Certification Course on Industrial Safety & Management

Resource Person Dr. P Sreenivas

Co-ordinator: Sri S. Vijaya Kumar

Date(s) of Event: 24/05/2021-15/06/2021

Organizing department: Mechanical Engineering

K.S.R.M.COLLEGEOFENGINEERING

(UGC-AUTONOMOUS)

Kadapa,Andhra Pradesh,India–516 005

ApprovedbyAICTE,NewDelhi&AffiliatedtoJNTUA,Ananthapuramu.

Cr./KSRMCE/(Department of ME)/2020-2021

Date: 17/05/2021

To

The Principal,

KSRM College of Engineering,

Kadapa.

Respected Sir

Sub: KSRMCE-(Department of ME) permission to conduct certification course on "**Industrial Safety & Management**"-Request-Reg.

It is brought to your kind notice that, with reference to the cited, the ME department is planning to conduct Certification Course on "**Industrial Safety & Management**" for B.Tech, VI Sem Students from **24 May, 2021 to 15 June ,2021**. In this regard I kindly request you to grant permission to conduct the certification course. This is submitted for your kind perusal.

Thanking you sir,

Forwarded to Principal Sir

Yours Faithfully

S. Vijaya Kumar

Asst.Prof,Dept.ME

KSRMCE,Kadapa.

To the Director for Information

To All Deans/HoD's/IQAC

Permitted

V. S. S. Murty

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Cr./KSRMCE/(Department of ME)/2020-2021

Date: 17/05/2021

Circular

All the B.Tech VI Sem ME students are here by informed that department of **MECHANICAL ENGINEERING** is going to conduct certificate course on **Industrial Safety & Management**" interested students may register their names on or before 22-05-2021, 5 PM

For any queries contact faculty coordinator:

Sri S.Vijaya Kumar,Asst.Prof,Dept.ME, KSRMCE, Kadapa.

Hod

Professor & Head
Department of Mechnical Engineering
K.S.R.M. College of Engineering
KADAPA - 516 003.

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Department of Mechanical Engineering

Certification Course on **Industrial Safety & Management**

List of Participants

S.no	Roll No	Name of the Student	Email Id's
1	189Y1A0333	MUTUKUNDU SOMA SEKHAR REDDY	189Y1A0333@ksrmce.ac.in
2	189Y1A0334	NAGURU SAMPATH KUMAR	189Y1A0334@ksrmce.ac.in
3	189Y1A0335	NERSUPALLI SAI KUMAR REDDY	189Y1A0335@ksrmce.ac.in
4	189Y1A0336	NETURI SANDEEP KUMAR REDDY	189Y1A0336@ksrmce.ac.in
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17	189Y1A0349	PRODDUTURU NAGA DASTAGIRI	189Y1A0349@ksrmce.ac.in
18	189Y1A0350	PULLAGURA SUNIL	189Y1A0350@ksrmce.ac.in
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21	189Y1A0353	SARVADE YATHEESH RAO	189Y1A0353@ksrmce.ac.in

22	189Y1A0354	SHAIK ASIF	189Y1A0354@ksrmce.ac.in
23	189Y1A0355	SHAIK FAIZAAN HABEEB	189Y1A0355@ksrmce.ac.in
24	189Y1A0356	SHAIK GOUSE LAZAM	189Y1A0356@ksrmce.ac.in
25	189Y1A0357	SHAIK IMDAD VALLI	189Y1A0357@ksrmce.ac.in
26	189Y1A0358	SHAIK MAHAMMAD SHARIEF	189Y1A0358@ksrmce.ac.in
27	189Y1A0359	SHAIK MOHAMMAD TAYEEB	189Y1A0359@ksrmce.ac.in
28	189Y1A0360	SHAIK SHAJAHAN	189Y1A0360@ksrmce.ac.in
29	189Y1A0361	SHAIK VAYALPAD ABDUL KHAVI	189Y1A0361@ksrmce.ac.in
30	199Y5A0317	KONETI VENKATA SIVA MANORANJAN	199Y5A0317@ksrmce.ac.in
31	199Y5A0318	KOTHAPALLI PRUDHVI	199Y5A0318@ksrmce.ac.in
32	199Y5A0319	KURUVA BHASKAR	199Y5A0319@ksrmce.ac.in
33	199Y5A0320	KURUVA KUMAR	199Y5A0320@ksrmce.ac.in
34	199Y5A0321	MADDURU SAITEJA	199Y5A0321@ksrmce.ac.in
35	199Y5A0322	MAJJARI CHARAN	199Y5A0322@ksrmce.ac.in
36	199Y5A0324	MALISETTY LAKSHMINARASIMHA	199Y5A0324@ksrmce.ac.in
37	199Y5A0325	MALLELA RAJASHEKHAR REDDY	199Y5A0325@ksrmce.ac.in
38	199Y5A0326	MITAIABDULSHEIK MOHAMMED BASHA	199Y5A0326@ksrmce.ac.in
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		RAJU	
53	199Y5A0341	VENNAPUSA SREEKANTH REDDY	199Y5A0341@ksrmce.ac.in
54	199Y5A0342	VENNAPUSA UMESHCHANDRA REDDY	199Y5A0342@ksrmce.ac.in
55	199Y5A0343	YADAVAKUNTA SIVA RAMI REDDY	199Y5A0343@ksrmce.ac.in
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58	199Y5A0346	YERRAGORLA BRAMHAIAH	199Y5A0346@ksrmce.ac.in

Coordinator

HOD

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INDUSTRIAL SAFETY & MANAGEMENT

AIM: To Impart Knowledge on Industrial safety

Course Objectives:

1. To understand need for safety, safety lustration, safety policy.
2. To understand hazard identification such as Mechanical, Electrical, Chemical hazards and safety in material handling.
3. To understand the safety in hazards machines such as Welding, Hot working, cold working.
4. To understand the importance of training, conferences, method of promoting safe practices.

Unit I

Introduction to Industrial Safety need for safety
Safety legislation: Act and Rules, Safety standards and codes
Safety Policy – Safety Organisation, Responsibilities and Authority of different Levels

Unit –II

Hazard Identification
Identification of hazard, Methods for eliminating of Hazards
Mechanical Hazards
Machine Guarding, Safety with hand tools / Portable power tools
Pressure vessel Hazards and their control
Electrical Hazards classification, safe work practices
Chemical hazards laboratory safety , Bulk handling of chemical

UNIT – III

Safety in material in handling
General safety, Consideration in material handling, ropes, chains ,hoops , clamps, prime movers.
Selection operation and maintenance of industrial truck , mobile cranes , tower crane , check list, competent persons .

UNIT – IV

Safety in engineering industry
Introduction, safety in operation of hazards machines, safety in welding in gas cutting , safety in cold forming , and hot working of metals , work permits for hard work , and cold work , safety of pressure vessels.

UNIT –V

Safety education and training

Importance of training, identification of training needs , training methods programme , seminars conference,
Competitions methods of prompting safe practise, motivation communication, role of govt agencies and private consulting agencies in safety.

OUTCOMES :

Asses the need for safety, acts, safety policy, safety standards.
Understand the methods of hazard identification.
Analyze the use of material handling.
Understand the techniques of safety in various manufacturing methods.
Understand the importance of training, need, roll of government agencies in industries safety.

TEXT BOOK:

1. Heinrich H.W. Industrial Accident Prevention
   McGraw Hill Company New York 1980
2. Rudenko N Material handling Equipment Mir Publishers Moscow,1981
3. Krishnan. N. V safety management in Industry Jaico Publishing house Bombay 1997

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Kadapa,Andhra Pradesh,India–516 005

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Department of Mechanical Engineering

Certification Course on Industrial Safety & Management

Schedule

Timing: 4:00pm – 6:00pm

S.No	Date	Course Coordinator	Topic Covered
1	24-05-2021	Dr P. Sreenivas	To understand need for safety, safety lustration, safety policy.
2	25-05-2021	Dr P. Sreenivas	Safety legislation: Act and Rules, Safety standards and codes
3	28-05-2021	Sri S. Vijaya Kumar	Identification of hazard, Methods for eliminating of Hazards
4	30-05-2021	Dr P. Sreenivas	Machine Guarding, Safety with hand tools / Portable power tools.
5	01-06-2021	Dr P. Sreenivas	Electrical Hazards classification, Chemical hazards: laboratory safety,
6	03-06-2021	Dr P. Sreenivas	bulk handling of chemicals
7	05-06-2021	Sri S. Vijaya Kumar	General safety: consideration in material handling - Ropes, Chains
8	07-06-2021	Dr P. Sreenivas	Sling, Hoops, Clamps, Arresting gears –Prime movers. Tower crane –Checklist -Competent persons.
9	09-06-2021	Dr P. Sreenivas	Introduction – Safety in Operations of Hazardous Machines – Safety in welding and gas cutting
10	10-06-2021	Dr P. Sreenivas	Safety in cold forming and hot working of metals – Work Permits for hot Work and Cold Work – Safety of Pressure vessels.
11	11-06-2021	Sri S. Vijaya Kumar	Importance of training-identification of training needs-training methods
12	12-06-2021	Dr P. Sreenivas	programme, seminars, conferences, competitions
13	13-06-2021	Sri S. Vijaya Kumar	method of promoting safe practice -motivation
14	14-06-2021	Dr P. Sreenivas	Communication -role of government agencies and private consulting agencies in safety.
15	15-06-2021	Sri S. Vijaya Kumar	Communication -role of government agencies and private consulting agencies in safety.

Coordinator

HoD

Professor & Head
Department of Mechnical Engineering
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(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India–516 005
Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu

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Department of Mechanical Engineering

Activity Report

Name of the Event	: Certification Course on **Industrial Safety & Management**
Duration of the Event	: 24-05-2021 to 15-06-2021
Scheduled Time	: 4.00 to 6.00PM
Target Audience	: B.Tech VI Sem Students
Course Coordinator	: S. Vijaya Kumar

Activity Description:

Industrial Safety & Management is one of the Advance Subject for Mechanical students to learn about safety Procedure that are to implemented in industry. Department of ME organized a Certificate Course on "Industrial Safety & Management". Head of the Department, faculty & participants of the Course inaugurated with all good spirit. Resource persons began the first day first session Introduction to Industrial Safety & Management.
Safety legislation: Act and Rules, Safety standards and codes and final the course is concluded Communication roll of government agencies in industries safety. finally valedictory. Students were issued participation certificates by the Head of the Department.

Coordinator

HOD

Principal

V. S. S. murty

PRINCIPAL
K.S.R.M. COLLEGE OF ENGINEERING
KADAPA - 516 003. (A.P.)

Professor & Head
Department of Mechnical Engineering
K.S.R.M. College of Engineering
KADAPA - 516 003.

K.S.R.M. COLLEGE OF ENGINEERING

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Kadapa, Andhra Pradesh, India– 516 003

Certificate Course on

Industrial Safety & Management

24/05/2021 to 15/06/2021

Organized by

DEPARTMENT
OF
MECHANICAL ENGINEERING

K.S.R.M.COLLEGEOF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India–516 005

Approved by AICTE, NewDelhi & Affiliated to JNTUA, Ananthapuramu.

Department of Mechanical Engineering

Certification Course on Industrial Safety & Management

Attendance Sheet

S. No	Name of the Student	Roll List	24/05	25/05	26/05	27/05	28/05	29/05	31/05	02/06	04/06	07/06	09/06	10/06	12/06	14/06	15/06
1	MUTUKUNDU SOMA SEKHAR REDDY	189Y1A0333	✓	✓	✓	✓	✓	A	✓	✓	✓	A	✓	A	✓	A	✓
2	NAGURU SAMPATH KUMAR	189Y1A0334	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓
3	NERSUPALLI SAI KUMAR REDDY	189Y1A0335	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	NETURI SANDEEP KUMAR REDDY	189Y1A0336	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	NUKANABOINA PULLAIAH	189Y1A0337	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	PALTHURU·BOJJAPPA	189Y1A0338	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓
7	PANDITI ANIL KUMAR	189Y1A0339	✓	✓	✓	✓	A	✓	A	A	✓	✓	✓	✓	✓	A	A
8	PASUPURATHI RAJASEKHAR REDDY	189Y1A0340	✓	A	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	A	✓	✓
9	PATAN ASHRAF ALI KHAN	189Y1A0341	✓	A	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓
10	PATAN SAMEER KHAN	189Y1A0342	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	PATHAN ARBAAZ KHAN	189Y1A0343	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	PATHAN NADEEM KHAN	189Y1A0344	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13	PEDDANAGGARI SIVAGIRINATH REDDY	189Y1A0345	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	PERAM VARUN KUMAR REDDY	189Y1A0346	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	POOJARI RAJKUMAR	189Y1A0347	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	POTHUTEJESWARREDDY	189Y1A0348	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	PRODDUTURU NAGA DASTAGIRI	189Y1A0349	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	PULLAGURA SUNIL	189Y1A0350	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	A	✓

19	RACHAMREDDY CHARAN KUMAR REDDY	189Y1A0351																
20	SANKEPALLI SUNIL REDDY	189Y1A0352																
21	SARVADE YATHEESH RAO	189Y1A0353																
22	SHAIK ASIF	189Y1A0354																
23	SHAIK FAIZAAN HABEEB	189Y1A0355																
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25	SHAIK IMDAD VALLI	189Y1A0357																
26	SHAIK MAHAMMAD SHARIEF	189Y1A0358																
27	SHAIK MOHAMMAD TAYEEB	189Y1A0359																
28	SHAIK SHAJAHAN	189Y1A0360																
29	SHAIK VAYALPAD ABDUL KHAVI	189Y1A0361																
30	KONETI VENKATA SIVA MANORANJAN	199Y5A0317																
31	KOTHAPALLI PRUDHVI	199Y5A0318																
32	KURUVA BHASKAR	199Y5A0319																
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38	MITAIABDULSHEIK MOHAMMED BASHA	199Y5A0326																
39	MOOLA ACHYUTH REDDY	199Y5A0327																
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42	NANDYALA SISINDRI	199Y5A0330																
43	PICHIPATI SHAIK MAHAMMAD AFRID	199Y5A0331																
44	PUTTA SASIKANTH REDDY	199Y5A0332																
45	RAJULA ANAND REDDY	199Y5A0333																
46	SANNA GURAPPA	199Y5A0334																
47	SHAIK GHOUSE LAZAM	199Y5A0335																
48	SHAIK IMRAN	199Y5A0336																
49	SHAIK MAHABOOB BASHA	199Y5A0337																

50	SHAIK SHEKSHAVALI	199Y5A0338	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	
51	URUMU SUDHEER KUMAR	199Y5A0339	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
52	VARIKUNTA MUNI DINESH PRAMOD RAJU	199Y5A0340	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	A	✓	✓	
53	VENNAPUSA SREEKANTH REDDY	199Y5A0341	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	
54	VENNAPUSA UMESHCHANDRA REDDY	199Y5A0342	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
55	YADAVAKUNTA SIVA RAMI REDDY	199Y5A0343	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	
56	YEDDULA GANGA PRASAD REDDY	199Y5A0344	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	
57	YEDDULA PRAVEEN KUMAR REDDY	199Y5A0345	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	
58	YERRAGORLA BRAMHAIAH	199Y5A0346	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Coordinator

HOD

Professor & Head
Department of Mechnical Engineering
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Part
Safety by Design

Introduction

1 Study Background

Construction industry is one of the most hazardous industries all over the world. The overall days lost by injuries and illness of construction were higher than any other industry sector. About 3% of construction workers in Great Britain suffered from work-related illness which leads to 1.2 million days lost (OSH 2004). Annually around 69,000 workers were suffering from illness in Great Britain. Mitigating the hazards is one of the challenging issues in construction projects. Identifying the root causes of hazards plays major role in many construction activities. Different companies from different industries put effort individually and jointly to improve safety in construction, but their results remain unchanged. Particularly, the construction industries in developing countries are found to be most dangerous on safety criteria. For past decades, the academics and professionals from different specialization worked jointly to address safety issues in construction. However, the results which they obtained were not sufficient to prevent hazards in construction. At present, the researchers have focused on the concept of preventing or minimizing the hazards in construction through design. Many researchers stated that addressing workers safety in the design phase of project will improve safety performance in construction. But in many countries, workers' safety is not a part in designer's role.

Design has the major impacts on construction safety (BLS; Driscoll et al. 2008; Kamardeen 2013; Behm 2005; Smallwood 2008) Australia National Coroner's Information System has drawn the conclusion that 37% of 210 identified workplace fatalities had design related issues (Driscoll et al. 2008). Nearly, 50% of construction workers in South Africa thought construction safety is impacted by design (Smallwood 2008). The analysis of data obtained from National Institute of Occupational Safety and Health (NIOSH) Fatality Assessment Control and Evaluation (FACE) program show that 42% of the 224 fatalities were related to design (Behm 2005). About 16.5% of construction accidents were design related incidents. The collected data from seven different countries were analyzed, and the result shows that 35% of construction accidents were related to design (Kamardeen 2013).

2 Health Hazards in Construction

Construction workers are exposed to a variety of health hazards every day. A hazard is a situation that can cause harm to people, environment, life, and property. In construction, health hazard is something that can cause harm to workers health. Hazardous activities which can cause harm to workers in construction include demolition works, excavation works, scaffolding and ladder works, construction machinery, and tool usage. The hazardous substances

associated with construction works are asbestos, lead, silica dust, gases, and fungi. Effect of this substances may result in acute injury, chronic illness and permanent disability or even death to workers. Exposure may differ from day to day, time to time, or even task to task. Chronic health effects develop slowly, whereas acute health effects can be seen quickly. For example, if the worker is affected by fungi during housekeeping, it may cause immediate itchiness and skin irritation. Extreme noise may lead to hear loss temporarily or permanently. In chronic health effect, if the worker breathes a small amount of silica dust, it will not affect the worker immediately but if the worker inhale silica dust regularly, then the worker is exposed to silicosis. The different source of health hazards at construction site includes chemical, physical, biological, and ergonomic hazards.

Chemical hazards are often airborne which can appear as gas, vapor, fume, dust, and mist. For example, pneumatic breakers, tunnel operators, drillers, and masons during breaking and crushing of stone/concrete/bricks get exposed to silica dust and suffer from silicosis. Welders and flame cutting operators during cutting and dismantling tanks get bronchitis. Building demolition works and steam pipe fitters get exposed to asbestos and suffer from asbestosis. Painters and others those who come in contact with solvents get neurological disorder. Workers who use materials which contain epoxy resins, acrylic resins, nickel, cobalt, timber will suffer from allergic dermatitis.

Physical hazards are due to exposes like extreme temperatures, noise, vibration, and radiation which cause different health hazards. Activities such as demolition, drilling, welding cause noise-induced hearing loss. Pneumatic breakers, disk grinders, hand tools cause vibration-induced carpal tunnel syndrome which affects fingers and hands of workers. Exposure to extreme heat and cold causes heat rashes, heat stroke, white finger, etc. Ionizing radiation affects the workers who come in contact with radioactive substance which are previously stored or used in site or may be released during demolition. Those who work under radioactive substance suffer from genetic disease and even cancer.

Biological hazards are due to infectious microorganisms or animal/insect attack at site. Workers are exposed to a risk of bacteria, poison plant, fungi, etc., while performing activities like housekeeping, excavation, site clearing. This may cause immediate itchiness and skin irritation to workers who perform the tasks.

Ergonomic hazards are due to lifting and carrying of objects, repetitive works, working in awkward postures, forceful and muscle efforts, external pressure. Workers who perform concrete work, flooring, roofing, painting, welding, and housekeeping are exposed to high risks of ergonomic threats. Workers who come in contact with tools and sharp objects feel external pressure. Activities such as drilling, hammering, painting with brush pose repetitive works. Workers who perform flooring, drywall insulation, masonry works, welding are used to work in awkward postures. The overall ergonomic threats cause musculoskeletal disorder leading to lifetime pain and/or body disability.

For the development of a national initiative on PtD, NIOSH partnered with organizations that include American Industrial Hygiene Association (AIHA), American Society of Safety Engineers (ASSE), Center to Protect Worker's Rights (CPWR), Kaiser Permanente, Liberty Mutual, National Safety Council (NSC), Occupational Health and Safety Administration (OSHA), ORC Worldwide and Regenstrief Center for Healthcare Engineering. To eliminate or reduce the hazards associated with work, PtD concept involves the design of tools, equipment, and work processes. The PtD workshop was first held at Washington in July 2007, which aims at eliminating occupational hazards and controlling risks at the early stage of project life cycle. Approximately 225 participants were attracted from diverse industrial sectors and the technical papers authored by experts in PtD; break-out session reports from industries were published as a special edition of Journal of Safety Research in 2008 (Yang and Li 2015).

The concept of PtD is applicable to diverse disciplines of agriculture, mining, transportation, forestry and fishing, construction, health care and social assistance, warehousing, and manufacturing for preventing workers from hazards through design. The concept of Prevention through design is defined as "*Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipments*" (Ertas 2010). The goal of PtD is to reduce occupational injuries and illness by integrating PtD process in all stages of generic design process. Figure 1.1 shows the process of PtD, which starts with defining the work related to the product and then identifying and analyzing the hazards associated with the products and finally establishing the control measures if hazards cannot be eliminated.

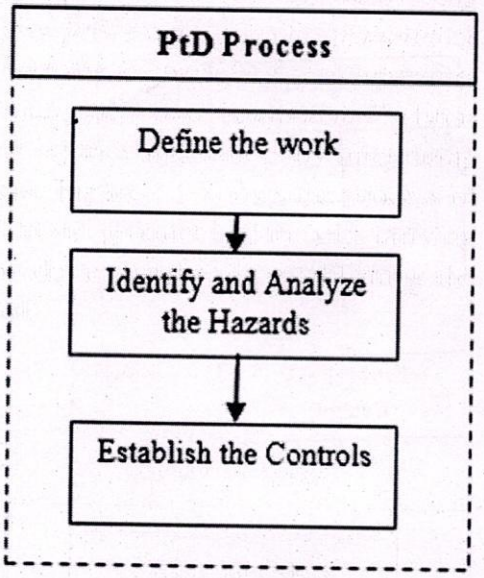

Fig. 1.1 Process of PtD (*Source*: *Prevention through design: Transdisciplinary process*)

concept design stage and detailed design stage. During preliminary design stage, the concept developed is further defined. If more than one concept is involved in concept design stage, the assessment over best solution is selected in preliminary design stage. In preliminary design stage, the concept development must be incremental rather than complete re-examination. The overall system configuration includes schematic and drawings, diagram, layouts, and other engineering configurations which are defined during preliminary design stage. Further, the safety consideration and selection of control measures must also be checked in preliminary design stage to know whether it is still appropriate for hazard analysis. Once the preliminary design is set, the detailed design phase of the project will be prepared with a detailed specification of each component. In the detailed design stage, a final set of hazard analysis is developed which will serve as a basis for the final design for construction.

1.4 PtD for Health Hazards in Construction

The main exposing activities are those which are associated with health hazards of construction projects such as excavation, manual handling, housekeeping, demolition, and concrete/brick work. The workers who perform these tasks are repetitively exposed to different kinds of health hazards. PtD process "design-out" hazards at workplace by integrating PtD in generic design process of projects. Some engineering control options are available to reduce expose to hazards at site. The process of integration of PtD in design process will select/allow to use the materials which are less hazardous, for example, solvent-free or low-solvent adhering and water-based paints. The advantage of integrating PtD in design process is that the designers can come to know about the issues in activities and alert the workers who perform the tasks.

The process which creates vibration can be minimized by selecting alternative process. For example, vibrators which are used manually can be replaced by machine vibrators. To keep workers away from microorganisms, workers must be allowed to use tools/equipment rather than working with hand during site clearing. The well-trained workers are allowed to do housekeeping to avoid unnecessary movements. The process which creates noise and dust can be avoided through choosing alternative process. For example, the methods which produce noise and dust during concrete/bricks breaking can be minimized by choosing alternative method.

To avoid musculoskeletal disorder, alternative equipment or methods must be used where workers are not able to carry or lift manually. The tools which are used by the workers of specific tasks must be less in weight and easy to access.

The demolition and renovation work contains more health hazards, and it can be avoided by choosing alternative process. For example, the noise produced during demolition work can be minimized by using alternative equipment or tool to demolish. The administrative controls and PPEs are used when hazards in sites are not able to prevent by engineering controls.

Chapter 2
Virtual Prototype based Simulator for EOT Crane

Abstract Electric overhead travelling (EOT) crane is associated with complex operational activities such as loading and unloading in manufacturing industry. Training to operators in real scenario is not possible because of these complex activities and the risk associated with the operation. It may also hamper the manufacturing process of the organization. This study aimed at developing a virtual prototype-based EOT crane simulator that can be used for providing training to the operators. In the proposed approach, EOT crane is considered as 3-degree-of-freedom system, and all the components related to the EOT crane operational environment have been modelled using 3D modelling software. All the models are then integrated in a single layout, and the virtual environment of the EOT crane has been made using unreal engine software. The operational process of the EOT crane can be simulated using keyboard and mouse of the computer in this virtual environment. Organization can adopt this simulator for giving training to their operators and to make the training process more time efficient and cost-effective.

Keywords Virtual reality · 3D modelling · Game engine

2.2 Virtual Prototype

Virtual prototyping (VP) is creation of simulated environment of a product where analysis and testing of the product can be done for design or qualitative performance analysis. It will help in product development owing to its availability and low prices (Choi et al. 2015) along with replacing the problems such as deployment of dedicated equipment and space in case of conventional training approaches (Goulding et al. 2012). In safety domain of a manufacturing industry, VP can be useful in solving the issues related to layout, operation and dynamic analysis of operating environment (Guo et al. 2013).

In order to change the status quo of the crane operator training, development of an overhead crane operation simulation system based on virtual reality technology is our goal. The developed simulated VR environment can be used for overhead crane operation training, skill improvement training, safety education and practice examination. The simulated system of overhead crane is composed of several parts, including visual system, human–computer system and hardware system ("The Virtual Crane" retrieved from http://venus.web.cern.ch/VENUS/vcs/virtcra2.2).

The use of virtual reality for simulating EOT crane operation improves the understanding of the mechanical structure and working principle of crane system. System architect uses 3D virtual simulation technology to produce realistic 3D overhead crane working scenes and working conditions. Trained person operates the overhead crane in 3D visualization of the scene using a large screen projector or a stereo imaging lens. Virtual reality system can be helpful for the operator to match real-time interaction in the three-dimensional environment, and they can operate trolley, hook and all kinds of safety devices to acquire knowledge of the operating procedure. Virtual environment gives the opportunity to operators for repetitive training. Accident reconstruction and analysis are possible for identification of errors occurred in training process.

2.3 Virtual Reality Application in Training

Application of virtual reality nowadays makes it possible to reconstruct, simulate and visualize the whole operation process and find out the deficiencies that are present in the operation. It is being widely applicable in chemical, mining, construction, health care industries but its applicability in manufacturing industries is still an issue to be taken care of. Accident prevention training and operational safety programmes will be beneficial for a worker in a theoretical sense but practical approach to training through immersion and visualization is possible through virtual reality. Visualization of accident that had happened in the past and providing training to the employees in the virtual environment which will give them the feel of real environment to avoid those in future is to be added in safety training programmes. Virtual reality platform can emulate immersive interactive scenarios

process in real scenario is also hazardous in nature. Trainee may not be allowed to do any mistakes at the time of training in the real scenario but repetitive training can be accommodated in virtual reality training.

2.5.1.2 The Crane Simulator

The crane simulator is in general a virtual crane in computer-made 3D environment. The environment is the replication of a real environment. When operator or user wears Head Mounted Display, he/she will be immersed in that computer's simulated environment. He/she will feel that they are in that environment. They can walk through the environment and interact with the objects. The realism of the environment means not only the photorealistic view of the environment, but the rigid body physics, dynamics, kinematics, gravity, collision, elasticity also. All the intractable factors must be incorporated in the environment. Users can practice as much time as they want and make mistakes there. By making mistake they will understand the path which leads to accident. They will also understand about the barriers that must be incorporated to get rid of from those accidents.

2.6 Methodology for Development of Crane Simulator

The methodology considered here for developing virtual reality-based crane simulator model is mentioned step by step. Some prerequisites for building virtual reality-based scenario are learning of 3D modelling software, texturing, programming language (C ++, C#, python) and game engine. The methodological flow work is given in Fig. 2.1 for development of virtual reality-based prototype for crane operation.

2.6.1 3D Modelling and Texturing

3D modelling is the description of spatial vector location of objects, environments through a computer system. This section provides the basic concepts of the modelling technique. The method of using basic building block that is used for creating objects and the process of moving, rotating and resizing the objects are also explored here. The fundamental steps for 3D modelling are described below (retrieved from https://www.unrealengine.com).

2.6.1.1 Coordinate Systems

There are three perpendicular axes, which are labelled as the x, y and z axes in the field of 3D design. The origin is called the world origin that is used as the reference

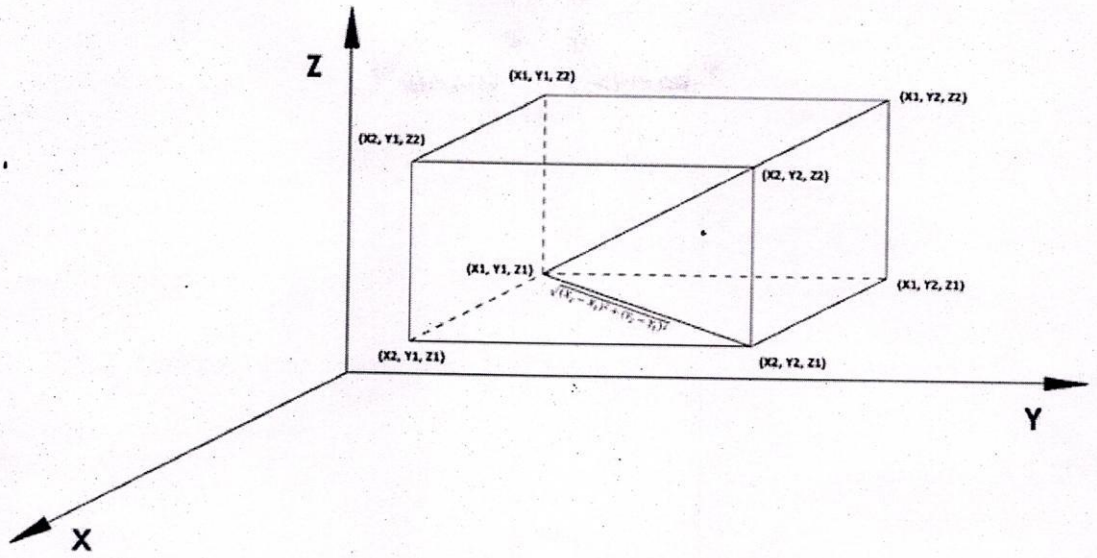

Fig. 2.2 Vertex, line, face

2.6.1.3 Image Mapping (Texture Mapping)

The 3D model above explained is only a mesh. Now to make that mesh look real, texturing is very much important. Texture mapping is a method for giving detailed surface texture (a bitmap or raster image) or colour to the 3D mesh. A shape or polygon gets live after applying texture map on their surfaces. In a simple way, texturing can be said as pasting some colourful pattern on white box. Every vertex of a polygon is a texture coordinate (in the 2D model, these vertexes are known as a UV coordinate). Figures 2.3 and 2.4 describe the essence of image mapping.

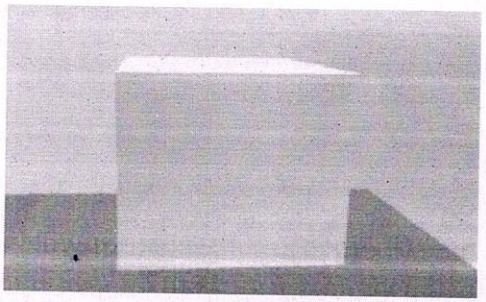

Fig. 2.3 3D model without texture

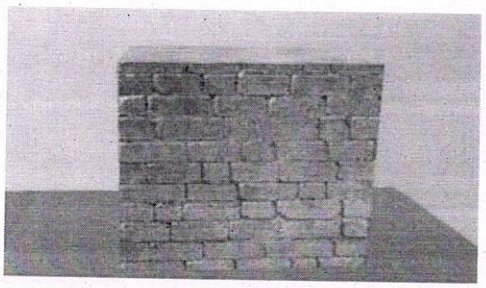

Fig. 2.4 3D model with texture

Reflection Mapping

This is needed to give the reflection of a 3D mesh in the environments.

After the texturing, the texture model has to be imported in virtual reality engine that is used for creating complex virtual scenario. Unreal engine or unity 3D can be used as per user's requirement.

2.6.2 *Animation*

Animation is to give life to a 3D model. The 3D static mesh, after animation, behaves like real character. Blend Space is one of the concepts that is widely used for animation. In Blend Space, different types of animation can be added and made a single animation. That makes the model more real. Suppose in one animation, the 3D avatar will walk and in another animation it will run. Now in Blend Space, these two animations can be grouped together.

2.6.3 *Immersive and Interactive Environment*

For making the virtual environment, geometric transformation, lighting and shadows and texturing have to be implemented for making immersive environment.

2.6.3.1 Geometric Transformations

Geometric transformations are used for modifying the size, shape of model proportion to other model and also used for the spatial position of the object in the world. The most common transformations that are used for this are translation, rotation and scaling. Transformations can be applied to entire world, single objects, or single primitives (points, lines and faces). The value of the axis should be specified in which the transformation is to be applied and which origin in the world has to be used at the time of transformation.

2.6.3.2 Lights, Cameras and Shading and Surface Characteristics

Overview of virtual lights and camera used for modelling technique and also the description of shading and surface options available in modelling software are given below.

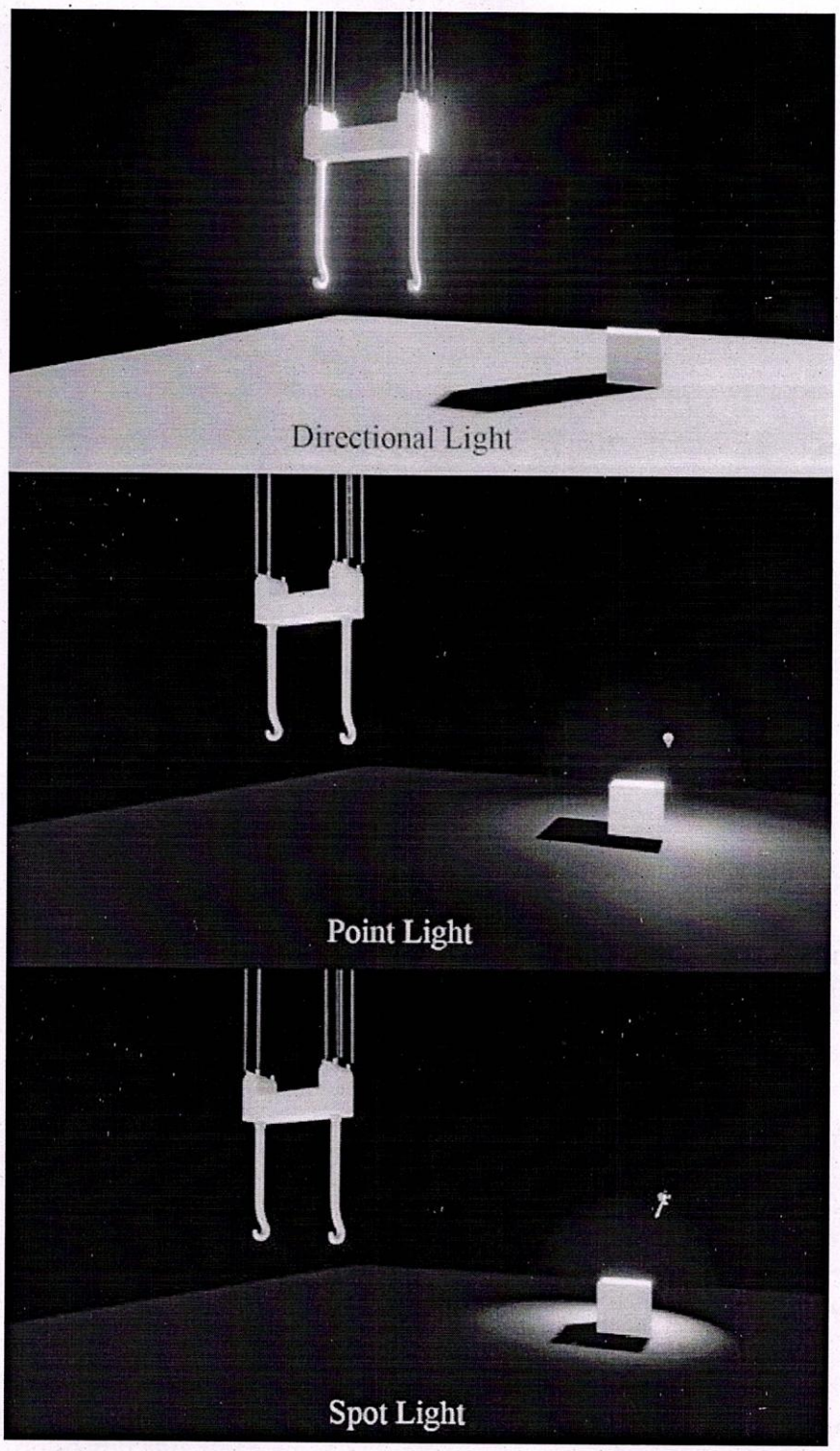

Fig. 2.7 Different light sources of the environment

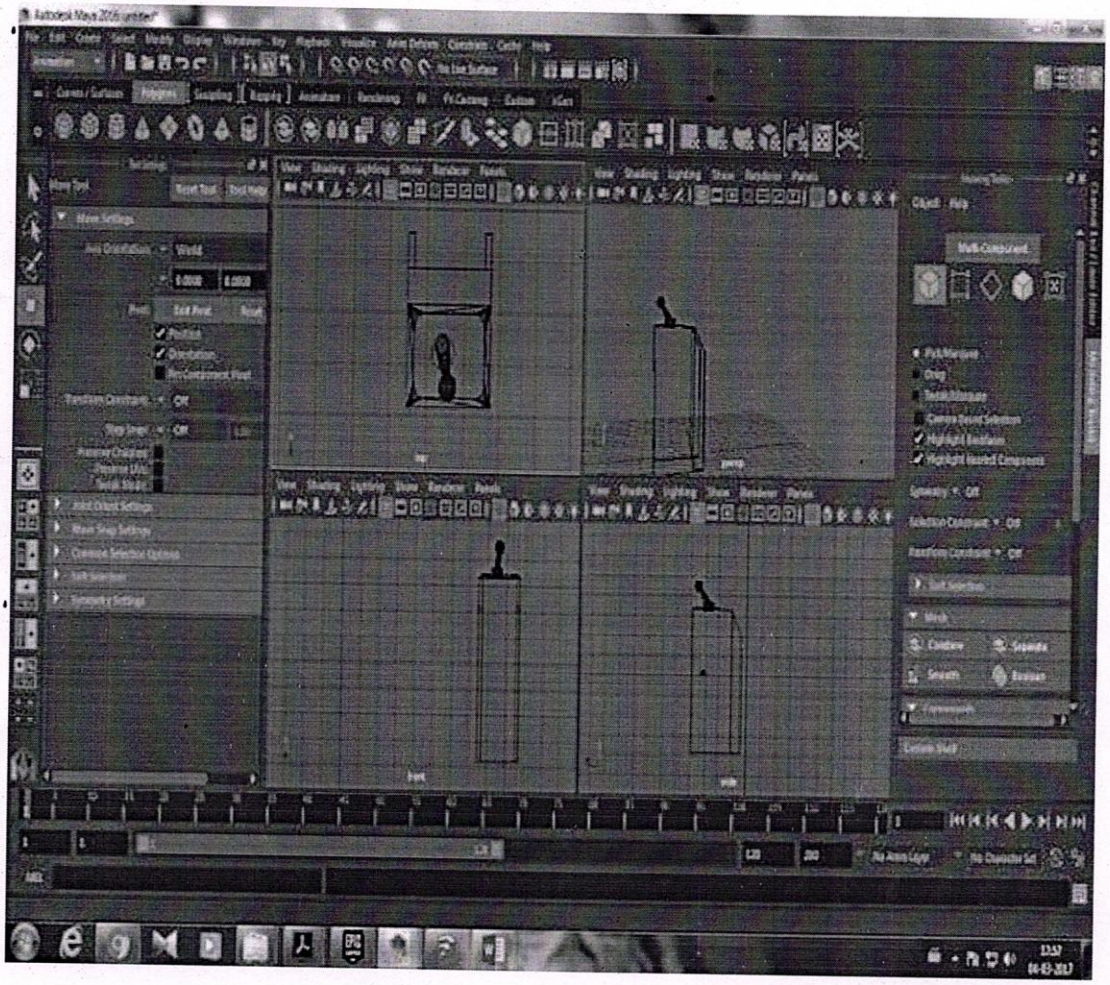

Fig. 2.9 Four views of liver

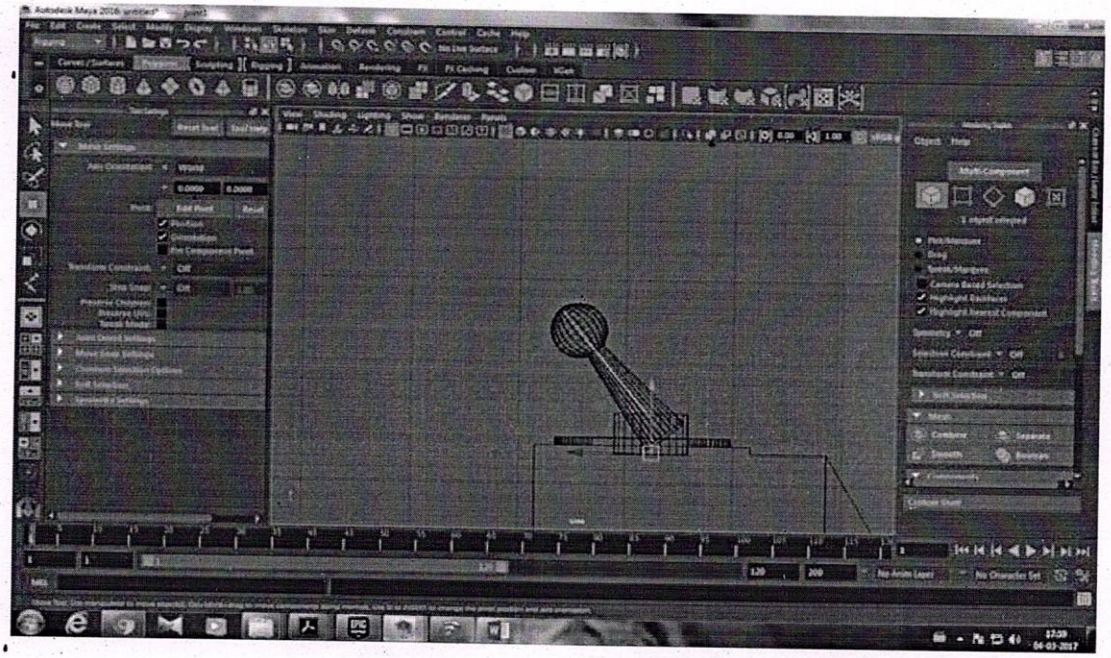

Fig. 2.10 Skeleton added to the liver

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1	MUTUKUNDU SOMA SEKHAR REDDY	189Y1A0333	yes	Agree	Strongly Ag	Yes	4	5	Nil
2	NAGURU SAMPATH KUMAR	189Y1A0334	yes	Agree	Agree	Yes	5	5	Need extra Explanation
3	NERSUPALLI SAI KUMAR REDDY	189Y1A0335	yes	Agree	Agree	Yes	4	5	Nil
4	NETURI SANDEEP KUMAR REDDY	189Y1A0336	yes	Agree	Agree	Yes	5	5	Nil
5	NUKANABOINA PULLAIAH	189Y1A0337	yes	Agree	Agree	Yes	5	5	Provide PPT
6	PALTHURU BOJJAPPA	189Y1A0338	yes	Agree	Agree	Yes	5	4	Nil
7	PANDITI ANIL KUMAR	189Y1A0339	yes	Agree	Agree	Yes	5	4	Nil
8	PASUPURATHI RAJASEKHAR REDDY	189Y1A0340	yes	Agree	Agree	Yes	4	5	Nil
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10	PATAN SAMEER KHAN	189Y1A0342	yes	Agree	Agree	Yes	5	5	Nil
11	PATHAN ARBAAZ KHAN	189Y1A0343	yes	Agree	Agree	Yes	5	5	Nil
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27	SHAIK MOHAMMAD TAYEEB	189Y1A0359	yes	Agree	Agree	Yes	5	5	Nil
28	SHAIK SHAJAHAN	189Y1A0360	yes	Agree	Agree	Yes		5	Nil
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39	MOOLA ACHYUTH REDDY	199Y5A0327	yes	Agree	Agree	Yes	5	5	Nil
40	NADDI HARIKRISHNA	199Y5A0328	yes	Agree	Agree	Yes	5	5	Nil
41	NALLABALLE HARI OBULESU	199Y5A0329	yes	Agree	Agree	Yes	5	5	Nil
42	NANDYALA SISINDRI	199Y5A0330	yes	Agree	Agree	Yes	5	5	Nil
43	PICHIPATI SHAIK MAHAMMAD AFRID	199Y5A0331	yes	Agree	Agree	Yes	4	5	Nil
44	PUTTA SASIKANTH REDDY	199Y5A0332	yes	Agree	Agree	Yes	5	5	Nil
45	RAJULA ANAND REDDY	199Y5A0333	yes	Agree	Agree	Yes	5	5	Nil
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58	YERRAGORLA BRAMHAIAH	199Y5A0346	yes	Agree	Agree	Yes	5	5	Nil

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