 937.5 \text{ N} \approx 1000 \text{ N}$$

By taking the factor of safety as 1.5, The reaction at movable support is  $R = 1.5 \times 1000$ ,  $R = 1500 \text{ N}$

By keeping the distance of Rest point 0.5M from column, Total Moment =  $15000 \times 0.5 = 750 \text{ NM}$

$$R = 1500 \text{ N, } M = 750 \text{ NM}$$

### 5.9 Design of Column

By selecting section 15mm inner diameter, 3.20mm thickness, Properties of section

$$A_{cs} = 1.82 \times 10^2 \text{ mm}^2, Z = 0.70 \times 10^3 \text{ mm}^3, \text{Radius of gyration (k)} = 0.65 \text{ cm}$$

$$f_a = \frac{1500}{1.82 \times 10^2} = 8.24 \text{ N/mm}^2$$

$$f_b = \frac{M}{Z} = \frac{750}{0.70 \times 10^3} = 1.071 \text{ N/mm}^2$$

$$\text{Now, } \frac{L}{K} = \frac{2000}{0.65} = 307.69$$

Now allowable direct stress for this section

300 → 13, 350 → 10, By interpolation for 307.69 = 12.53

Check for design

$$\frac{F_a}{F_a} + \frac{F_b}{F_b} < 1$$

$$= \frac{8.24}{12.53} + \frac{1.071}{205} = 0.66$$

Hence design is safe

By keeping the distance between column and screw as 0.25 M

The load on the screw is calculated as per theory of lever

$$W \times l_1 = p \times l_2$$

$$1500 \times 0.5 = p \times 0.25$$

$$P = 3000 \text{ N}$$

Design of Screw and Bolt (Material Bolt → C.I), (Material Nut → hardened steel on C.I)<sup>[9]</sup>

Nominal Dia( $d_1$ ) = 40 mm, Minor Dia( $d_c$ ) = 33 mm

$D_0$  = 40 mm, Pitch = 7 mm, The screw has triple start thread

$$\mu = \tan \phi = 0.15, \phi = 11.30^\circ$$

Lead = no. of start × pitch

$$= 3 \times 7 = 21 \text{ mm}, A_c = 855 \text{ mm}^2$$

$$d = \frac{d_0 + d_c}{2} = \frac{40 + 33}{2}, D = 36.5 \text{ mm}$$

$$\text{Direct Stress} = \frac{W}{A_c} = \frac{3000}{855}, \sigma_c = 3.50 \text{ N/mm}^2$$

$$\tan \alpha = \frac{\text{lead}}{\pi \times d} = \frac{21}{\pi \times 36.5}, \alpha = 0.2092$$

$$\alpha = 11.820, T = p \times \frac{d}{2} = W \tan(\alpha + \phi) \frac{d}{2}, T = 3000 \tan(11.82 + 11.30) \frac{36.5}{2}, T = 23,375 \text{ N-mm}$$

For calculation of shear stress,

$$T = \frac{\pi}{16} \times \tau \times d_c^3, 23375 = \frac{\pi}{16} \times \tau \times 33^3, \tau = 3.33 \text{ N/mm}^2$$

According to the maximum shear stress theory

$$\tau_{\max} = \frac{1}{2} \sqrt{\sigma_c^2 + 4\tau^2} = \frac{1}{2} \sqrt{3.50^2 + 4 \times 3.31^2} = 3.74 \text{ N/mm}^2$$

$$\text{Ideal torque } (T_0) = W \tan \alpha \times \frac{d}{2}, T_0 = 11457 \text{ Nmm}$$

$$\text{Efficiency } (\eta) = \frac{T_0}{T} = \frac{11457}{23375} = 0.49, = 49\%$$

It is self locking screw

Dimension of nut

$$d_0 = 40.5 \text{ mm}$$



Fig. 2

$$R_f = 3000 - 1500 = 1500 \text{ N}$$

Design of fulcrum pin ,Given bearing pressure for the material  $25 \text{ N/mm}^2$

$d_p$  = dia of pin ,  $l_p$  = length of pin

$$\text{Bearing area} = d_p \times l_p \quad (l_p = 1.25d_p)$$

$$\text{Load on fulcrum pin} = \text{bearing area} \times \text{bearing pressure} = 1.25d_p^2 \times P_b, \quad 1500 = 31.25 d_p^2, \quad d_p = 6.92 \approx 8 \text{ mm}$$

$$\text{checking pin for shearing, } 1500 = 2 \times \frac{\pi}{4} \times d_p^2 \times \tau, \quad 1500 = 2 \times \frac{\pi}{4} \times 8^2 \times \tau, \quad \tau = 14.92 \text{ N/mm}^2$$

The value of induced stress is less than permissible value i.e.  $\tau = 500 \text{ N/mm}^2$ , Hence design is safe

Thickness of bush = 2 mm

Total dia of hole =  $12 + 2 \times 2 = 16 \text{ mm}$ , Moment = 750 Nm

We know that section modulus,  $Z = \frac{1}{8} \times t \times b^2$  ( $b = 4t$ ),  $Z = 2.67 t^3$ ,  $\sigma_b = 70 \text{ N/mm}^2$

$$\sigma_b = \frac{M}{Z} = \frac{750}{2.67 t^3}, \quad 70 = \frac{750}{2.67 t^3}$$

$$t = 5 \text{ mm}, \quad b = 4t = 20 \text{ mm}$$

shear stress induced in the lever

$$\tau = \frac{3000}{20 \times 5} = \frac{3000}{100} = 30 \text{ N/mm}^2$$

Hence the Design is Safe.

### 5.10 Design of material handling crane (gantry girder)<sup>[7]</sup>

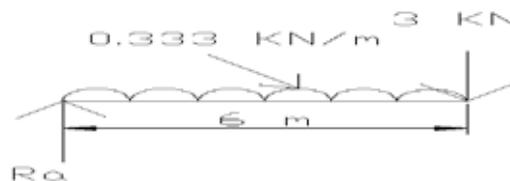


Fig. 3

$$\begin{aligned} \text{Reaction of column} &= (0.333 \times 6) + 3 \\ &= 5 \text{ KN} \end{aligned}$$

$$\text{Reaction on each wheel is } \frac{5}{2} = 2.5 \text{ KN}$$

By taking section of side view of crane



Fig. 4

$$\text{Bending moment is given as, } B.M._1 = \frac{W \times l^2}{8} = \frac{0.25 \times 0.4^2}{8} = 5 \times 10^{-3} \text{ KNm}$$



Fig. 5

$$B.M._2 = 6 + 18 = 24 \text{ KNm}, \quad B.M._2 > B.M._1, \quad \text{Design is based on } B.M._2$$

Now calculating section modulus , for steel  $\sigma_{bc} = 165 \text{ N/mm}$

$$Z = \frac{M}{\sigma_{bc}} = \frac{24 \times 10^6}{165} = 145.45 \times 10^3 \text{ mm}^3$$

Depending upon this section modulus ,Selecting the I section ISMB 200 from steel table ,Properties of ISMB 200

1. Sectional area (a) = 32.33 cm<sup>2</sup>
2. Thickness of web (t<sub>w</sub>) = 5.7 mm
3. Thickness of flange (t<sub>f</sub>) = 10. Mm
4. Moment of inertia (I<sub>xx</sub>) = 235.4 × 10<sup>4</sup> mm<sup>4</sup>
5. Moment of inertia (I<sub>yy</sub>) = 150 × 10<sup>4</sup> mm<sup>4</sup>
6. Width of flange = 100 mm

For selecting the 'C' channel , we have to consider width of the flange and keeping the 25 mm clearance on both side. By selecting the ISMC 150 channel

From steel table ,Properties of IMSC 150

1. Area of cross Section (a) = 2088 cm<sup>2</sup>
2. Thickness of web (t<sub>w</sub>) = 5.4 mm
3. Thickness of flange (t<sub>f</sub>) = 9mm
4. Moment of inertia (I<sub>xx</sub>) = 779.4 × 10<sup>4</sup> mm<sup>4</sup>
5. Moment of inertia (I<sub>yy</sub>) = 102.3 × 10<sup>4</sup> mm<sup>4</sup>
6. Width of flange = 2.22 mm

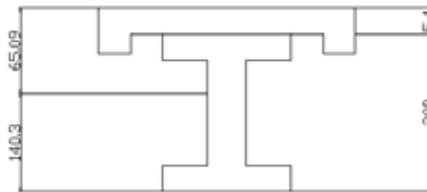


Fig. 6

To find out  $\bar{Y}$  of built up section ,  $\bar{Y} = \frac{a_1 Y_1 + a_2 Y_2}{a_1 + a_2}$  ,  $\bar{Y} = \frac{32.33 \times 105.4 + 2088 \times 2.7}{32.33 + 20.88}$  ,  $\bar{Y} = 65.09 \text{ mm}$

Now moment of inertia about X-X axis , of total built up section

$$I_{xx} = I_{xx1} + a_1 k_1^2 + a_2 k_2^2 + I_{xx2} = 235.4 \times 10^4 + 32.33 \times 40.31^2 + 102 \times 10^4 + 2088 \times 42.89^2 = 31.44 \times 10^6 \text{ mm}^4$$

$$I_{yy} = I_{yy1} + I_{yy2} = 150 \times 10^4 + 779.4 \times 10^4 = 9.294 \times 10^6 \text{ mm}^4$$

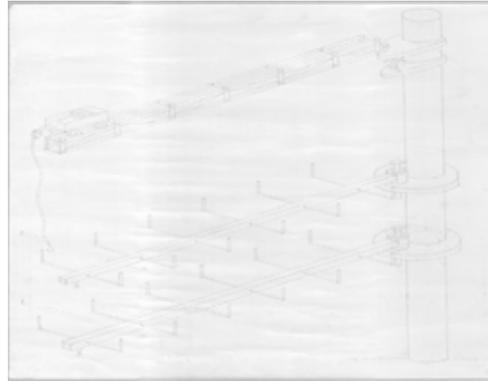
$$\sigma_{bc} = \frac{M_{xx} \bar{Y}}{I_{xx}} = \frac{24 \times 10^6 \times 140.3}{31.44} = 1.1 \times 107.099 \text{ N/mm}^2 = 117.8089 \text{ N/mm}^2. \text{ The design is safe}$$

## VI. CONCLUSION

PARAMETERS	CONVENTIONAL METHOD	PROPOSED METHOD
Time	3-4 hrs	½ hrs
Man power	6	2

required		
Working cost/day	$600+6000=6600$	$500+200=700$
Efficiency	Less	More
damage Possibility	More	Less
Fatigue to labors	More	Less

**Table No.1 Comparison Table**



**Fig.7 Material Handling System**

By implementing the material handling system shown in Fig.7 we are minimizing the cycle time of production and also minimizing the no. of labors from 6 to 2 which indirectly increases productivity as well as profit of the organization. We are saving 66% manpower required for material handling and saving 89% of cost of material handling.

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# FIXED POINT LEAST MEAN SQUARE ADAPTIVE FINITE IMPULSE RESPONSE FILTER

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## ABSTRACT

Fir filters is highly used in Digital communication & Signal processing applications Digital radio receivers, Downconverts Software Radio.in this project I present an efficient architecture for the implementation of a delayed least mean square adaptive filter.Sofor achievingthis lower adaptation-delay and area-delay-power efficient implementation, I use a novel partial product generator and propose a strategy for optimized balanced pipelining across the time-consuming combinational blocks of structure to the proposed architecture. This paper implements the less area delay and less energy delay compare to existing one. From this one I am saving the 20% in ADP and 9% in EDP compare to the existing one in this paper I am using 8 bit filter length this is normally uses in various application like digital signal processing.

**Keywords - Adaptive Filters, Circuit Optimization, Fixed-Point, Least Mean Square Algorithm**

## I. INTRODUCTION

The basic operation of the adaptive filter is LMS whereused to minimize a desired filter by finding the filter coefficients that relate to producing the least mean squares of the error signalThe least mean square (LMS) adaptive filter is the most popular and most widely used this one so not only because of its simplicity but also because for its satisfactory convergence performance.LMS algorithms is a class of adaptive filterThe direct-form LMS adaptive filter involves a long critical path due to an inner-product computation to obtain the filter output. In this paper existing one will take so much time to get the filter output.so I went for the delayed LMS adaptive filter which it will reduce the operation.

The critical path is required to be reduced by pipelined implementation when it exceeds the desired sample period. Asthe conventional LMS algorithms donot support pipelined implementation because of its recursive behavior .Therefore suitable pipelined implementation should be used in further architecture to reduce the area and it will have the high throughput & delay.

For the reason I implemented the DLMS adaptive filterit is same as least mean square but structure required delay is very low. Then it will allow the pipelined structure to reduce the critical path when it exceeds the sample period of the pipelined structure

Therefore I go through basic of fir filter which having linearity of phase and stability in frequency response and having constant group delay. It describes an FIR filter of length K. Theny[n] of the (i.e., (1) reads as “equation 1”) represented as

$$y[n] = \sum_{k=0}^{K-1} a_k x_{[n-k]}$$

x and y are the input and transformed data.

$a_k$  will be the set of constant coefficients of the filter.

(K-1) is the order of the FIR filter.

An FIR filter can also be characterized by its number of taps (K), which is the order incremented by the one. Therefore the transfer function A(z) will be the FIR filter of the (i.e., (2) reads as “equation 2”) is expressed as follows:

$$A(z) = \frac{Y(z)}{X(z)}$$

$$A(z) = \sum_{k=0}^{K-1} a_k z^{-k} = a_0 + a_1 z^{-1} + \dots + a_{(K-1)} z^{-(K-1)}$$

Therefore FIR filter is also called an all-zero filter because the frequency response is only determined by the zeros in the z-transform.

FIR filters are mostly preferred because of its linear phase characteristic and stability. Therefore IIR filters can be used in applications that require sharp cut-off or narrow band filters and where linear phase is not required because FIR filters require much higher order implementations than IIR filters for a similar performance.

## II. OPTIMIZATION OF FIXED POINT LMS ADAPTIVE FILTER

In this paper discuss the fixed-point implementation and optimization of the proposed DLMS adaptive filter. A bit level pruning of the adder tree is also proposed to reduce the hardware complexity without noticeable degradation of steady state MSE.

Then the weights of LMS adaptive filter during the  $n$ th iteration are used according to the following (i.e.; read as equation 3”)is expressed as

$$w_{n+1} = w_n + \mu \cdot e_n \cdot x_n$$

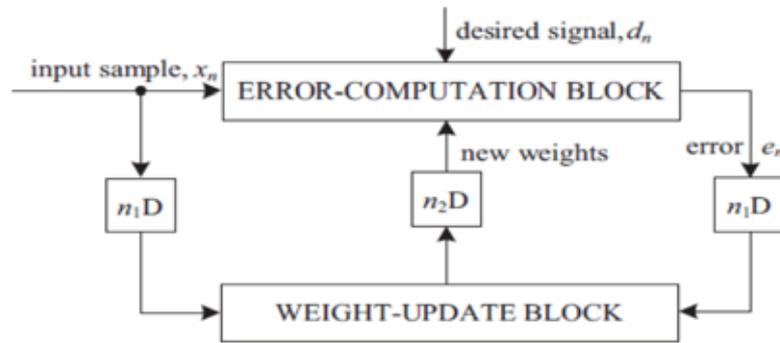
Therefore the input vector  $x_n$  and the weight vector  $w_n$  at the  $n$ th iteration are expressed as

$$x_n = [x_n, x_{n-1}, \dots, x_{n-N+1}]^T$$

and

$$w_n = [w_n(0), w_n(1), \dots, w_n(N-1)]^T,$$

$d_n$  is the desired response,  $y_n$  is the filter output, and  $e_n$  denotes the error computed during the  $n$ th iteration. Where  $\mu$  is the step-size, and N is the number of weights used in the LMS adaptive filter.



**Fig.1: Modified Delayed Lms Adaptive Filter**

Then the weight-update equation for DLMS adaptive filter of the (i.e., read as “equation 4”) is expressed as

$$w_{n+1} = w_n + \mu \cdot e_{n-m} \cdot x_{n-m}$$

Then the adaptation delay of  $m$  cycles amounts to the delay introduced by the whole of adaptive filter structure consisting of finite impulse response (FIR) filtering and the weight-update process.

Then the weight update equation for modified DLMS algorithm is given as

$$e_{n-1} = d_{n-1} - y_{n-1}$$

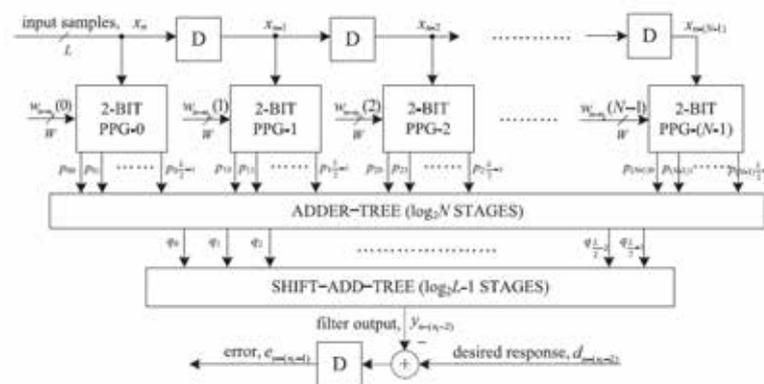
$$\& Y_n = w^T_{n-1} \cdot x_n$$

We notice that during the weight update the error with  $n_1$  delays were used. Then the filtering unit uses the weights delayed by  $n_2$  cycles. The modified DLMS algorithm decouples computations of the error-computation block and the weight-update block and allows us to perform optimal pipelining by feed forward cut-set retiming of both these sections separately to

less the number of pipeline stages and adaptation delay.

### III. ERROR-COMPUTATION BLOCK

It having  $N$  number of 2-b partial product generators (PPG) corresponding to  $N$  multipliers and a cluster of  $L/2$  binary adder trees, followed by a single shift-add tree.



**Fig.2: Error Computation Block**

### IV. WEIGHT UPDATED BLOCK

Therefore It will performs  $N$  multiply-accumulate operations of the form  $(\mu \times e) \times x_i + w_{i0}$  to update  $N$  filter weights.

The step size  $\mu$  is taken as a negative power of 2 to realize the multiplication with recently available error only by a shift operation. Each of the MAC units therefore performs the multiplication of the shifted value of error with the delayed input samples  $x_i$  followed by the additions with the corresponding previously weight values  $w_i$ . Then All the  $N$  multiplications for the MAC operations were performed by NPPGs and to  $N$  shift– add trees.

This will leads to substantial reduction for the adder complexity. The final outputs of MAC units contains the desired updated weights to be used as inputs to the error-computation block as well as the weight-update block for the next iteration

Each of the PPGs generates  $L/2$  partial products corresponding to the product of the recently shifted error value  $\mu \times e$  with  $L/2$ , the number of 2-b digits of the input word  $x_i$ , wr. Since the scaled error ( $\mu \times e$ ) is multiplied with the entire  $N$  delayed input values in the weight-update block then this sub expression can be shared across all the multipliers as well.

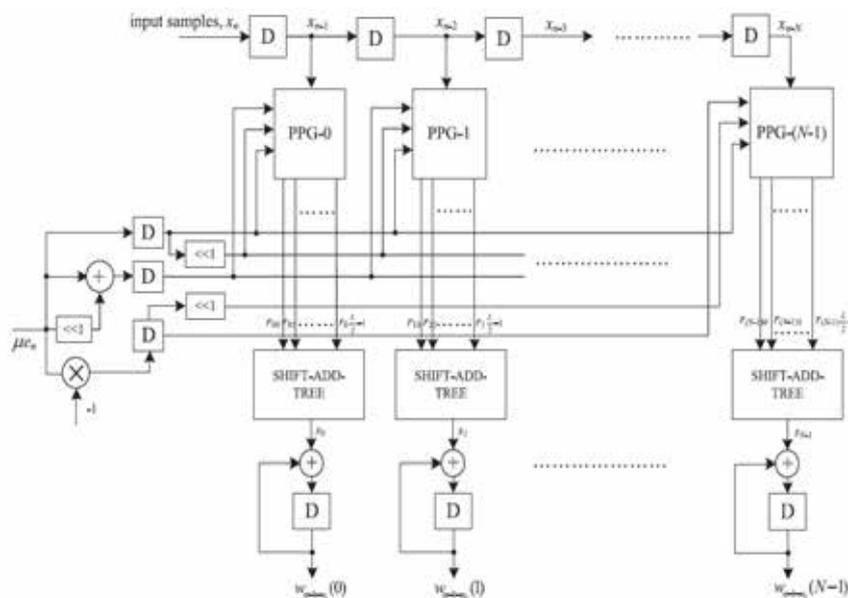


Fig.3: Weight Updated Block

## V. RESULTS

In this paper comparison of the both existing and proposed system. Where no of LUT (look up tables) will be increased and the no of gates should be reduced compared to existing one output.

Then the simulation output will be given 8 digit binary values where It have the reset and clock pin and inputs and filtered output.

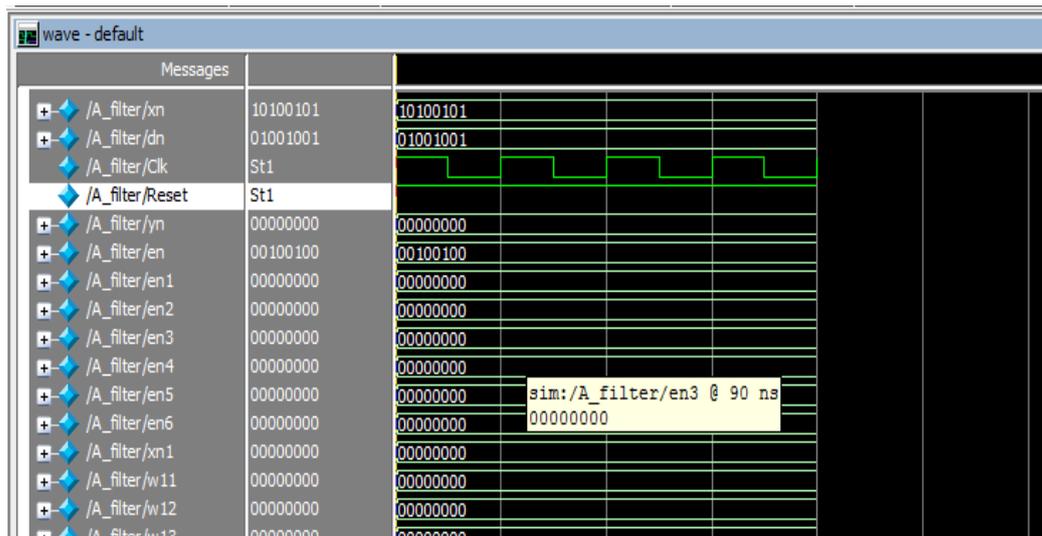
## VI. PROPOSED OUTPUT

Where reset=1 the filtered output will be remains 0 then clock will be same the input signal will be  $x_n$  and desired signal  $d_n$  and the output will  $y_n$  at 90 ns.

When reset=0 then the clock will be same the input signal will be  $x_n$  and desired signal  $d_n$  and the output will  $y_n$  at 90 ns.

Device utilization of the adaptive fir filter in the existing one. In that number of gate count are high compare to proposed one.so that we are going for the better delay to reduce the computation time in the pipelined architecture.

The results are shown in the figures are from simulation output and the Xilinx output and executed in the hardware part of the Spartan 3E board.

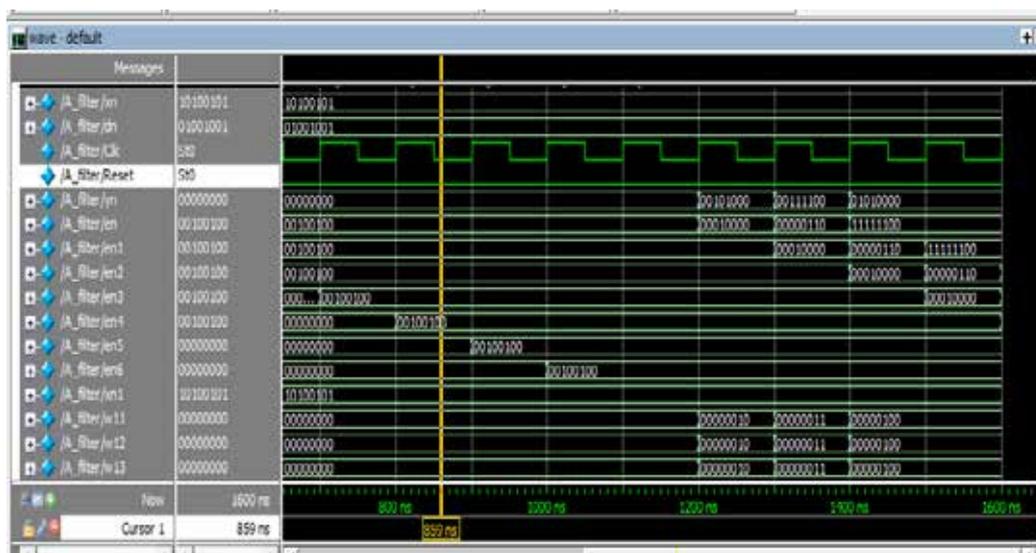


**Fig.4: Proposed Wave Form Output**

When reset=0 then the clock will be same the input signal will be xn and desired signal dn and the output will yn at 90 ns where xn=10100101 dn=01001001 then yn=00000000 then it will change periodically. Where “equation 3” is expressed as

$$y_n = w_n \cdot x_n,$$

$$w_{n+1} = w_n + \mu \cdot e_n \cdot x_n$$



**Fig. 4a: Proposed wave form output**

Where en will change for next combination of input in the proposed system. Therefore the tabular column of compared the existing and proposed outputs

$$e_n = d_n - y_n = w_n \cdot x_n$$

Comparison table of the existing and proposed outputs in the Xilinx software using Spartan 3e board get the results

## 6.1 Existing Output

Device Utilization Summary				
Logic Utilization	Used	Available	Utilization	Note(s)
Number of Slice Flip Flops	132	7,168	1%	
Number of 4 input LUTs	435	7,168	6%	
<b>Logic Distribution</b>				
Number of occupied Slices	281	3,584	7%	
Number of Slices containing only related logic	281	281	100%	
Number of Slices containing unrelated logic	0	281	0%	
<b>Total Number of 4 input LUTs</b>	<b>452</b>	<b>7,168</b>	<b>6%</b>	
Number used as logic	435			
Number used as a route-thru	17			
Number of bonded IOBs	26	141	18%	
IOB Flip Flops	8			
Number of GCLKs	1	8	12%	
<b>Total equivalent gate count for design</b>	<b>5,295</b>			
Additional JTAG gate count for IOBs	1,248			

**TABLE 1**

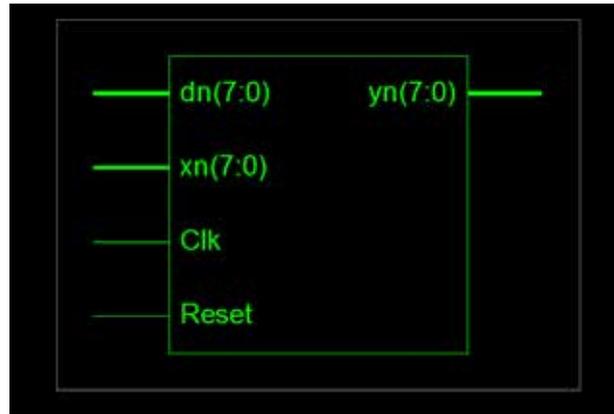
In the given table the total no of gates in the design is more compared to proposed one so they are using DLMS algorithm in the adaptive filter. Then getting the output from hardware called Spartan 3E

## 6.2 Proposed Output

Device Utilization Summary				
Logic Utilization	Used	Available	Utilization	Note(s)
Number of Slice Flip Flops	143	7,168	1%	
Number of 4 input LUTs	435	7,168	6%	
<b>Logic Distribution</b>				
Number of occupied Slices	289	3,584	8%	
Number of Slices containing only related logic	289	289	100%	
Number of Slices containing unrelated logic	0	289	0%	
<b>Total Number of 4 input LUTs</b>	<b>453</b>	<b>7,168</b>	<b>6%</b>	
Number used as logic	435			
Number used as a route-thru	18			
Number of bonded IOBs	26	141	18%	
IOB Flip Flops	8			
Number of GCLKs	1	8	12%	
<b>Total equivalent gate count for design</b>	<b>4,990</b>			
Additional JTAG gate count for IOBs	1,248			

**TABLE 2**

In RTL schematic there is having the input desired signal and weight update block and they are giving the clock signal has 1 then it will set. Where reset will be 0 the operation of the process will start to execute.

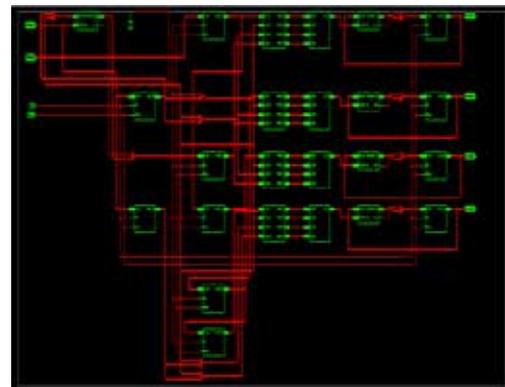


**Fig.4c: RTL SCHEMATIC**

In error computation block. It having structure adder trees where it performs the operation in the error computation and it have the 4 no of LUT's have been present .Therefore the gates in design will be reduced then they are having weight update block to reduce the computation time



**Fig.4d: ERROR COMPUTATION BLOCK**



**Fig. 4e: Weight Update Block**

Then fig 4e represents the schematic flow of the weight update block getting from the Xilinx software and executed in Spartan 3E board.

## VII. CONCLUSION

In this paper the advancement of performance will be reduced the adaptation delay and power consumption as well it will reduce the critical path to support high sampling rates. We found that the adaptation delay will provide significant saving of ADP and EDP compared to the existing one. The performance factor of the proposed one increased by 8% more than the existing one.

In future work we will modify the proposed system by reducing the Area and delay of the design.

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# PERFORMANCE ESTIMATION AND ANALYSIS OF PULSE DETONATION ENGINE WITH DIFFERENT BLOCKAGE RATIOS FOR HYDROGEN-AIR MIXTURE

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## ABSTRACT

*This paper provides an introduction to the concept of Detonation waves in the application of Pulse Detonation Engine (PDE) which includes the Detonation initiation and propagation of wave. A review of previous computational studies of Pulse Detonation Engine shows a wide variation in the performance of system. We present the results of systematic study of Pulse Detonation Engine operating with Hydrogen-Air mixture with different blockage ratios to attain high Detonation velocities. We use these results to provide an explanation for the wide variation in a system performance. The system contains the single tube with one end closed and other end opened, which is maintained at two different temperatures and pressure values. Results are computed and analyzed using Computational Fluid Dynamics (CFD) modelling.*

**Keywords:** Blockage Ratio, C-J Velocity, DDT, Detonation, Shchlekin Spiral, Fuel-Air Mixture, Rarefaction Waves.

## I INTRODUCTION

### 1.1 Air Breathing Engines

Air Breathing Engines can be classified according to the type of combustion process employed in the device. The combustion process can be characterized as either steady or unsteady, propulsion system may be further classified according to whether a deflagration or detonative mode of combustion is utilized.

### 1.2 Deflagration

A Deflagration is the propagation of wave at low speeds that is subsonic which is said to be governed by laminar. The thermodynamic property in the deflagration undergoes constant pressure process. i.e., at isobaric stage. This shows the small variations of pressure in deflagration.

### 1.3 Detonation

A Detonation is the propagation of wave at high speeds which consists of supersonic speeds with large pressure differences. And it operates at constant pressure cycle which is much more efficient at the constant pressure

cycle. The material conversion rate is typically tens of thousands of times faster than any flame can lead to several advantages for propulsion such as more compact and efficient systems.

### 1.4 Pulse Detonation Engine

The pulse Detonation engine is a new idea propulsion system using repeating explosions to produce thrust or power. Pulse detonation engine typically consists of a sufficiently long tube which is filled with fresh fuel oxidizer mixtures and ignited by sufficiently strong energy source. Flame initiated by ignition must be in relatively shorten to accelerate the detonation velocity. So, the transition from deflagration to detonation must happen in relatively small distance.

Detonative combustion produces high pressure which is converted to thrust. PDE can operate in wide Mach number ranging from 0 to 4 with engine operating in the pulsed mode. So the thrust is varying in time and the detonation must be initiated each time. Pulse Detonation Engine is operating in the stoichiometric condition (due to necessity of fast initiation of detonation and frequencies relatively low). PDE system is more advantageous because of its less complexity and weight.

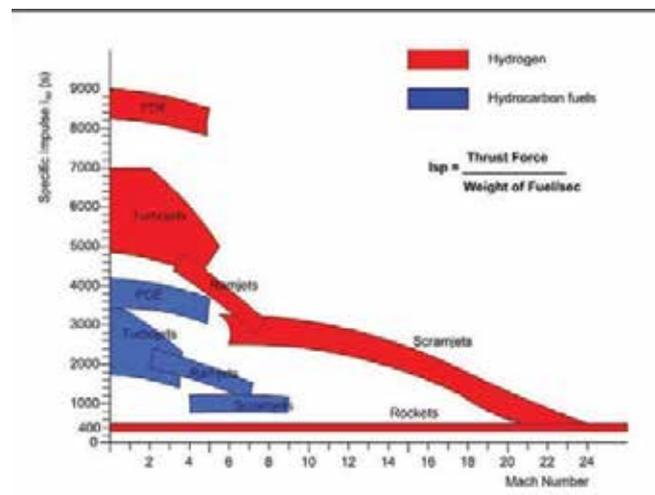


Fig.1 Comparison between different values for Specific Impulse [1]

### 1.5 Pulse Detonation Engine Applications And Issues

- PDE applications in rocket engines and missiles and UAV's.
- The flow in a pulse detonation engine is a challenging research problem because it involves compressible, chemically reactive flows in complex geometry configurations with moving boundaries.

## II RESEARCH REVIEW

Lee et al [4] conducted a parametric study on blockage ratio, spacing between the obstacles and its length, they conducted the experiments with ethylene-air mixture. They found effective blockage ratio between 0.3 and 0.6 to accelerate the flame relative to C-J speed. Lindstedt and Michels [5] found that the optimal blockage ratio is 0.44.

Cooper et al [6] shows the detonation transition time will be reduced by using the obstacles with the blockage ratio of 0.43 for propane and ethylene-oxygen-nitrogen mixtures. Eidelman and Yang [7] shows the parameters

affecting the Detonation with the parameter length of the tube. The performance was not affected as the detonation occurred within the tube. Desbordes [8] observed the transition analysis in the tube is due to the blockages.

### III PDE CYCLE OPERATION

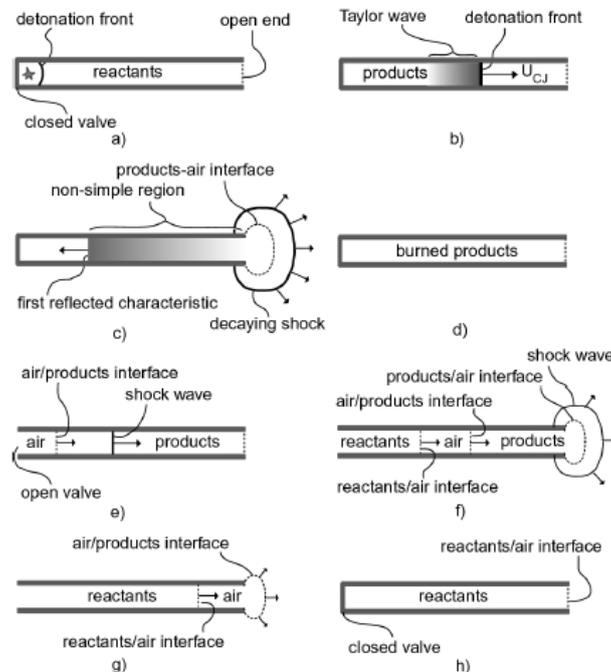


Fig.2 PDE Cycle Operation [2]

#### 3.1 Detonable Mixture Fills Combustor

Detonation tube consists of an open and closed end to start the detonation engine cycle. The fuel-air injection process can impact the net thrust generated by the engine, high combustor inlet Mach numbers decrease thrust performance because of the low static pressures generated in de-accelerating the combustor inlet flow when the wall closes. Low fuel-air injection Mach numbers will also degrade performance by increasing the time required to fill the chamber.

#### 3.2 Detonation Initiation at Closed End

After the fuel-air mixture enters the chamber, a valve at the beginning of the combustion chamber is closed in preparation for detonation initiation. Detonation wave can be initiated through deposition of a large amount of energy at a given spatial location. The wall seals the combustion when the downstream fuel - air mixture is still at some finite distance from the open end of the chamber. Detonation tube is filled with fuel-air is calculated from the overall length of the tube and the relative velocities of the injected fuel-air mixture in detonation wave.

A detonation wave is initiated immediately in the fuel-air mixture region near the closed end of the chamber. An expansion zone is created between the closed end and the detonation wave. Rarefaction waves are generated at the closed end of the detonation chamber and proceed towards the exit.

The rarefaction waves originates at the closed end and maintains the zero axial velocity of fluid normal to the wall [3]. The strength of the expansion region is the function of the axial velocity of the burned gases behind the detonation wave which must be de-accelerated to satisfy the closed end boundary conditions. The detonation wave is a self-propagating wave which makes the burned gases moves at C-J velocity conditions (Speed of sound). The velocity of its burned wave depends on the velocity produced by the detonation wave and the initial fuel-air mixture and propagates towards the open end of the tube.

### 3.2.1 Chapman-Jouget Condition for Detonation

- The solution to the conservation equations is only determined with some additional considerations, for detonations gas dynamic considerations are sufficient to determine the solution. Chapman (1899) and Jougete (1902) proposed that detonations travel at one particular velocity which is minimum velocity for all the solutions on the detonation.
- At the solution point(C-J Detonation point) the Hugoniot, Rayleigh line and isentropic are tangent. The Fig.3 represents the flow behind the C-J detonation point is sonic relative to the wave.
- Most detonations travel at the C-J Velocities.

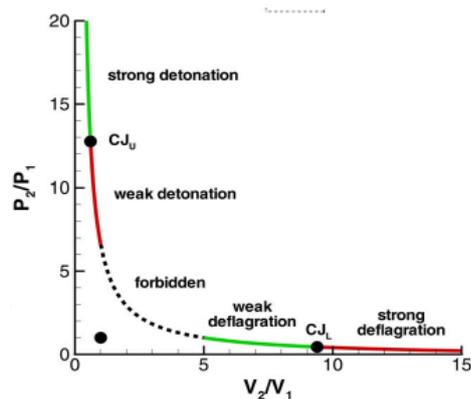


Fig.3 Theoretical regions of Hugoniot curve [2]

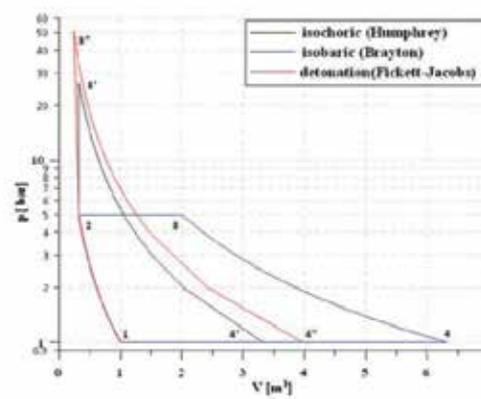


Fig.4 Comparison between constant volume and constant pressure cycles [1]

### 3.3 Detonation Wave Characteristics

The detonation wave can be modelled as a strong shock wave which makes combustion and thin flame front in which heat addition occurs behind the shock. The shock moves at the detonation velocity related to the gas which increases the pressure and temperature of the gas from its previous values.

The region of the burned gas just behind the shock is a high pressure region known as the Von Neumann spike. Rarefaction waves will be generated near the closed end of the tube behind the detonation tube, because of this rarefaction waves the low pressure region will be created than the pressure just behind the detonation wave.

## IV COMPUTATIONAL FLUID DYNAMICS MODEL

### 4.1 Design Consideration of PDE

In the analysis, we will consider the liquid hydrogen and gaseous oxygen as fuel and oxidizer separately. The reactants combination was ignited by direct initiation, and the detonation was achieved by deflagration to detonation transition (DDT) process with Shchelkin-type spirals.

Our model with a 40mm inner diameter also a total length of 540mm is used. It consists of two different sections where the first section which is from the closed end having more pressure and temperature values, the second section is having ambient conditions.



**Fig.5 Isometric view of the Straight tube**



**Fig.6 Isometric View of the Pre Detonator with Shchelkin Spiral**

The blockage ratio of the Shchelkin spiral welded inside the DDT chamber was 0.5 and the length of the DDT chamber was 480mm.

#### **4.2 Geometric Modelling**

We have created a cylindrical tube of diameter 40mm, length 540mm with blockage ratio 0.5. The pre detonator tube of diameter reduced to 20mm, and length between each spiral is 40mm. By using commercial tools we analyzed the model and the results were discussed in performance estimation.

#### **V PERFORMANCE ESTIMATION**

The research in PDE is mainly based on performance estimation. PDE consists of a straight tube with a thrust wall at the closed end and other is opened [10]. To avoid the premature ignition [9], buffer gas is needed between consecutive fillings so that it will reduce the frequency of operation and thrust. Another way to minimize frequency of operation is to have multiple tubes in that some tubes are filled while other tubes are detonated or evacuated. Daniauetalexperimentally investigated the nozzles with different shapes and by varying length. This nozzle maintains high frequency by conversion of unsteady to steady so that the thrust can be increased. So, the effects of the nozzles are considered basing on the fuel filling the tube that is partial fulfill effects have been discussed in their results. The effects of partially filling the thrust tube with detonable mixture and filling the rest with air is interpreted as straight nozzle [4]. The fuel based straight nozzle has indicated specific impulse ( $I_{sp}$ ) will be more.

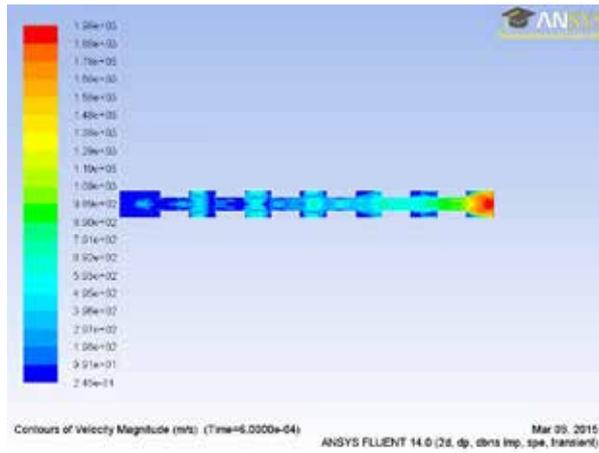


Fig.7 Velocity contour for Shchlekin Spiral

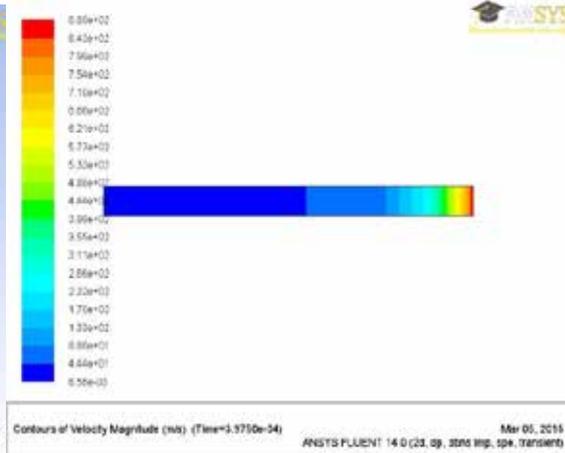


Fig.8 Velocity Contour Straight Tube

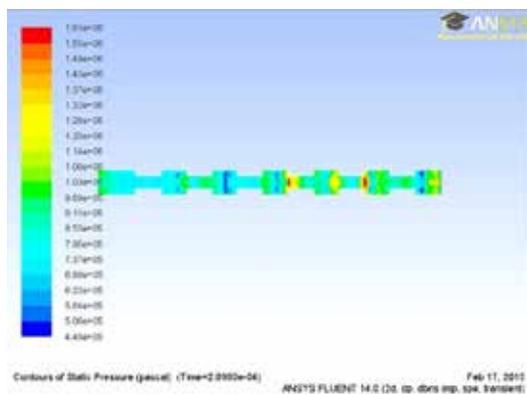


Fig.9 Pressure Contour for Shchlekin Spiral

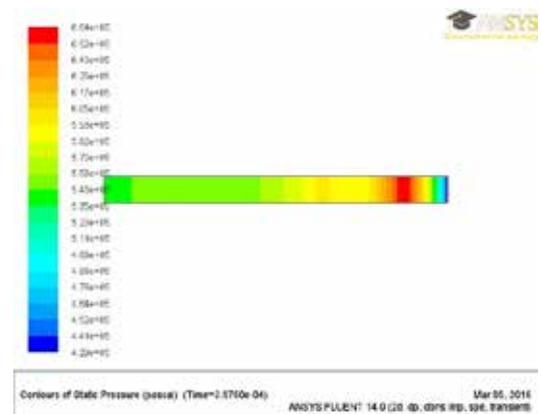


Fig.10 Pressure Contour for Straight Tube

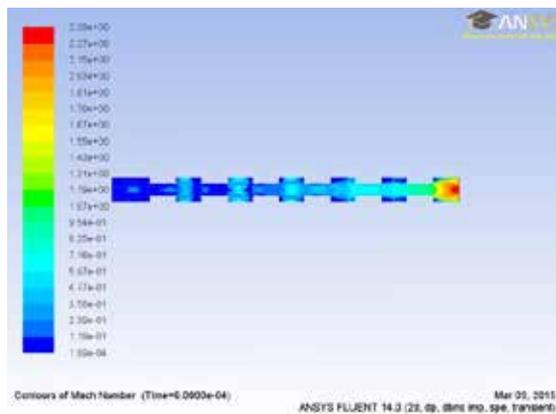


Fig.11 Mach number contour for Shchlekin Spiral

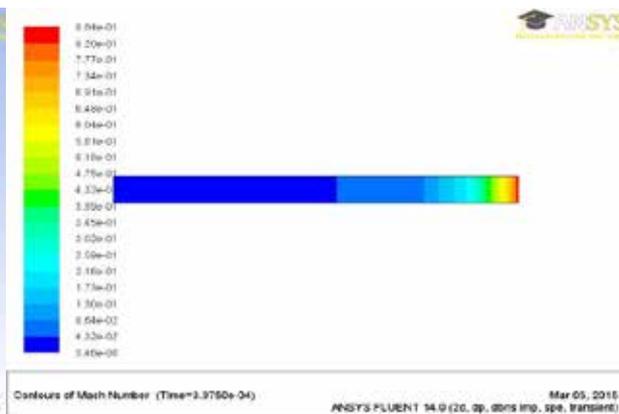
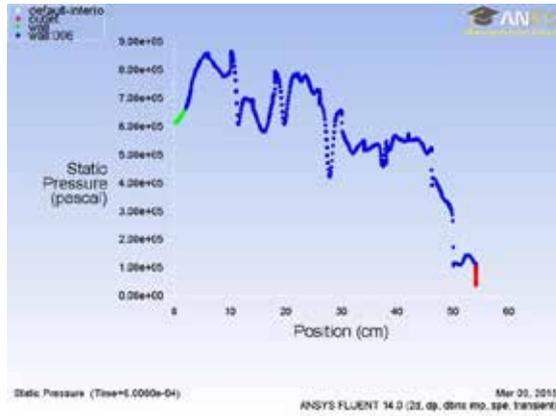


Fig.12 Mach Number contour for Straight Tube

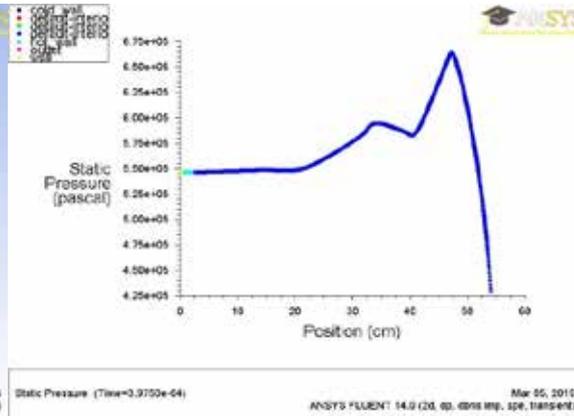
*Values at Tube End				
Type of Tube	Velocity (m/s)	Mach Number	Pressure (Bar)	Flow Time (In Seconds)

<b>Straight Tube</b>	888	0.86	6.6	0.00039
<b>Shchlekin Spiral</b>	1980	2.39	16	0.0006

**Table.1 Values for Straight Tube and Shchlekin Spiral**

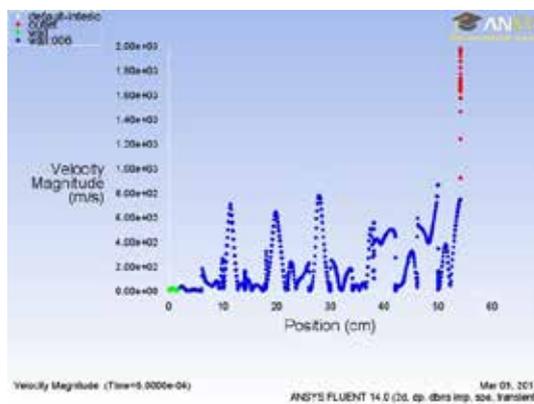


**Fig.13 Pressure plot for Shchlekin Spiral**

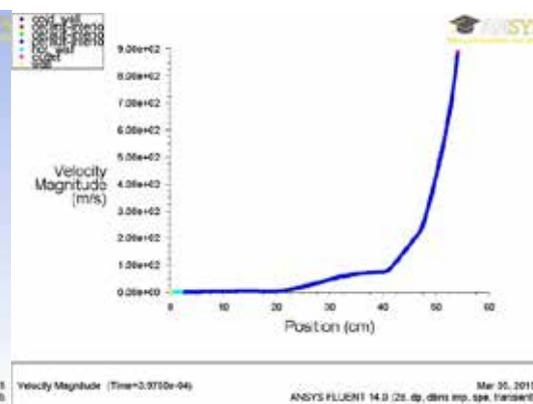


**Fig.14 Pressure plot for Straight Tube**

In the pressure plot at the maximum velocity, pressure value reached to 25bar. At the end of the tube we got 16 bar when flow time is 0.0006sec where as in straight tube, pressure value reached to 6.6bar when flow time is 0.00039sec. When wave reaches to spiral region, pressure value decreases.



**Fig.15 Velocity plot for Shchlekin Spiral**



**Fig.16 Velocity plot for Straight Tube**

In the velocity plot, the detonation wave started from 900m/sec as subsonic speed, at the end of tube velocity reaches to 1980m/s when flow time is 0.0006s, whereas for straight tube velocity reached to 880m/s when flow time is 0.00039s. During the propagation of wave, Detonation velocity reaches to 2050m/s in the Shchlekin spiral tube.

**VI CONCLUSION**

Performance estimation of Pulse Detonation Engine towards the research development, concludes that the detonation tube with Shchlekin Spirals will produce more detonation velocity with effective Mach number

compared to straight tube because of generation of turbulence caused by the hot spots which are responsible for formation of DDT at the surface of obstacles. So, the performance of the engine will get increased by producing high thrust and effective Specific Impulse.

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# INVESTIGATING THE EFFECTIVENESS OF WIRED RESTAURANTS

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## ABSTRACT

*Investigating the effectiveness of online hotel reviews in shaping the opinion of the customers. In less than ten years social media has become a global phenomenon that is attractive to both clients and companies. A major role of the Hotel industry in the social media world is done by Hotel/Restaurant reviews. As a result of embracing the Internet, online Restaurant reviews have become an important information source for the modern day's foodies. The purpose of this research is to examine online Restaurant reviews in order to conduct an in depth analysis of the influence it has on guests. A Restaurant is described as a commercially run establishment providing Food and Beverage for guests, and often containing a public bar. This research is undertaken to determine the effects online reviews have on a guest. Two questionnaires were prepared one of which were filled by 12 employees who work in an online reviewing company in Bangalore and the other questionnaire was filled by the customers who use these portals regularly. Along with this online information and secondary data was used to find the result of these reviews on the Customers.*

**Keywords:** *Food and Beverage, Guest, Hotel Industry, Internet, Online Restaurant.*

## I PROLOGUE

The prologue introduces the reader to the background of the study and presents the immense information on online restaurants and its importance. Derived from the problem discussion, the purpose of the study is presented. Further a brief presentation of research design, which ends up with an overview of the study outline.

### 1.1 Background

The rise of the Internet brought changes to customary Word-of-Mouth Communication (WOM). Customers have the capacity to impart and trade insights with anybody on the planet, while WOM has usually come about because of eye to eye connections. Online entrances permit people to buy books, film tickets, and music CDs and also cordiality administrations. Those shoppers settled on buy choices in view of other clients' assessments on the Internet). Buyers feel more secure subscribing to assessments expressed by the masses in light of the fact that individuals attempt to mirror online stages which purchasers correspond with other people who have data or past encounters about the lodgings.

In this paper, the relationship between amount of purchaser surveys and online shopper acquiring plan in the inn business is tried. Exploiting Hotel audit sites empowers clients to trade one another's data and assessments to

their stay experience. Online audits have been a compelling part for leaders, yet little is thought about the effect of visitor's assessment and reception (Choi, & Ok, 2011).

Inside the previous decade, the Internet has turned into a standout amongst the best and generally utilized correspondence media (Lagrosen, 2005; Namkung, Shin, & Yang, 2007; Woisetschläger, Hartleb, & Blut, 2008). This new ideal model has altered the way individuals impart and secure learning because of its low exchange expense, absence of topographical limitations, and simple access to plentiful data (Jepsen, 2007; Porter, 2001; Rabjohn, Cheung, & Lee, 2008). For better staying background in which utilization experience is vigorously elusive and heterogeneous, clients are ready to allude to online audits to evade potential hazard or vulnerability over sustenance/administration quality and to increase extra data (Bearden, Netemeyer, & Teel, 1989; Bickart, & Schindler, 2001; Cash, 2005; Heskett, Sasser, & Schlesinger, 1997). Customary Word-of-Mouth (WOM) has been perceived as a viable promoting apparatus that has a critical effect on client conduct. From various perspectives, the rise of the Internet implies shoppers are currently making and spreading advertising data for different organizations. Suppliers and purchasers have ended up profoundly joined with the Internet environment. Subsequently, client created promoting data ought to be viewed as an imperative showcasing apparatus in the inn business.

The reason for this study is to discover the way buyer buy choices are being affected by internet grouping impacts and User-Generated Content (UGC) in Online crowding impacts happen when shoppers, in an online domain, are faced with the verbalization of going before clients' or master encounters. Elements, which are affected by web crowding impacts, are deals volume correspondence or positive and negative number of customer surveys. Social Impact Theory will be connected in this study to confirm online buyer crowding practices.

### **1.2 Purpose of the Study**

The purpose of this research is to examine online Restaurant reviews in order to conduct an in depth analysis of the influence it has on guests. A Restaurant is described as a commercially run establishment providing Food and Beverage for guests, and often containing a public bar.

### **1.3 Objectives of the Study**

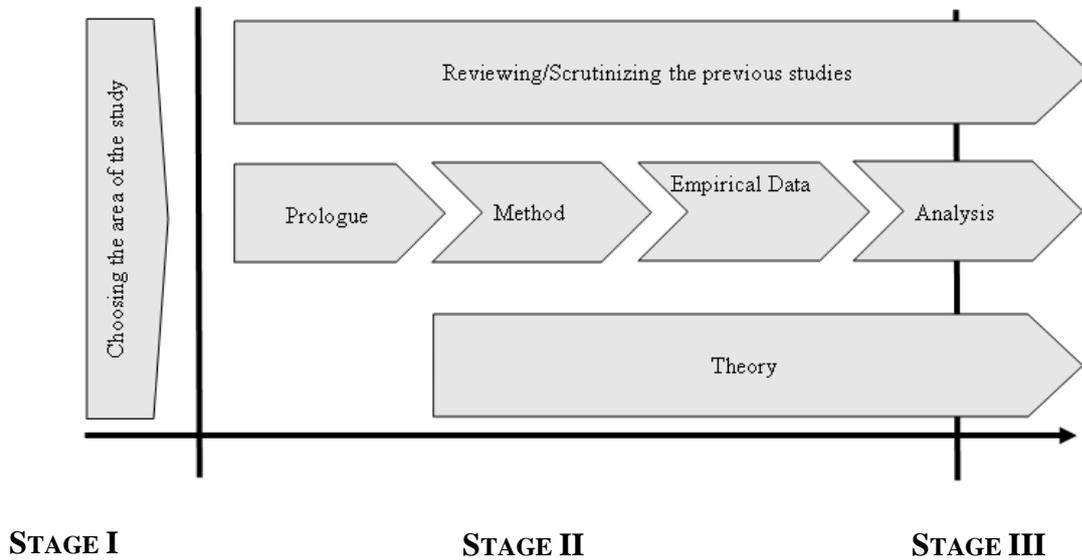
The main objectives for the study are specified below:

- [1]. To determine the mindset of the guests and their willingness and curiosity to try a new Restaurant in Bangalore based on an online review.
- [2]. To understand the guests in terms of how much they are willing to spend their money on an establishment based on a review.
- [3]. To see if they experiment new themes and innovative or different concepts.
- [4]. To identify factors, which influence restaurant review readers' evaluations of the review's credibility and usefulness.
- [5]. To identify motivations and barriers to posting an online Restaurant review.
- [6]. Understanding frequent online restaurant review Readers and Restaurant review Writers in terms of demographic characteristics, Meal experience/planning style, and Internet use/online activities.

[7]. To determine the advantages and disadvantages of online review websites.

**1.4 Research Design**

The research design of the study presents the process which contains both parallel and sequential working techniques. The process is divided into three stages that has originally been named Stage I, Stage II and Stage III.



**Figure 1 – Study Process**

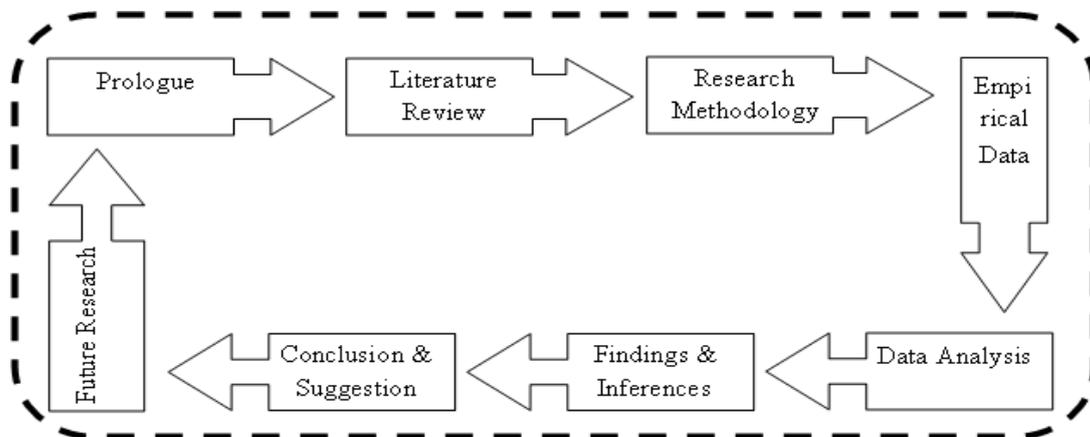
*Stage I* where the researchers initiated in identifying the area of the study. Furthermore it includes the interaction between the hotel experts to fulfill and get the requirements and request.

*Stage II* includes gathering information through a detailed literature review as well as empirical study.

*Stage III* concerns analysis and discussions, comparing the literature study with the empirical study, which finally led to fulfilling the purpose.

**1.5 Outline of the Study**

The study is organized and presented in figure 2.



**Figure 2 – Study Outline**

## II REVIEW OF LITERATURE

This portion of the study presents an overview of current literature in the frame of the presented research purpose. As the literature review explains, the views of researcher on the subject vary from one to another. The present study is an attempt to review several study for the purpose of understanding the main focus of the study and also draw the attention for the readers to understand what this study all about. It is segregated into fifteen categories.

### 2.1 The Hotel/Restaurant Industry

Inn items and administrations are elusive, importance of procurement choice is very passionate and hard to repeat. With an end goal to settle on the most casual choice, other purchasers' sentiments assume a huge part. Numerous online room reservation organizations give portrayals of lodgings that permit shoppers to reserve a spot utilizing the Internet (Yeh, Leong, Blecher, & Hu, 2005). Those organizations likewise give online stages through which inn visitors have the capacity to correspond about inns with others. With the Internet, customers can seek data about lodgings without fleeting or geographic limitations, and it is simple for administration of inns to collaborate with clients. Subsequently, lodging organizations have moved promoting procedures from conventional channels to Internet-based client maintenance since the utilization of the Internet in the client connection methodology is developing at a quick pace (Kim, 2007).

### 2.2 Social Impact Theory

Buyers take after the past conduct of others and nonchalance their own data. Such imitative conduct can be gotten from reasonable derivations taking into account the choice data of others that commands individual signs (Anderson, & Holt, 1997). It will lessen hazard when shoppers settle on a choice on obtaining items or administrations. What's more, purchasers will be affected by larger part of other shoppers' conclusion whether it is certain or negative. Bibb Latané (1981) built up the social effect hypothesis, the hypothesis clarifies when other individuals are the wellspring of effect and the individual is the target, effect ought to be a multiplicative capacity of the quality, promptness, and number of other individuals. Moreover, effect ought to take the manifestation of a force capacity, with the peripheral impact of the Nth other individual being not as much as that of the  $(N-1)^{th}$ . At the point when other individuals stand with the single person as the focus of strengths from outside the gathering, effect ought to be partitioned such that the resultant is a reverse force capacity of the quality, promptness, and number of persons standing together. In this study, the quantity of respondents will be connected to build up the model proposition.

### 2.3 Online tourism

Werthner and Klein (1999) proposed a theoretical structure, which depicts the association between the buyer and the business suppliers with the Internet playing an encouraging and intervening part. With the expanding significance of the utilization of the Internet for travel purposes, more consideration has been coordinated to the investigation of the tourism space, with an accentuation on the interceding part of particular Internet in speaking to tourism inside a travel arranging setting (Pan, & Fesenmaier, 2006; Wöber, 2006; Xiang, *et al.*, 2008). Wöber, *et al.* (2006) inspected one part of the online tourism, i.e., the perceivability of tourism ventures, especially destination showcasing associations and individual lodging operations in Europe, among six well known internet searchers. His discoveries demonstrated that numerous tourism sites experience the ill effects of low rankings among the indexed lists, which makes it greatly troublesome for online explorers to specifically get to individual tourism sites through these web

search tools. As of late, Xiang, et al. (2008) conceptualized the online tourism area based upon a coordination of various hypothetical points of view, including: (1) the industry viewpoint (Leiper, 1979, 2008; Smith, 1994), which concentrates on what constitutes the supply of tourism and, consequently, the authoritative substances that contain the online tourism space; (2) the typical representation viewpoint (Cohen, & Cooper, 1986; Dann, 1997; Leiper, 1990), which depicts the representation of tourism items and related encounters gave by the business in different structures; (3) the travel conduct point of view (Crompton, 1992; Pearce, 1982; Woodside, & Dubelaar, 2002), which incorporates the exercises and the supporting frameworks at distinctive phases of the travel experience; and, (4) the travel data seek viewpoint which is identified with the way of the data looked to help travel encounter.

#### **2.4 Social media and travel**

While there is an absence of a formal definition, "online networking" can be by and large seen as Internet-based applications that convey shopper created substance which incorporates "media impressions made by customers, ordinarily educated by pertinent experience, and documented or imparted online for simple access by other naive buyers" (Blackshaw, 2006). This incorporates a mixed bag of utilizations in the specialized sense, which permit purchasers to "post", "label", "digg", or "blog", et cetera, on the Internet. The substance produced by these social medias incorporate a scope of new mechanical applications, for example, media and substance syndication, concoction, AJAX, labeling, wikis, web discussions and message sheets, client appraisals and assessment frameworks, virtual planets (e.g., Second Life), podcasting, sites, and online features (Schmallegger, & Carson, 2008). Buyer websites have risen as a standout amongst the most unmistakable topics in exploration on online networking in travel and tourism (Braun-LaTour, Grinley, & Loftus, 2006; Mack, *et. al.*, 2008; Pan, *et al.*, 2007; Pudliner, 2007; Pühringer, & Taylor, 2008; Waldhör, & Rind, 2008). The studies on this kind of online networking concentrate on its utilization and additionally its effect on travel choice making.

#### **2.5 Fake It Till You Make It**

Customer surveys are currently a piece of ordinary choice making. Yet the believability of audits is in a general sense undermined when entrepreneurs submit survey extortion, either by leaving positive surveys for themselves or negative surveys for their rivals. In this paper, we examine the degree and examples of survey misrepresentation on the mainstream customer audit stage Yelp.com. Since one can't straightforwardly watch which surveys are incredible, we concentrate on audits that Yelp's algorithmic pointer has distinguished as deceitful. Utilizing this intermediary, we display four primary discoveries. To start with, approximately 16 percent of restaurant audits on Yelp are distinguished as fake, and have a tendency to be more compelling (ideal or unfavorable) than different surveys. Second, a restaurant is more prone to confer audit extortion when its notoriety is frail, i.e., when it has few surveys, or it has as of late gotten awful audits. Third, chain restaurants - which profit less from Yelp - are additionally more averse to submit audit extortion. Fourth, when restaurants face expanded rivalry, they get to be more prone to leave unfavorable surveys for contenders. Taken in total, these discoveries highlight the degree of audit misrepresentation and recommend that a business' choice to submit survey extortion reacts to rivalry and notoriety impetuses as opposed to just the restaurant's morals (Luca, & Servas, 2013).

#### **2.6 Electronic word-of-mouth**

Electronic Word-of-Mouth (eWOM) has numerous similitudes to customary Word-of-Mouth (Goldsmith, & Horowitz, 2006). Purchasers look for inn item or administration data from other individuals who have had an

involvement with the items or administrations (Kim, 2007). Hennig-Thurau and Walsh (2003) analyzed the relationship between eWOM intentions in seeking shopper audits and the effect these have on purchaser online conduct. From past research, the creators characterized eight hypothetical intentions in looking for buyer audits: hazard lessening, reduction in pursuit time, figure out how an item is devoured, analyze new item, determination of social position, disharmony diminishment, compensation, and fitting in with a virtual group. In view of Hennig-Thurau and Walsh's (2003) study, buyers look for suppositions on the Internet to diminish dangers, which helps them settle on better obtaining choices and spare time.

Taking into account the meaning of WOM by Westbrook (1987), electronic Word-of-Mouth (E-WOM) can be characterized as all casual correspondences coordinated at buyers through Internet-based innovation identified with the use or qualities of specific merchandise and administrations, or their dealers. This incorporates correspondence in the middle of makers and customers and also those between purchasers themselves – both fundamental parts of the WOM stream, and both uniquely separated from interchanges through broad communications (Goldsmith, 2006; Lazarsfeld, Berelson, and Gaudet, 1944). Interpersonal impact and verbal (WOM) are positioned the most vital data source when a purchaser is settling on a buy choice. This impact may be particularly essential in the accommodation and tourism industry, whose impalpable items are hard to assess before their utilization. At the point when WOM gets to be computerized, the extensive scale, and unknown, fleeting nature of the Internet affects better approaches for catching, breaking down, translating, and overseeing online WOM. This paper portrays online interpersonal impact, or E-WOM, as a conceivably practical means for advertising accommodation and tourism, and talks about a percentage of the incipient innovative and moral issues confronting advertisers as they look to saddle developing E-WOM innovations Litvin, Goldsmith, & Pan, 2006). It additionally gives a reasonable picture about the accompanying:

- a) Why do buyers spread WOM?
- b) Where does WOM start?
- c) What are a few variables that intercede WOM?
- d) What are the expected outcomes from the dissemination of WOM?

## **2.7 The Effect of Online Restaurant**

This expresses that restaurant survey sites empowers clients to trade one another's data and feelings to their restaurant experience. It discusses how online audits have been a compelling part for chiefs and what an effect it has on the coffee shops. The motivation behind this study is to decide how online restaurant audits influence clients' choices to pick a restaurant. The magic words for this examination paper were: online restaurant audits, contention quality, data quality, source believability, data helpfulness, visit plan. The presentation discusses how the internet has gotten to be Internet a standout amongst the best and regularly utilized correspondence media. It alludes to the eating and utilization angle as an elusive experience for which clients are eager to allude to online surveys to stay away from potential hazard or instability over nourishment/administration quality and additionally to increase extra data. It expresses that Information quality or contention quality and source validity has demonstrated to have direct impacts on clients' observation to value in the virtual stage. The system used to attempt this examination was a study that was directed for members that were haphazardly chosen among people who have gone by restaurant survey sites. The primary discoveries were that the data quality and source validity of online audits have a beneficial outcome on the clients. Next, the value of online audits did have a

beneficial outcome on cafes' visit plan, as they would not like to go out on a limb; they rather assemble all the data before entering a restaurant. At last, clients utilizing companion made audits were influenced by the believability of data though clients utilizing master made surveys were influenced by the ability of data (Choi, & OK, 2011).

## 2.8 Consumers Rank Most-Trusted Restaurant Review Sites

As per another study from Maritz Research, one in four shoppers accept the data accessible on restaurant appraisals destinations is unjustifiable, and numerous have concerns over one-sided or incredible audits. A Maritz Research's 2013 Online Customer Review Study reviewed more than 3,400 individuals about their utilization of 13 prominent appraisals destinations. While more seasoned, very went to locales were for the most part seen as more reliable, "Numerous individuals communicated concern over surveys on client evaluations destinations being one-sided or even incredible. Numerous site guests accept that evaluations locales select which surveys are posted, that workers post stunning constructive audits for the organizations they work for, and that raters just impart their constructive or antagonistic encounters as opposed to imparting an adjusted insight, and today with the development in social networking, individuals are particularly employed to verify that just great things are being said in regards to the associations they are working for. For the individuals who felt evaluations locales were for the most part reasonable, numerous reported despite everything they need to independent reliable audits from non-dependable ones in light they could call their own instinct. Particular study respondents noticed that they:

- a) Can typically tell when an audit is incredible — in the event that it is excessively positive."
- b) Try to figure out whether the audit is genuine or if the essayist is out for retribution."
- c) Read between the lines to see what the analyst is truly saying
- d) Try to peruse a scope of audits. On the off chance that there are insufficient surveys, [they] don't consider it important.

On the off chance that the absence of trust in client audits proceeds with, these locales could get to be out of date. To address trust issues, organizations and evaluations locales ought to consider more secure and trustworthy approaches to give clients surveys that have been confirmed and skewed (Zhihong, & De, 2014).

## 2.9 Local Review Web Sites and Their Impact

Online audit Web locales has empowered new connections in the middle of organizations and their clients. In this article we draw on meetings with clients, analysts, and foundations to investigate how neighborhood audit Web destinations can change connections around nearby places. Survey Web locales, for example, Yelp and Trip guide permit clients to "returns to" foundations and regions of a city before a real visit. The gathering of a huge quantities of client produced audits has additionally made another classification of composing, with analysts increasing impressive delight from passing on informal and impacting others' decisions. Audits additionally offer another channel of correspondence between foundations, clients, and contenders. We talk about how audit Web locales can be intended to cook for a more extensive scope of associations around surveys past an attention on proposals (Brown, 2012).

## 2.10 Social Media on The Restaurant Industry

In an advanced age where online networking and the eating society are rapidly merging, shoppers are getting to be progressively subject to and intensely affected by client produced substance in restaurant rating sites, for example, Yelp, Zagat, Foursquare, and Groupon. In this paper, we explore whether client appraisals have any factually huge

relationship with restaurant incomes. We additionally inspect the variables that impact how clients rate their feasting knowledge and the restaurant credits that prompt them to give higher appraisals. We utilize a relapse examination on information set of restaurants in New York City and check, among other significant discoveries, that there is a positive relationship between appraisals and incomes. The consequences of this study all in all give bits of knowledge on how restaurateurs can use social networking and its client produced substance to enhance choice making, address client issues, and boost their incomes (Chua, 2013).

### **2.11 Electronic Meal Experience**

A substance investigation of 2,471 client, remarks in regards to three hundred London restaurants on an online restaurant aide. Positive remarks far dwarfed negative surveys. The study's boss reason for existing was to recognize the elements that are most remarkable in a visitor's assessment of a restaurant. Despite the fact that sustenance is made as the lord of the supper experience, as found in different studies, the starter is referred to as a very vital thing in numerous shoppers' remarks. An inclination structure model rises recommending that clients consider sustenance, administration, atmosphere, value, menu, and ornamentation when pondering their encounters. In spite of desires, the model remains generally consistent when tried in times of financial bounty and monetary emergency. Contingent upon how administration screens and reacts to them, remarks on electronic aides and in online networking can devastate a restaurant or help secure the business' life span restaurant administrators who react effectively to remarks in electronic discussions can turn an unsatisfied client to a steadfast one. The study gives a correlation of remarks made amid times of great monetary conditions and times of financial subsidence. (Pantelidis, 2010).

### **2.12 Reviews, Reputation, and Revenue: The Case of Yelp.com**

In only six years, Yelp.com has figured out how to swarm source 20 million audits of restaurants and different administrations by making and utilizing an amazing informal community of individuals who appreciate composing surveys. At the same time can a bundle of novice opinionates working for nothing truly change the restaurant business, where intensely advertised chains and exceedingly respected proficient commentators have long had a fortress? To answer this inquiry, HBS teacher Michael Luca consolidated Yelp audits with incomes for each restaurant that worked in Seattle, WA anytime somewhere around 2003 and 2009. Applying another strategy to tease out the causal impact of audits (separate from the impact of fundamental quality), the study demonstrates that an one-star increment on Yelp prompts a 5 to 9 percent expansion in income. Yet Yelp doesn't work for all restaurants. Chain restaurants —which as of now spend intensely on marking —are unaffected by changes in their Yelp appraisals. This recommends that buyer audits exhibit another method for adapting in the Internet age, and are quick turning into a substitute for conventional types of notoriety. Key ideas include: Online shopper survey sites give more data to customers than was already suspected to be financially savvy. By depending on client produced substance, Yelp has the capacity survey a larger number of items than conventional media, for example, daily paper surveys. More than 70 percent of Seattle restaurants are on Yelp. The effect of purchaser surveys relies on upon the current notoriety of an organization or item. Purchaser audits are successful in general, yet inadequate when an item has a solidly settled notoriety, (for example, a chain restaurant). Purchaser audits give a substitute to more conventional manifestations of showcasing. Different manifestations of notoriety, for example, chain alliance may get to be less persuasive as sites like Yelp keep on gaining footing. Confirmation proposes that this example is as of now developing. Shoppers depend on basic measurements, for example, the normal rating and the quantity of

surveys, and are additionally trusting of audits that are composed by "tip top" analysts (as distinguished by Yelp) (Michael, 2011).

### **2.13 Is Groupon Good for Retailers?**

For retailers offering arrangements through the uncontrollably famous online start-up Groupon, does the one-day attention make up for the profound hit to net revenues? Another working paper, "To Groupon or Not to Groupon," sets out to help little organizations choose. Harvard Business School teacher Benjamin G. Edelman talks about the paper's discoveries.

Key ideas include: Discount vouchers give value segregation, letting shippers pull in shoppers who would not normally belittle their business without a noteworthy value motivator. These vouchers additionally profit shippers through promoting, essentially by advising purchasers of a shipper's presence by means of email. For a few traders, the profits of offering markdown vouchers are pointedly decreased if singular clients purchase various vouchers. As an advertising device, markdown vouchers are prone to be best for organizations that are moderately obscure and have low peripheral expenses.

On the off chance that you take a gander at Groupon from a promoting point of view, then it's not an awful arrangement. It produces verbal, obliges no cash in advance by the promoter, installment to Groupon is in view of execution (something more publicists are clamoring for), and the outcomes are effortlessly followed. Purchasers pick up consciousness of retailers they didn't know existed, and they ponder retailers that they're as of now acquainted with. From a budgetary viewpoint, Groupon likewise offers advantages. Clients pay in advance (giving income and buoy opportunities), and there's the likelihood of breakage (inability to reclaim). Those have all been praised as advantages of blessing cards and blessing endorsements; they're currently simply deciphered into an online medium. Groupon bargains likewise help piece of the overall industry (in any event incidentally), since clients will now buy from that retailer instead of the opposition. Groupon's profits augment past simply the business (Nobel, 2011).

### **2.14 Do Friends Influence Purchases in a Social Network?**

Interpersonal organizations, for example, Facebook and Myspace have seen a fast development in their enrollment. Some of these organizations have attempted a promoting based model with exceptionally restricted achievement. On the other hand, these organizations have not completely investigated the force of their individuals to impact one another's conduct. This potential viral or social impact can have noteworthy effect on the achievement of these organizations and additionally give a remarkable new advertising open door for customary organizations. Notwithstanding, this potential is predicated on the presumption that companions impact client's conduct. In this study we experimentally analyze this issue. Particularly we address three inquiries - do companions impact buys of clients in an online interpersonal organization; which clients are more impacted by this social weight; and would we be able to measure this social impact regarding increment in deals and income. To address these inquiries we utilize information from Cyber world, an online informal communication website in Korea. Cyber world clients make smaller than usual landing pages to associate with their companions. These small scale landing pages, which turn into a method for elucidation toward oneself for individuals, are embellished with things (e.g., wallpaper, music), a significant number of which are sold by Cyber world. Utilizing 10 weeks of procurement and non-buy information from 208 clients, we manufacture an individual level model of decision (purchase no purchase) and amount (the amount of cash to spend). We appraise this model utilizing Bayesian methodology and MCMC strategy. Our

outcomes demonstrate that there are three unique gatherings of clients with altogether different conduct. The low-status assemble (48% of clients) are not decently joined, show restricted connection with different individuals and are unaffected by social weight. The center status bunch (40% clients) is reasonably associated, show sensible non-buy action on the site and have an in number and beneficial outcome because of companions' buys. As such, this gathering shows "staying aware of the Joneses" conduct. By and large, their income increments by 5% because of this social impact. The high-status bunch (12% clients) is decently associated and extremely dynamic on the site, and demonstrates a noteworthy negative impact because of companions' buys. At the end of the day, this gathering separates itself from others by bringing down their buy and unequivocally seeking after non-buy related exercises. This social impact prompts very nearly 14% drop in the income of this gathering (Iyengar, Han, & Gupta, 2009).

### 2.15 Information and Incentives in Online Affiliate Marketing

Researchers consider option systems for managing staff who have huge attentiveness and whose endeavors are liable to both inadequate data and skewed motivating forces. In particular, we look at online member promoting projects in which dealers manage a huge number of members they have never met. A few vendors enlist expert outside counselors to set and uphold arrangements for subsidiaries, while different traders ask their customary advertising staff to perform these capacities. For clear infringement of pertinent standards, we find that outside guides are best at barring the mindful members which we decipher as an advantage of specialization. Notwithstanding, in-house staff are more fruitful at distinguishing and barring members whose practices are seen as "marginal" (though still in opposition to traders' hobbies), previous the efficiencies of specialization for the better motivating forces of an organization's staff. We consider ramifications for promoting of online subsidiary projects and for internet advertising all the more for the most part (Edelman, & Brandi, 2014).

## III RESEARCH METHODOLOGY

The concept of research methodology is extensive. It can be classified as a tool for problem solving or a way to conduct and gather new knowledge. Everything that can contribute to this research methodology. However, all methods are not as bearable or suitable for its purpose (Holme & Solvang, 1997). This portion will begin to present the research strategy along with the sample size, the techniques, questionnaire design etc. Continuing with presenting the tools used for the study and to finish up with an overall presentation of research model.

### 3.1 Research Strategy

The strategy followed for this study is deductive approach. A deductive approach is initialized by reviewing and gather theory from where collection and conclusions are based upon (Holme, & Solvang, 1997).

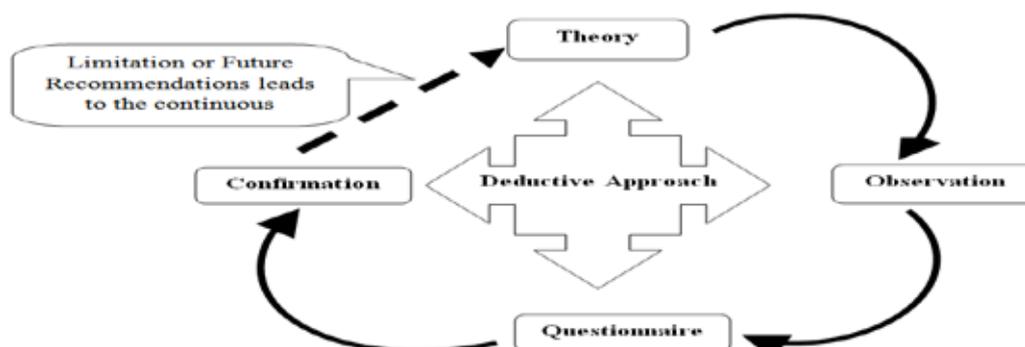


Figure 3 – Research Strategy

### 3.2 Questionnaire development

The study pursues the investigation of online restaurants employee's and customers' perception and expectations in a one – column format.

		<i>Completely failed to meet</i>		<i>Far exceeded</i>
1	With regard to your _____	1	2	3

**Table 1: One – column format questionnaire**

*Note 1:* All items measured on a five-point likert scale adopted from *The Handbook of Marketing Scale*.

An example of the questionnaire that was developed to gather necessary information in the empirical data collection. The matters in the questionnaire were measured on a three – point scale ranging from “completely failed to meet” to “far exceeded”, consistent with the earlier studies.

### 3.3 Size of the population

While doing a study it is very difficult and expensive to gather data from the entire population, so we divided the questionnaire into two sets, one for the employees and the other set prepared for customers. So we have chosen the sampling size of 30. Set one, that is prepared for employees responded through online reviewing company in Bangalore and the other set of questionnaire was filled by the customers who use these portals regularly.

### 3.4 Data collection tools and procedures

While doing the study, the data collected were primary and secondary data. Primary data were collected in the form of the questionnaire from the customers and from the employees. Whereas, the secondary data was collected in the form of literature review from journals and articles from the internet and online library.

### 3.5 Questionnaire design

The questionnaire was divided into 4 segments of open ended questions, close ended questions, rating scale and demographic questions.

### 3.6 Limitations

The major limitation faced during the research was that most of the participants of the questionnaire were from Bangalore City only so people from different locations who have visited the wired restaurant could not be covered.

### 3.7 Research model

Research model illustrates the model of the study where the different stages of the research process are presented.

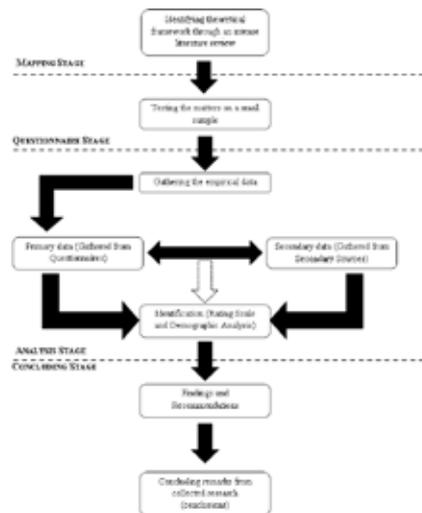


Figure 4 – Research Model

**Note 2:** The framework given above is the different stages of the research process of the study.

The *first stage* of the study involved observation and several discussions with staff, customers and managers in the small scale food and beverage outlet. The purpose on these discussions was to get an understanding on what area to focus. The literature review was made to present relevant theory from out a questionnaire was extracted. The *second stage*, the questionnaire stage with customers and managers was conducted. These questionnaires were gathered later to justify the next stage, the *analysis stage*. The analysis stage is represented in the model, by the different methods used to verify reliability and validity of the research. Finally in the concluding *fourth stage*, all gathered information in the different stages was composed and analyzed to answer the research purpose.

## IV EMPIRICAL DATA

The focus of this portion is to present the empirical data gathered during the handouts that was provided throughout Bangalore. First, the data of the survey are presented. The duration and context is discussed, followed by the respondents demographic and to finish up with the division demographics of questionnaire based on customers and employees.

### 4.1 Duration and Context

The study duration was approximately five weeks from the end of January until the end of February. In total, the number of usable respondents was 30, distributed indirectly on the sight through questionnaire. The respondents answered the questionnaire in the context of the study matter. They were asked to give the most appropriate answer from their experience.

### 4.2 Respondents Demographics

The questionnaire was administered to 50 participants, this includes both customers and employees. Out of the 50 questionnaire administered, 34 were obtained but 30 were valid for analysis while 4 were invalid as a result of improper responses. The valid questionnaires which formed the analysis yielded 60% response rate. The table

(2) reports the demographic analysis participants chose for the study purpose, of the chosen site. The demographic data of the respondents is presented below (Table 2).

<i>Age</i>	<i>Respondents count</i>	<i>Percentage of respondents</i>
<20	9	30%
20 – 35	12	40%
36 – 50	5	16.67%
51 – 65	3	10%
>66	1	3.33%
<i>Gender</i>	<i>Respondents count</i>	<i>Percentage of respondents</i>
<i>Male</i>	19	52.5%
<i>Female</i>	11	47.5%
<i>Income( )</i>	<i>Respondents count</i>	<i>Percentage of respondents</i>
<20,000	15	50%
20,000 – 40,000	8	26.67%
40,000 – 60,000	4	13.34%
60,000 – 80, 000	1	3.33%
80,000 – 100,000	1	3.33%
>100,000	1	3.33%

**Table 2: Demographic data**

The majority of the respondents were in the age group of less than 20 – 35 years old followed by the age groups 36 – 50 years old and those 51 – 65 years old respectively. Among 30 participants surveyed in the online restaurant, 11 were female and remaining 19 were male. This shows that both the sexes are comfortable sitting for online restaurant. One more reason for good amount of female visitors in the restaurant can be that it is a residential area. 15 participants who visited the restaurant had income between 0 and 20000`. This shows that most of the customers who visited are common public and it is an affordable option for them to visit the restaurant.

#### 4.3 Demographic Data

##### *Respondents Response of Two Sets of Questionnaire*

As mentioned earlier the questionnaire was distributed in two sets for collecting the data. Set one was distributed to the employees responded through online reviewing company in Bangalore and set two was responded by the customers who use these portals. This is sorted out from all the other demographic question since it was not part of the two sets of questionnaire.

<i>Questionnaire Distribution</i>	<i>Respondents Count</i>	<i>Percentage of Respondents</i>
<b>Total Participants</b>	<b>50</b>	<b>100%</b>
Questionnaires for Employees	20	40%
Questionnaires for Customers	30	60%
<b>Fully Completed Questionnaires</b>	<b>34</b>	<b>68%</b>

Questionnaires for Employees	13	38.24%
Questionnaires for Customers	21	61.76%
<b>Valid Questionnaires</b>	<b>30</b>	<b>60%</b>
<i>Questionnaire Partition</i>	<i>Respondents Count</i>	<i>Percentage of Respondents</i>
Total Respondents Taken for the Study Purpose	<b>30 (Total)</b>	
Set I – Questionnaires for Employees	12	40%
Set II – Questionnaires for Customers	18	60%

**Table 3: Respondents Response – Two Sets of Questionnaire**

The two sets of questionnaires were distributed to 50 participants, which includes both employees and customers. Out of this 50 filled questionnaires, 16 questionnaires were found incomplete and only 34 (68%) was fully completed questionnaires. During the process of screening the selected 34 filled questionnaires the researchers found only 30 (60%) questionnaires was valid and other 4 questionnaires were not considered due to the invalid response from the participants. The selected questionnaires – employee perspective is 40% and the rest that is customer perception questionnaires were 60%.

## V DATA ANALYSIS

This following portion of the study presents the analysis of the data collected by the questionnaire made for this study. The data was analysed according to the steps outlined in the methodology. First, the resulted analysed data of the questionnaire are presented in the form of table and figure, followed by the discussion and interpretation of the same.

**Note 3:** Property name is not allowed to unveil. Consequently the researcher mentioned the property as café for the purpose of carrying out this study.

### 5.1 Data Analysis

Customers Opinion poll – Data Collected through questionnaire distributed to the Customers of Online reviewing websites.

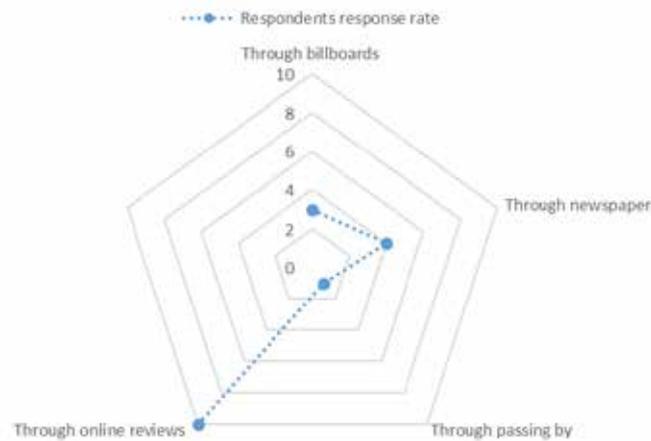
Under this sub – portion, 18 valid customers opinion poll will be analyzed in a statistical form under 3 different categories based on the survey prepared. Out of 3 categories, 1 and 2 are based on specific point and 3<sup>rd</sup> one is based on 3 – point likert scale.

#### 5.1.1 Getting to know a new Hotel/Restaurant in a city

Table 4 represents the statistics analysis of how do people get to know a new hotel or restaurant in a city, selected for the purpose of the study.

<i>Knowing the Hotel/Restaurant</i>		
<i>About the Hotel/Restaurant</i>	<b>Respondents response rate</b>	<b>Respondents response in percentage</b>

<i>Through billboards</i>	3	16.67%
<i>Through newspaper</i>	4	22.22%
<i>Through passing by</i>	1	5.56%
<i>Through online reviews</i>	10	55.55%
<b>Total</b>	<b>18</b>	<b>100%</b>

**Table 4: Knowing the Hotel/Restaurant****Figure 5 – Knowing the Hotel/Restaurant**

Out of 18 participants, 55.55% of respondents getting to know about a hotel or restaurant is through online. This shows that the demand of online restaurant is quite more in the city, selected for purpose of the study. 22.22% is through newspaper. And the rest from billboards (16.67%) and passing by (5.56%). Most of the customers from the city search for the nearest hotels or restaurants through internet technology.

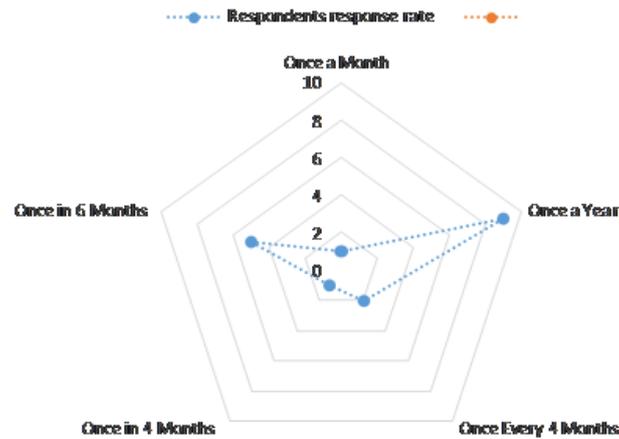
### 5.1.2 Frequency of Visiting Hotels and Restaurants

The table 5 reports the statistics analysis of how frequently the customers visit hotels or restaurants, in other words, this represents how often do customers stay in hotels or restaurants. This gives an output of how much aware and important for the customers in visiting hotels or restaurant.

**Frequency of Visiting Hotels and Restaurants**

<i>Frequency</i>	<b>Respondents response rate</b>	<b>Respondents response in percentage</b>
<i>Once a Month</i>	1	5.5%
<i>Once a Year</i>	9	50%
<i>Once Every 4 Months</i>	2	11%
<i>Once in 4 Months</i>	1	5.5%
<i>Once in 6 Months</i>	5	28%
<b>Total</b>	<b>18</b>	<b>100%</b>

**Table 5: Frequency of Visiting Hotels and Restaurants**



**Figure 6 – Frequency of Visiting Hotels and Restaurants**

Out of 18 customer participants, 50% of respondent's visit a hotel in a year whereas a good number of people often visit hotels and restaurants. This shows that the frequency of the customers visiting hotel or restaurant is not on a daily or regular basis. The demand for a customer are found during a certain occasion. Though the higher visiting rate of a customer is once in a year, whereas a good number people often visit hotels or restaurants once in 6 months (28%). And the rest falls under regular visitors. These are just countable visitors who visit the hotels or restaurant on a regular basis that is once in 4 months (5.5%), once every 4 months (11%) and once in a month (5.5%).

### 5.1.3 Rating Scale

The table 6 reports the statistics analysis of rating scale, selected for the purpose of the study, which is the main matter of the study and also it gives an output of how the customers feel about wired restaurant. This was analyzed on the scale of one to three on a three – point likert scale ranging from 'Always' to 'Never'.

Rating Scale									
Rating Scale	Respondents response rate						Total		
	Always (1)		Sometimes (2)		Never (3)				
	R	%	R	%	R	%	R	%	
Reading Online Reviews	5	28%	9	50%	4	22%	18	100%	
Cancellation of Booking	2	11%	15	83%	1	6%	18	100%	
Writing Online Reviews	7	39%	5	28%	6	33%	18	100%	
Trying New Concepts	2	11%	11	61%	5	28%	18	100%	
Effect of Mentoring Price Range	5	28%	9	50%	4	22%	18	100%	
Accuracy of Reviews	3	17%	6	33%	9	50%	18	100%	
Trustworthiness of Reviews	6	33%	7	39%	5	28%	18	100%	
Recommending use of Online Reviews Website	6	33%	7	39%	5	28%	18	100%	

**Table 6: Rating Scale**

**Note 4:** R = Rating; % = Percentage



**Figure 7 – Rating Scale**

The above table (6) shows the outcomes resulted on online reviews. This data shows that there are many people who actually read online reviews whereas only four people said they don't read online reviews. Whereas many people are dependent on the online reviews and these reviews play a major role in influencing their decisions (83%). On the basis of writing the reviews online, there is an almost equal distribution of people of who write online reviews and who do not prefer to write them. 28% of the people said they write sometimes. The analysis above shown, can be seen that majority of the people are open to trying different cuisines and different concept based restaurants based on their online reviews and popularity. Most of the people prefer to see the price range and then decide if they want to dine at that restaurant while only a few people said that they do not consider the price range while choosing a restaurant. Majority of the people think that the information or reviews provided on these restaurants or hotels are not accurate. On recommending the use of online reviews, most of them said that they would recommend these websites or reviews to others before taking the decision of choosing a restaurant.

**5.2 Data Analysis**

Employee Opinion poll – Data Collected through questionnaire distributed to the Employees of Online reviewing websites.

Under this sub – portion, 12 valid customers opinion poll will be analyzed in a statistical form under 1 different category based on the survey prepared. This category is measured in three – point likert scale.

**5.2.1 Rating Scale**

The table 7 reports the statistics analysis of rating scale, selected for the purpose of the study, which is the main matter of the study and also it gives an output of how the employees feel about wired restaurant. This was analyzed on the scale of one to three on a three – point likert scale ranging from 'Always' to 'Never'.

Rating Scale									
Rating Scale		Respondents response rate						Total	
		Always (1)		Sometimes (2)		Never (3)			
R	%	R	%	R	%	R	%	R	%

Encouragement to be Creative	7	58%	1	8%	4	33%	12	100%
Feeling of Accomplishment	4	33%	6	50%	2	17%	12	100%
Satisfaction with the Tools and Resources Given	2	17%	4	33%	6	50%	12	100%
Definition of Quality of Goals	8	67%	3	25%	1	8%	12	100%
Employees Being Informed	6	50%	5	42%	1	8%	12	100%
Effectively Helping Customer Satisfaction	3	25%	5	42%	4	33%	12	100%
Effectively using their Skills	7	58%	2	17%	3	25%	12	100%
Monitoring Quality by Mangers	4	33%	7	58%	1	8%	12	100%

Table 7: Rating Scale



Figure 8 – Rating Scale

The above table (7) shows the outcomes resulted on employee's online reviewing websites. Majority of the employees feel that they are encouraged by the company to be creative and come up with new alternatives. Other majority category of the employees feel that their job gives them a sense of accomplishment sometimes and most of them were content. Most of the employees feel that they are not given enough resources and support in order to get their job done. 67% of the employees feel that they are given clear cut goals and objectives that they have to achieve. Though 67% feel that they are given proper goals there is another good number of people who feel that they are not given proper information or not being involved in the organizational decisions. Around 33% of the employees feel that it is very difficult to correct the problems that are being faced by the customers. 58% of the Employees feel that their skills and abilities are always put to the test in their current job. 33% of the employees feel that their supervisors are visibly demonstrating a commitment to quality whereas, another 8% feel they are not doing a good job.

## VI FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

This portion gives the summary of the key findings of the study presented according to the objectives of the research. Conclusions are based on the findings and suggestions to help improve the quality of the services delivered through online.

### 6.1 Findings and Inferences

The findings resulted that most of the people get to know about new restaurants and hotels through newspaper, magazines and online review websites. It shows that majority of the people visit a hotel in a year whereas a good

number of people often visit hotels and restaurants. The study projected that the majority of the people belong to the age group of 18 to 25 years of age who are considered as the Gen X or Gen Y who are more technologically sound compared to older generations. People think that the information or reviews provided on these restaurants or hotels are not accurate. Majority of the employees feel that they are encouraged by the company to be creative and come up with new alternatives. Widely held employees feel that it is very difficult to correct the problems that are being faced by the customers. More than half of the employees feel that their skills and abilities are always put to the test in their current job. 33% of the employees feel that their supervisors are visibly demonstrating a commitment to quality whereas, 8% feel they are not doing a good job. On an average the employees are moderately satisfied with their job in the company. Some of the employees are very satisfied on the other hand some of them are also dissatisfied. The employees are not too satisfied with their growth opportunities within the company. Employees are neutrally satisfied with the information being given to them about what is being done in the company.

## **6.2 Conclusion and Suggestions**

The data shows that most of the people get to know about new restaurants and hotels through newspaper, magazines and online review websites by this we get to know that the majority of people today are dependent on online reviews. This data shows that there are many people who actually read online reviews whereas only five people said they don't read online reviews and a majority of them are influenced by these online reviews.

It can be noted that the majority of the people belong to the age group of 18 to 25 years of age who are considered as the Gen X or Gen Y who are more technologically sound compared to older generations who use these online reviewing sites on a regular basis. This indicates the importance of online reviewing sites as they play a vital role in shaping customer perceptions and behaviors.

Though many people felt that they don't really trust these reviews they still recommended these websites to others so that it can give the real image and information about the restaurant to the customers. Food is a very subjective matter and what one person may like, need not be likable to other people.

One of the major gaps we found while doing this project are that most of the employees who work for these online reviewing companies are never considered while doing a research. So we thought of circulating a questionnaire to these employees to see their aspect of these websites and how satisfied they are with their current jobs. Majority of the employees feel that their job gives them a sense of accomplishment sometimes and most of them were content they also felt that the organization tries their best to help them by encouraging them to achieve more through incentive programs and schemes.

Main stream employees feel that it is very difficult to correct the problems that are being faced by the customers because once a bad impression is created in the service industry it is very difficult to change that. According to them most of the customers who were dissatisfied with the ratings cited some of the restaurants being overrated and underrated. On an average the employees are moderately satisfied with their job in the company. Some of the employees are very satisfied on the other hand some of them are also dissatisfied.

### 6.3 Identification for future needs

The present work is an open book of information for the upcoming researchers in hotel sectors. This study is an auxiliary information tool for considering as one of the elements for service delivery in the hotel sector. This study concept can apply in other industries too by adding the more online reviewing upcoming technology used in that particular choose an industry.

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# DESIGN, ANALYSIS & FABRICATION OF PORTABLE CAR WASH TROLLEY

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## ABSTRACT

*In industries, there are large numbers of huge machines, being used for various purposes. These machines are taken for maintenance according to its maintenance period. These machines are washed using high pressure washer to remove the dirt, grease or any other lubricants or rust from its surface before they are being worked on for maintenance. These pressure washers removes large amount of dirt.*

*Washing the buses in our institute is a tedious job for the driver. Nowadays there are pressure washers available which are used for domestic purpose. The technique used in this pressure washer will be used to fabricate a portable car wash which can be used to wash the buses of the institute. A suitable pump and motor unit is selected and along with a tank are mounted on a trolley with wheels so that the whole machine becomes portable to be carried anywhere.*

**Keywords:** Nozzle, Plunger pump, portable, pressure, trolley.

## I. INTRODUCTION

As the weather gets nicer every day, and we clean our house and care for our lawns; it's only natural that we want to give our ride a nice wash. Just drive past any car wash on a weekend and you'll see cars lined up waiting for their turn in the wash tunnel.

A pressure washer is a high pressure mechanical sprayer used to remove loose paint, mold, grime, dust, mud, and dirt from surfaces and objects such as buildings, vehicles and concrete surfaces. The volume of a pressure washer is expressed in gallons or litres per minute, often designed into the pump and not variable. The pressure, expressed in pounds per square inch, pascals, or bar, is designed into the pump but can be varied by adjusting the unloader valve. Machines that produce pressures from 750 to 30,000 psi (5 to 200 MPa) or more are available. Car wash is a \$24 billion industry according to international car wash association.

The basic pressure washer consists of:

- A motor, such as electric, internal combustion, pneumatic or hydraulic, that drives a high pressure water pump
- A high-pressure hose
- Trigger gun-style switch

Just as a garden hose nozzle is used to increase the velocity of water, a pressure washer creates high pressure and velocity. The water supply must be adequate for the machine, as water starvation leads to cavitation causing damage to the pump elements.

Different types of nozzle are available for different application. Some nozzles create a water jet that is in a triangular plane (fan pattern), others emit a thin jet of water that spirals around rapidly (cone pattern). Nozzles that deliver a higher flow rate, lower the output pressure. Most nozzles attach directly to the trigger gun.

Some washers, with an appropriate nozzle, allow detergent to be introduced into the water stream, assisting in the cleaning process. Two types of chemical injectors are available — a high-pressure injector that introduces the chemical after the water leaves the pump (a downstream injector) and a low-pressure injector that introduces the chemical before water enters the pump (an upstream injector).

Washers are dangerous tools and should be operated with due regard to safety instructions. The water pressure near the nozzle is powerful enough to strip flesh from bone. Particles in the water supply are ejected from the nozzle at great velocities. The cleaning process can propel objects dislodged from the surface being cleaned, also at great velocities. Pressure washers have a tendency to break up tarmac if aimed directly at it, due to high pressure water entering cracks and voids in the surface.

Most consumer washers are electric or petrol-powered. The electric ones plug into a normal outlet, use cold tap water and typically deliver pressure up to about 2,000 psi (140 bar). Petrol washers can deliver twice that pressure, but due to the hazardous nature of the engine exhaust they are unsuitable for enclosed or indoor areas. Some models can generate hot water, which can be ideal for loosening and removing oil and grease [2].

The fabrication of a Portable High Pressure Washer is done by mounting a motor and pump assembly of specific requirement on a suitably designed mobile trolley. A jet producing nozzle is connected to a pump with the help of a suitable hose. This washer can be used to wash the underbody of the vehicle due to its high velocity jet, wash the greasy walls of the workshops, etc.

Car washes fall into five categories:

- Self service - An open bay (the area that the car sits inside) is typically used in these systems. Self-service systems have a pressure sprayer, and sometimes a foaming brush, that is connected to a large central pump. The sprayer has a coin-operated dial system to select the option you want, such as "soap," "rinse" and "wax." A timer shuts the water off after a certain period of time, at which point you must put in more coins if you want more water.
- Exterior rollover - A system that is growing in popularity, exterior rollover car washes are automated systems where you drive your car inside the bay. Once your car is in the correct position, a signal informs you to stop. At that point, the car-wash equipment moves over your car on a track, performing a specific function, such as applying soap or rinsing, with each pass. Exterior rollover systems are very common at gas stations, where the price is often discounted in conjunction with buying a tank of gas.
- Exterior only - This automated system is popular in the northeastern part of the United States, but can be found all over the world. You drive your car into the entrance of a long, tunnel-like bay. The front tire, usually on the driver's side, is positioned on a special conveyor belt, and you put the car in neutral. The conveyor belt

guides the car through the bay, where the car goes past several pieces of equipment, each with a specific purpose.

- Full service - A modification of the exterior-only system, full service uses the same conveyor-belt-based automated system. The difference is that the interior is manually cleaned by attendants, and some exterior services, such as hand-drying and wheel-cleaning are available.
- Detail shop - A detail shop may hand wash or use an automated system to wash the car. Then, attendants completely clean and polish the car, normally applying wax and using a tool called a buffer to remove the wax and polish the car. Detail shops are often able to remove dull paint and small scratches, steam clean carpets and seats, brighten chrome, remove tar and perform a variety of other services.

## **1.1 Home Car Wash**

Things you need for the home car wash before your start include:

- 2 bucket
- Soft water or rainwater - avoid dam or bore water
- Shade - direct sunlight will dry the car too quickly and leave spots
- Warm soapy water - PH neutral shampoo
- Sheeps wool wash mitt - kinder and easier to use than a sponge

### **1.1.1 Washing Procedure**

**Wheels** - Start with the wheels. This is because the wheels of a car will be dirtier than the rest with potentially large bits of dirt that can scratch the paint of a car. Be sure to use a different water bucket, wash mitt or sponge for the wheels than the rest of the car as not to damage the body work. To clean in small holes in the wheels use a toothbrush to easy reach hidden areas. Rinse thoroughly with a hose and be extra careful not to mix your wheel cleaning equipment with you regular washing equipment.

**Rinse** - It is important that you rinse your car thoroughly before starting to wash; this is to remove any harmful dirt and grit that can scratch the paint finish of the car. Top to bottom, spray from the roof down. Make sure to spray underneath the windscreen wipers as extra dirt may collect there.

**Separate Buckets** - It's best to have a separate bucket to use as a rinse bucket where possible using grit guard. The guard and the separate bucket of water allow for all of the dirt, grit and contaminants to remain in the separate bucket away from the clean soapy water. By keeping separate buckets it ensure that the dirty water will not contaminate the clean water and ruin the over finish of the car wash.

**Wash and Rinse** - Again it is important to wash and rinse from top to bottom gently. When washing tough spots such as droppings or sap, apply concentrated soap to the area and gently rub to avoid scratching the paint. If you have any dents or crack in the paint be sure to pay attention to these places as there may be a buildup of dirt. When rinsing the car start from the roof to ensure that the water droplets catch all the soap suds and rinse them away to the ground.

Dry - Use car washing towel rather than a chamis, most of these will hold more than their weight in water and are super absorbent. Dry the bodywork of the car using small circles to avoid streaking. The best way to tell if your windows are streak free is to dry the outside horizontally and the inside vertically this way if there are extra marks you can tell which side they're on.

## **1.2 Objectives of the Project**

- To build a Portable Car Washer, which can be moved easily to any location?
- To get a high pressure jet of water to remove the dirt, grease or any other lubricants or rust from the surface before they are being worked on for maintenance.
- To fabricate the trolley for the portable car washer, considering the weight & dimensions for different parts.

## **II. LITERATURE REVIEW**

People have found ways to wash their cars ever since cars were invented. They either washed it themselves at home, or paid someone else to wash it by hand. Then, in 1914, two Detroit men opened the first car wash business, which they called the “Automated Laundry”, but it wasn’t really automated. It was basically a pail and sponge type of operation where the cars were pushed manually through an assembly-line-like tunnel, where one attendant would soap the car as it went past, another would rinse, and a third would dry. After pushing a few cars through, the attendants got pretty tired.

The first “automatic” conveyor car wash was opened in Hollywood, California in 1940. Instead of manually pushing the cars through, this car wash had a winch system that hooked to the bumper and pulled the car through as men splashed away in the tunnel, soaping, scrubbing, wiping, and drying cars as they came through. By 1946, a man named Thomas Simpson is credited with inventing the first semiautomatic car wash system that took most of the manual labor out of the tunnel [8]. It had a conveyor belt that hooked to the bumper of automobiles, an overhead water sprinkler with three sets of manually operated brushes, and a 50 HP air blower to help dry the car.

Then, in 1951, Archie, Dean and Eldon Anderson got the great idea to fully automate their car wash. As the story goes, the Anderson clan invented the completely hands-free automatic car wash in Seattle. Cars would be pulled through the tunnel and machines sprayed soap on them, big brushes scrubbed them, nozzles rinsed them, and giant blowers dried them. Needless to say, this was a big hit! Soon, many other car wash owners were installing automatic equipment in their car wash business

A lot happened to the car wash industry in 1955, Dan Hanna being inspired by the Detroit carwashes opened his own automated car wash (Rub-a-Dub) in Oregon. By 1957 Hanna Enterprises had 31 carwashes in America. Around the same time in 1955 car wash professionals formed the Automatic Car Wash Association (ACWA) later being recognized worldwide, being re named to the International Carwash Association (ICA).



**Fig. 2.1 Fully Mechanized Car washing**

Through the 1960's, fully mechanized car washing systems were being installed across America. With conveyor car wash equipment advancing, the 60's saw inventions such as recirculating water systems, soft cloth friction washing, roller on demand conveyor, and wraparound brush. By the late 60's car washes were becoming a prominent industry worldwide with car washes being installed in many countries, including Japan.

The 70's saw a downturn in business for car washes with the global economy weakening, However car washes managed to stay alive with innovative inventions.

The 90's saw the global boom of the car wash with new technologies expanding across the Far East, China, Russia and Eastern Europe. With Latin America and Southeast also amongst the growth Hanna Enterprises now (Hanna-Sherman International) were the biggest global car washing factory in the world.

The car wash evolved into weekly trip for many people predominantly on a Saturday with hand car washes developing into charity fund raisers and weekend jobs for kids. The ICA estimates that there around 22,000 car washes worldwide employing about 500,000 people.

Today's car washes are literally cleaning machines. They not only wash all five sides of the car at once, but scrub tires and wash the undercarriage as well. They are more Eco-friendly, with milder soaps and lower water and electric requirements. Many of the newer car washes even have express tunnels that get your car through quickly, all of which leads to more clean cars and happier car owners.

### **III. COMPONENTS**

The following components are part of our project. They include;

- Pump - Swash Plate Type 3 Piston Pump
- Trolley
- Water Tank
- Hose
- Trigger Gun
- Nozzle

The above components are assembled together to make the portable car wash. These components are explained below.

### 3.1 Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Pumps that move liquid by mechanical action are called hydraulic pumps.

#### 3.1.1 Hydraulic Pump

Hydraulic pumps are used in hydraulic drive systems and can be hydrostatic or hydrodynamic. Hydrostatic pumps are positive displacement pumps while hydrodynamic pumps can be fixed displacement pumps, in which the displacement (flow through the pump per rotation of the pump) cannot be adjusted, or variable displacement pumps, which have a more complicated construction that allows the displacement to be adjusted [4].

Hydraulic pump types

- Gear pumps
- Rotary vane pumps
- Screw pumps
- Bent axis pumps
- In-line Axial piston pumps, swashplate principle
- Radial piston pumps

#### 3.1.2 Swash Plate Type 3 Plunger Pump

Swash Plate Type 3 Piston Pump, an in-line axial piston pump is a positive displacement pump that has a number of pistons in a circular array within a cylinder block. An axial piston pump has a number of pistons (usually an odd number) arranged in a circular array within a housing which is commonly referred to as a cylinder block, rotor or barrel. This cylinder block is driven to rotate about its axis of symmetry by an integral shaft that is, more or less, aligned with the pumping pistons [1].

One end of the cylinder block is convex and wears against a mating surface on a stationary valve plate. The inlet and outlet fluid of the pump pass through different parts of the sliding interface between the cylinder block and valve plate. The valve plate has two semi-circular ports that allow inlet of the operating fluid and exhaust of the outlet fluid respectively [5].

The pumping pistons protrude from the opposite end of the cylinder block. There are numerous configurations used for the exposed ends of the pistons but in all cases they bear against a cam. In variable displacement units, the cam is movable and commonly referred to as a swash plate, yoke or hanger. For conceptual purposes, the cam can be represented by a plane, the orientation of which, in combination with shaft rotation, provides the cam action that leads to piston reciprocation and thus pumping. The angle between a vector normal to the cam plane and the cylinder block axis of rotation, called the cam angle, is one variable that determines the

displacement of the pump or the amount of fluid pumped per shaft revolution. Variable displacement units have the ability to vary the cam angle during operation whereas fixed displacement units do not.

As the cylinder block rotates, the exposed ends of the pistons are constrained to follow the surface of the cam plane. Since the cam plane is at an angle to the axis of rotation, the pistons must reciprocate axially as they precess about the cylinder block axis. The axial motion of the pistons is sinusoidal. During the rising portion of the piston's reciprocation cycle, the piston moves toward the valve plate. Also, during this time, the fluid trapped between the buried end of the piston and the valve plate is vented to the pump's discharge port through one of the valve plate's semi-circular ports - the discharge port. As the piston moves toward the valve plate, fluid is pushed or displaced through the discharge port of the valve plate.

When the piston is at the top of the reciprocation cycle (commonly referred to as top-dead-center or just TDC), the connection between the trapped fluid chamber and the pump's discharge port is closed. Shortly thereafter, that same chamber becomes open to the pump's inlet port. As the piston continues to precess about the cylinder block axis, it moves away from the valve plate thereby increasing the volume of the trapped chamber. As this occurs, fluid enters the chamber from the pump's inlet to fill the void. This process continues until the piston reaches the bottom of the reciprocation cycle commonly referred to as bottom-dead-center or BDC. At BDC, the connection between the pumping chamber and inlet port is closed. Shortly thereafter, the chamber becomes open to the discharge port again and the pumping cycle starts over.

In a variable displacement unit, if the vector normal to the cam plane (swash plate) is set parallel to the axis of rotation, there is no movement of the pistons in their cylinders. Thus there is no output. Movement of the swash plate controls pump output from zero to maximum.

A swash plate is a device used in mechanical engineering to translate the motion of a rotating shaft into reciprocating motion, or to translate a reciprocating motion into a rotating one to replace the crankshaft in pump designs. A swash plate consists of a disk attached to a shaft. If the disk were aligned perpendicular to the shaft, then rotating the shaft would merely turn the disk with no reciprocating (or swash plate) effect. But instead the disk is mounted at an oblique angle, which causes its edge to appear to describe a path that oscillates along the shaft's length as observed from a non-rotating point of view away from the shaft. The greater the disk's angle to the shaft, the more pronounced is this apparent linear motion. The apparent linear motion can be turned into an actual linear motion by means of a follower that does not turn with the swash plate but presses against one of the disk's two surfaces near its circumference. The device has many similarities to the cam. The picture of the pump can be seen below.



**Fig. 3.1.1: Swash Plate Type 3 Plunger Pump**

The pump is coupled with a 240V 50 Hz AC motor with a power of 1 hp. An electric motor is an electric machine that converts electrical energy into Mechanical energy. Most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as from the power grid, inverters or generators.

### 3.2 Trolley

The trolley used in this project is an L-shaped box-moving handcart with handles at one end, wheels at the base, with a small ledge to set objects on, flat against the floor when the hand-truck is upright. The objects to be moved are allowed to rest on the ledge. Then the truck and object are tilted backward until the weight is balanced over the large wheels, making otherwise bulky and heavy objects easier to move. The whole assembly of portable car wash is mounted on the trolley. The trolley consists of a main frame and an extension to it. The pump will be mounted on the front extension and the tank will be placed on the main frame. The Model of the trolley is shown in the figure;



**Fig. 3.2.1: Trolley**

The width of the trolley is 370 mm and the length of the trolley is 370 mm and the height of the trolley is 60 mm. The trolley frames is made using angle channels and its material is Mild Steel. The main frame is made using the angle of outer sides 50 mm and thickness 7 mm. The extended frame is made up of angle channels of sides 40 mm each and the thickness 5 mm. The two pillars of height 320 mm are welded at the front of main frame to which the pump will be clamped. Another two pillars of height 690 mm are welded to which a handle is fixed which will be used to move the trolley.

### 3.3 Water Tank

A water tank is a container for storing water. Water tank parameters include the general design of the tank, and choice of construction materials. By design a water tank or container should do no harm to the water.

A water tank of capacity 35 liters is used to store the water. This water will be used by the pump to spray it via nozzle. An outlet hole is drilled to the tank to which a tank nipple is placed. The picture of the tank is shown in the figure below;



**Fig. 3.3.1: Tank**

The pipe is connected to the tank nipple which then again forms the inlet to the pump. The tank is made up of plastic material. Its thickness is 3 mm. When fully filled to 35 liters, its weight that acts on the trolley is around 35 kg.

### **3.4 Hose**

A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of a hose is usually cylindrical.

Hose design is based on a combination of application and performance. Common factors are Size, Pressure Rating, Weight, Length, Straight hose or Coil hose and Chemical Compatibility.

To take the water from the pump to the area of application a hose is required. The hose should sustain the pressure produced inside it by the action of pump and the nozzle. The hose used is of 5 mm diameter and its length is 3.5 m. It is connected to the outlet of the tank and its other end to the trigger gun.

### **3.5 Trigger Gun**

In most pressure cleaning equipment, the pump motor is turned on and off at the machine. The operator, however, may be cleaning as far as 100 feet away. When he wants to stop spraying water he needs a way to stop water flow without walking back to the machine. The trigger gun and pressure switch/unloader valve provide that kind of control literally at the operator's fingertips. The trigger gun used is shown in the picture on the next page.



**Fig. 3.5.1: Trigger Gun**

A trigger spray gun is nothing more than a valve that closes when the trigger is released [6]. Trigger guns are fairly simple mechanisms designed around a trigger-operated switch. It prevents the gun from getting out of control and causing damage or injury. It also saves water and fuel by switching off the motor once trigger is released.

The trigger gun is connected between the hose and the nozzle. Its main function is to start or stop the flow. The hose is connected to the trigger gun, from which the water is passed to the nozzle. The trigger gun is manufacture by BOSCH. It is able to sustain the maximum pressure upto 130 bar. When the trigger switch is pressed the water is pumped out and sprayed through nozzle. When the trigger is released the flow is stopped. This develops back pressure in the pump. Due to this a back pressure switch is provided in the pump which stops the motor when the pressure is built up in the pump.

### 3.6 Nozzle

A nozzle is a device designed to control the direction or characteristics of a fluid flow as it exits (or enters) an enclosed chamber or pipe.

A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas) [7]. Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them.

#### Types

- Jet
- Propelling
- Magnetic
- Spray
- Vacuum
- Shaping

#### 3.6.1 Adjustable Nozzle

Adjustable nozzles are basically a type of jet nozzle which allows variable pressure or variable spray pattern adjusted at the nozzle. Instead of several standard nozzles on a rotating mount, the true adjustable nozzle is designed with moving parts, which allow orifice restriction or enlargement to change output pressure or variable spray deflection to change the nozzle spray pattern.



**Fig. 3.6.1: Adjustable nozzle**

Some adjustable nozzles are designed for both adjustable pressure and spray pattern. Since these nozzles have moving parts, they are more expensive and more subject to wear than standard nozzles. Adjustable nozzles are usually supplied with equipment producing volumes and pressures in the lower ranges. For example, many hobby and small cold-water machines come with an adjustable nozzle to allow for low-pressure chemical injection. The diameter of the nozzle used is 1 mm and the angle is 1°.

### 3.6.2 Nozzle performance factors

- Liquid properties

Almost all drop size data supplied by nozzle manufacturers are based on spraying water under laboratory conditions, 70 °F (21 °C). The effect of liquid properties should be understood and accounted for when selecting a nozzle for a process that is drop size sensitive.

- Temperature

Liquid temperature changes do not directly affect nozzle performance, but can affect viscosity, surface tension, and specific gravity, which can then influence spray nozzle performance.

- Specific gravity

Specific gravity is the ratio of the mass of a given volume of liquid to the mass of the same volume of water. In spraying, the main effect of the specific gravity  $S_g$  of a liquid other than water is on the capacity of the spray nozzle. All vendor-supplied performance data for nozzles are based on spraying water. To determine the volumetric flow rate  $Q$ , of a liquid other than water the following equation should be used.

$$Q_f = Q_{water} \sqrt{\frac{1}{S_g}} \quad \cdot \quad \text{Viscosity} \quad \dots \text{Eq 3.6.2.1}$$

Dynamic viscosity is defined as the property of a liquid that resists change in the shape or arrangement of its elements during flow. Liquid viscosity primarily affects spray pattern formation and drop size. Liquids with a high viscosity require a higher minimum pressure to begin spray pattern formation and yield narrower spray angles compared to water.

- Surface tension

The surface tension of a liquid tends to assume the smallest possible size, acting as a membrane under tension. Any portion of the liquid surface exerts a tension upon adjacent portions or upon other objects that it contacts. This force is in the plane of the surface, and its amount per unit of length is surface tension. The value for water is about 0.073 N/m at 21 °C. The main effects of surface tension are on minimum operating pressure, spray angle, and drop size. Surface tension is more apparent at low operating pressures. A higher surface tension reduces the spray angle, particularly on hollow cone nozzles. Low surface tensions can allow nozzles to be operated at lower pressures.

- Nozzle wear

Nozzle wear is indicated by an increase in nozzle capacity and by a change in the spray pattern, in which the distribution (uniformity of spray pattern) deteriorates and increases drop size. Choice of a wear resistant material of construction increases nozzle life. Because many single fluid nozzles are used to meter flows, worn nozzles result in excessive liquid usage.

- Material of construction

The material of construction is selected based on the fluid properties of the liquid that is to be sprayed and the environment surrounding the nozzle. Spray nozzles are most commonly fabricated from metals, such as brass, Stainless steel, and nickel alloys, but plastics such as PTFE and PVC and ceramics (alumina and silicon carbide) are also used. Several factors must be considered, including erosive wear, chemical attack, and the effects of high temperature.

- Orifice diameter

Orifice diameter (the diameter of the hole in the discharge side of the nozzle) determines the pressure produced at a particular flow. A smaller orifice will produce a higher pressure or psi figure at a specific flow or gpm than a larger orifice. Pressure represents the amount of force needed to move water through the nozzle orifice

- Distance From The Surface Being Cleaned

How far the spray nozzle is from the surface being cleaned makes a major difference in water impact. The greater this distance, the less impact water will have. However, the greater distance increases the amount of area covered by the spray. The operator can easily adjust the spraying distance to suit different types of cleaning applications and perform his job most efficiently.

When water is sprayed into the atmosphere from the nozzle it immediately begins losing speed, and consequently force, due to air friction and other factors. Holding the spray nozzle very close to the surface will give more impact on hard-to-clean areas.

Holding the spray nozzle four or five inches away will be adequate for most moderate soils. The larger the equipment's output, the greater the distance the water spray is capable of traveling while still retaining adequate cleaning ability.

- Theoretical Spread and Spray Angle Coverage

Although nozzle spray patterns are expressed in degrees of spread, these figures are not precisely accurate as the distance between the cleaning surface and the nozzle increases, which is why the terms theoretical spread or theoretical coverage are used. Theoretical spray angles indicate approximate spray coverage's based on water velocity. In actual use the spray angle varies with distance.

- Nozzle Protectors

Most nozzle wear is due to external abuse. Concrete is probably the great nozzle killer. Equipment operators will bang the nozzle against the concrete, drag it across concrete or even use the lance and gun nozzle down as a crutch or cane. It's very easy for the operator to develop a habit of leaning on the gun and lance when taking a break. Not only will this wear down the nozzle, resulting in spray pattern deterioration, the nozzle can easily become clogged. Nozzle protectors are available. Usually made of rubber, these devices should extend past the nozzle a little and can prolong nozzle life. The protectors, however, will have to be replaced on a regular basis.

#### IV. CALCULATIONS

##### 4.1 Hydraulic Power

$$\text{Power} = \frac{Q \times p}{1715} \quad \dots \text{Eq 4.1.1}$$

Where Q= Flow rate in Gallons per minute

P= Pressure of water in psi

Now, 1 Gallon per minute = 3.78 Liters per minute

$$1 \text{ psi} = 0.0689 \text{ bar}$$

The flow rate of the pump is 4.5 lpm and power is 1 hp.

$$1 = \frac{1.18877 \times P}{1715}$$

$$P = 1442.66 \text{ psi} \\ = 99.399 \text{ bar}$$

The maximum pressure developed by the pump is approximately 100 bar.

##### 4.2 Velocity of the jet

$$Q = A \times V \quad \dots \text{Eq 4.2.1}$$

Where Q = discharge in m<sup>3</sup>/sec

A = Area of the nozzle exit in m<sup>2</sup>

V = Velocity of jet in m/sec

$$\text{Now, } A = \frac{\pi d^2}{4}$$

Where d = diameter of nozzle = 1 mm.

$$A = 7.88 \times 10^{-7} \text{ m}^2$$

Discharge of the pump is 4.5 lpm i. e.  $7.5 \times 10^{-5} \text{ m}^3/\text{sec}$

Now,  $V = Q/A$

$$= 7.5 \times 10^{-5} / 7.854 \times 10^{-7}$$

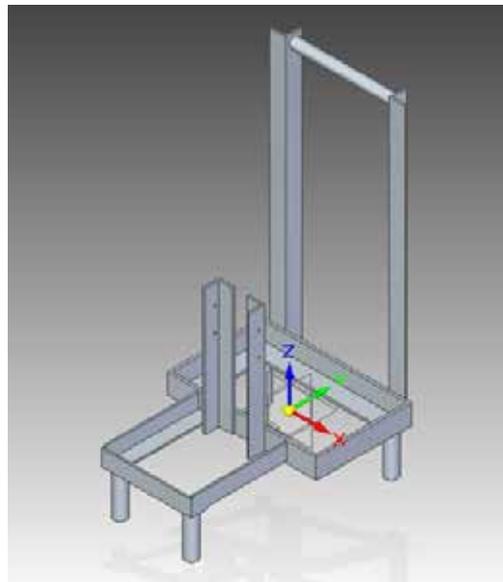
$$V = 95.49 \text{ m/sec}$$

## V. MODELLING AND ANALYSIS OF TROLLEY

### 5.1 Modeling of Trolley

Major platform on which the components will be mounted is a trolley. To check whether it is safe to handle the weights of the pump and the tank we are modeling the trolley using software available for modeling and then the trolley is analyzed for load conditions.

The modeling is carried out using SOLID EDGE ST5 from the 2D drawings, and the models are further imported for meshing of the models. The SOLID EDGE was used as the modeling software and from the 2D drawings of the trolley, the 3D model was generated. The models are shown below in the figure 5.1.1



**Fig. 5.1.1: Trolley 3D Model.**

The trolley comprises mainly:

- Main frame
- Extension for mounting of pump
- Angle pillars to clamp the pump

### 5.2 Finite Element Analysis

In the field of Engineering Design we come across many complex problems, the Mathematical formulation of which is tedious and usually not possible by analytical methods. At such instants we resort to the use of numerical techniques. Here lies the importance of FEA, which is a very powerful tool for getting the numerical solution of a wide range of engineering problems. The basic concept is that a body or structure may be divided into smaller elements of finite dimensions called as "Finite Elements". The original body or structure is then

considered as an assemblage of these elements connected at a finite number of joints called as “Nodes” or “Nodal Points”. The properties of the elements are formulated and combined to obtain the properties of the entire body.

The equations of equilibrium for the entire structure or body are then obtained by combining the equilibrium equations of each element such that the continuity is ensured at each node. The necessary boundary conditions are then imposed and the equations of equilibrium are solved to obtain the required variables such as stress, strain, temperature distribution or Velocity flow depending on the application.

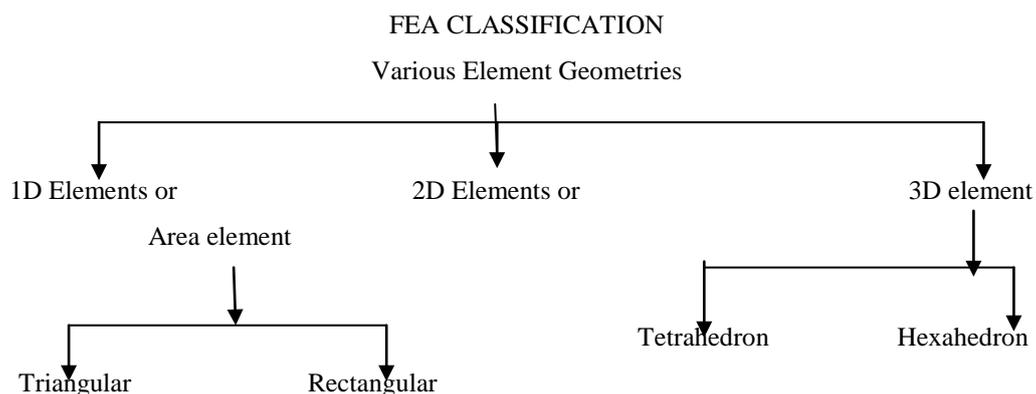
Thus instead of solving the problem for the entire structure or body in one operation, in the method the attention is mainly devoted to the formulation of properties of the constituent elements. A common procedure is adopted for combining the elements, solution of equations and evaluation of the required variables in all fields. Thus the modular structure of the method is well exploited in various disciplines of engineering.

### 5.3 Stepwise Approach for FEA and Underlying Principle

The most fundamental underlying concept of finite element analysis is the piecewise approximation of solution of a known geometry for which the characteristics are well established. Thus, the first requirement of FEA approach is discretization of the physical domain for which appropriate type of element is required to be selected.

#### 5.3.1 Domain discretization for a field Problem

This is also referred to as finite mesh generation step. Here the domain of problem addressed is divided into a number of geometrically simple sub domains termed as finite elements with certain nodal points being associated with each element. In the process, data concerning nodal coordinates, node numbers, element numbers and connectivity is generated. Following figure provides examples of elements employed in one, two and three dimensions.



#### 5.3.2 Discretization of Problem

Element equation: the next step is to develop equations to approximate the solution for each element. This involves two steps.

First, we choose an appropriate function with unknown coefficients that will be used to approximate the solution.

Second is evaluating the coefficients so that the function approximates the solution in an optimal fashion.

### **5.3.3 Optimal Fit**

The element equation is an approximate solution. In this step the attempt to minimize the error of fitting the solution over the element domain is made using celebrated methods like direct approach method, the method of weighted residuals, and the variational approach.

### **5.3.4 Assembly to obtain global system of equation from element equations**

After the individual element equations are derived, they must be linked together or assembled to characterize the unified behavior of the entire system. The assembly process is governed by the concept of continuity. That is, the solutions for contiguous elements are matched so that the unknown values at their common nodes are equivalent. Thus, the total solution will be continuous.

### **5.3.5 Boundary Conditions**

The nodes on the boundary of domain subjected to known conditions are considered to take effect in assembled set of equations.

### **5.3.6 Solution**

Now the number of unknowns in the equations' set is equal to number of equations, which could be solved using Gaussian elimination equation or other suitable algorithms.

### **5.3.7 Post Processing**

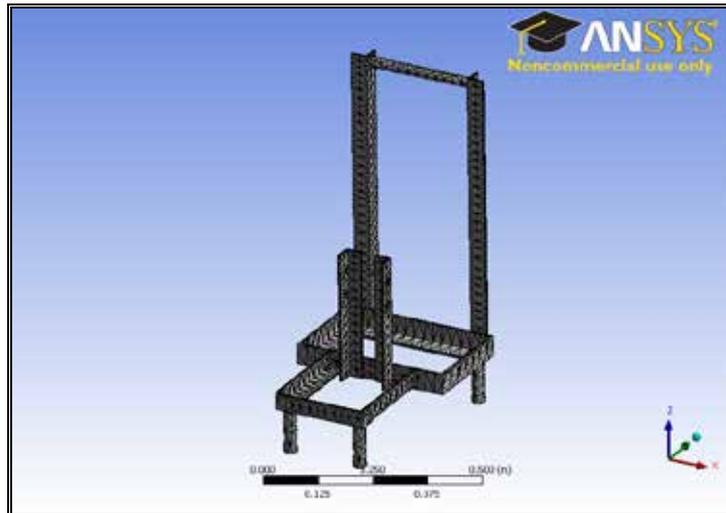
Upon obtaining a solution it can be output in tabular form or displayed graphically.

## **5.4 Analysis**

The model is analyzed using the software ANSYS 14.0.

### **5.4.1 Meshing**

The meshing of the model is done using ANSYS 14.0 Workbench. The meshed model is further used for various analysis. The meshed model is shown in the figure below;



**Fig. 5.4.1: Meshed Model of Trolley.**

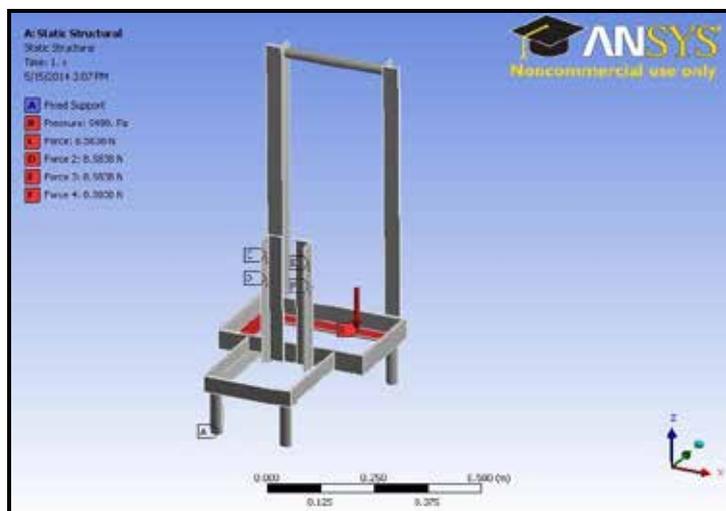
The table 5.4.1 shows the mesh information of the trolley

No. of Elements	6463
No. of nodes	14639

**Table 5.4.1: Mesh information of Trolley**

### 5.5 Static Structural Analysis of Trolley

The static structural analysis is carried out for static loadings on the trolley.



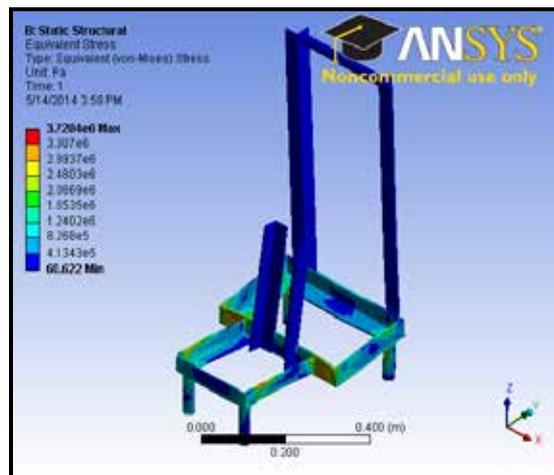
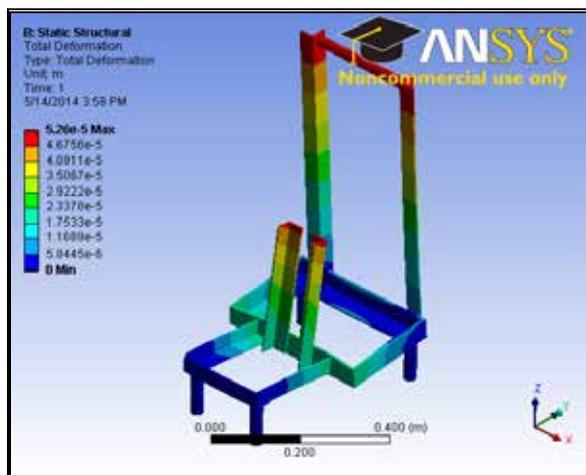
**Fig. 5.5.1: Load distribution on trolley**

The above figure 5.5.1 shows the constraints and load distribution which is due to the tank load acting on the main frame of the trolley and the pump load acts on the pillars provided to clamp the pump. The load of the tank which is 343.35 N is converted into pressure of 9480 Pa and applied to the main frame on which the tank sits. The load of the pump which is 34.335 N is divided into four equal parts and it is distributed on the four holes in the downward direction perpendicular to the hole axis. The table 5.5.1 shows the load distribution on Trolley;

Sr. No.	Boundary Condition	Value	Application area
---------	--------------------	-------	------------------

A	Fixed Support	————	Legs
B	Pressure	9480 Pa	Base of Main Frame
C	Force	8.5838 N	Clamping Hole
D	Force	8.5838 N	Clamping Hole
E	Force	8.5838 N	Clamping Hole
F	Force	8.5838 N	Clamping Hole

**Table 5.5.1: Load distribution on Trolley**



**Fig. 5.5.2 Displacement Plot of trolley Fig. 5.5.3: Equivalent (Von-Mises) Stress Plot of Trolley.**

Particulars	Value
Von-Mises Stress	3.7204 Mpa
Total Maximum Deformation	0.0526 mm

**Table 5.5.2: von-Mises Stress and Deformation**

The value of yield stress for mild steel is 250 Mpa. Hence Factor of Safety is given by:

$$\text{Factor of Safety} = \frac{\text{Yield Stress}}{\text{Maximum Stress}} = \frac{250}{3.72} = 67.204$$

The maximum deformation value is (Fig. 5.5.2) of around 0.0526 mm with loads exerted on the trolley which is acceptable level of deformation considering the dimensions of trolley. The maximum stress is 3.72 Mpa which is very less as compared to the yield strength of the material (250 Mpa) which gives the factor of safety as 67.204. Hence the Trolley is safe in working condition. The further optimization can be carried out with respect to weight distribution & dimensions. But we have not done it due to less availability of time.

## VI. RISKS INVOLVED & SAFETY PRECAUTIONS

### 6.1 Risks Involved

The strong spray from a pressure washer can cause serious wounds that might first appear minor. Wounds that appear minor can cause a person to delay treatment, increasing risk for infection, disability or amputation. The fast, strong spray can throw objects that strike and injure others who are close by. Electric shock can occur if the pressure washer is not used properly and if safety instructions are not followed. Using small, gasoline powered engines to drive pump can cause carbon monoxide poisoning. Workers should not use any washers powered by gasoline engines inside buildings or other partially enclosed spaces unless the gasoline engine can be placed outdoors and away from air intakes [9].

## **6.2 Safety Precautions**

- Never point a pressure washer at yourself or others [11].
- Never attempt to push or move objects with spray from the washer.
- Never use a gasoline powered washer in an enclosed space.
- If an extension cord must be used, keep the pressure washer's power cord connection out of any standing water, and use a heavy duty extension cord with components rated for use in wet locations.
- Keep both the power cord and extension cord connections as far away as possible from the item being washed and away from any water runoff.
- Wear rubber soled shoes that provide some insulation when using the pressure washer.
- Never cut or splice the pressure washer's power cord or extension cords.
- Always have a qualified electrician check the pressure washer for electrical problems after it has tripped a circuit breaker.
- Never allow children to operate a pressure washer. Keep children at a safe distance when using a pressure washer.
- **If you are hurt by a pressure washer:**
  - Call 108 if emergency help is needed.
  - Before treating the wound, wash your hands with soap and clean water.
  - Remove any object that is in the way of caring for the wound.
  - Put pressure on the wound with a clean cloth to stop bleeding.
  - After bleeding has stopped, pour bottled or clean running water over the wound.
  - Gently clean around the wound with soap and clean water.
  - Pat dry and use an adhesive bandage or dry clean cloth to cover the wound.

## **VII. CONCLUSION & FUTURE WORK**

### **7.1 Conclusion**

The portable car wash is fabricated for its use in washing the vehicles of our institute. It can be concluded that the results were satisfied for the stable working of the machine and is as follows:

- The pressure developed by the machine is 100 bar and it is suitable enough to clean the vehicle by removing the grease and other dirt as can be seen during demo run.

- The model is working successfully and vehicle was washed satisfactorily during the demo run of the machine.
- The Pump runs continuously for 30 minutes. When the pump heats up it switches off automatically and it is allowed to be cooled for 15 minutes before it can be started again.
- The pump flow turns off when the trigger switch is released due to the presence of pressure switch inside the pump. This saves water and the pump need not be turned off by switching off the main switch while applying soap.
- From the analysis of trolley, the whole structure of the trolley is balanced and it can sustain the load from the tank and motor. Hence the trolley is safe to mount the pump-motor unit.

## **7.2 Future Work**

As with most technologies there is endless advancements waiting to be discovered and the well established car wash is no different. From humble beginnings in the early 20<sup>th</sup> century the car wash as evolved beyond anyone's expectations. It has become almost amazing what technologies have been introduced to transform a simple car wash into the futuristic structures we see today. Here are the big technologies for the future:

- Steam Car wash

Steam washing is a new addition to how cars can be washed; using a steam jet it is safe on both the car exterior and interior. The majority of car washes will use 113 liters of water per car or 378 liters if washing at home. However a steam wash will only use around 4 liters of water (and doesn't give off waste water) per car making it cost and eco friendly.

- Self Serve Car Washes

Car washing has evolved from automatic tunnels to top of the range self serve facilities, especially in Australia. If you want a professional finish but want to wash your vehicle yourself there are a number of self service car washes with top of the range products and equipment. Many self serve car washes will have coin operated equipment and many in the future will have electronic pay facilities.

- Mobile Car Washing

In recent times many people have commitments that may restrict their spare time and activities such as car washing. There are many dedicated mobile car washing companies in Australia that will come to your home or office to wash or detail your car. This comes as convenience is a crucial part of living in the 21<sup>st</sup> century. Mobile car washing saves time driving to (and through) a car wash.

- Trolley Weight Optimization

The weight of the trolley can be optimized by a new design where in the holes can be drilled into the angles to reduce the weight and thereby making the trolley lighter.

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