Design And Development Of Automatic Wheelchair And Bed For Old-age Home

Prepared By:-

Group No.:- 10
Joshi Mohit J. (110780119026)
Bhavsar Deep S. (110780119029)
Patel Vishal N. (110780119020)
Prajapati Mehul P. (110780119098)

Group No.:- 15
Shah Rushabh J. (110780119038)
Patel Jimmy R. (110780119042)
Patel Hiren M. (110780119002)
Patel Hardik B. (110780119047)

Guided By:-
Prof. J. B. Patel
Prof. H. C. Patel
The way we proceed .......

- Introduction
- Objectives
- Working plan
- Literature Survey & Hospital Survey
- Project Concepts
- Project Design
- Animation video
- Design calculation
- Input and Output parameter
- Equipment Used and their description
- Problem Faced during development
- Development
- Working Video
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- References
Introduction

The need for automatic Wheelchair is especially present in care of immovable people (people with persistent vegetative state, paraplegia, stroke and spinal cord injuries), where the care requires a lot of time and manpower. This report is the result of a design and development of an automated multifunctional Wheelchair that would perform all functions present in today’s Wheelchair (Wheelchair with adjustable portion of back rest and leg rest and also convert to bed to wheelchair and vice versa and also remote control with which we can provide all necessary movement) as well as new functions of appropriate Wheelchair sections (leg positions adjusting). It is expected that this new automatic Wheelchair would enable people’s better medical care, and would greatly reduce time and manpower to the old-age home staff.
Objectives

- Give the comfort to the senior adults (Age: 65+)
- Bedsore prevention for support
- Commode facility in wheelchair
- Improve balance and postural stability of Old-Age people
- Convert Sleeping Position from sitting position easily
- Prevention of incapable of surviving serious injuries
- Easy movement one place to another place
- Wheelchair and Bed can attached together
- Specific service to the human in a safe and comfortable manner
- Focusing on mobility assistance for bedridden persons
<table>
<thead>
<tr>
<th>Task</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July</td>
<td>Aug</td>
</tr>
<tr>
<td>Survey</td>
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<tr>
<td>Finding Problems</td>
<td></td>
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<td>Solutions of Problems</td>
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<td>Optimum Solution</td>
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<tr>
<td>Concept Sketches of Wheelchair &amp; Bed</td>
<td></td>
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<tr>
<td>Selecting Best Concept according to objectives</td>
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<tr>
<td>Design of Wheelchair &amp; Bed</td>
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<tr>
<td>Material Survey &amp; Purchasing</td>
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<tr>
<td>Fabrication</td>
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<tr>
<td>Assembling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing</td>
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</tr>
</tbody>
</table>
LITERATURE SURVEY
• Mohan Kumar R. and et al. (2012)

• Found Design of Multipurpose Wheel Chair for Physically Challenged and Elder People. The design of wheel chair started by means of literature review to know its evaluation from earlier to the present generation. Market study was carried out to know the present competitors available in the market with cost analysis of the existing product.
Ehsanullah Khan and et al. (2011)

- He says synthesis of trolley cum wheelchair for patient handling. Handling of patient from hospital bed to CT-Scan, MR Scan, X-Ray, Sonography centre etc is a cumbersome and tedious job. Generally from bed, the patient is moved to trolley manually. Three to four persons lift the patient and keep him on the stretcher. The trolley is moved to lift if necessary.

Trolley cum Wheel Chair
• Jingtao. Chen and et al. (2013)

• Found design of the wheelchair bed. People's request, in this paper by considering the wheelchair on the research of the front foot and back structure, finally decided to use in forefoot plate rack mechanism, backplane using slider-crank mechanism, so as to achieve transformation between the wheelchair and the bed. And using computer application software for 3d drawings of drawing and carry on simulation test.
• Nenad Pavlović and et al. (2010)

• Found development of multifunctional hospital bed. The need for multifunctional hospital beds is especially present in care of immovable patients (patients with persistent vegetative state, paraplegia, stroke and spinal cord injuries), where the care requires a lot of time and manpower.

Multifunctional Hospital Bed
• Meng-Hui Hsu and et al. (2009)[8]

• Found dual-purpose wheelchair mechanism designs. A wheelchair with dual-function of sitting and lying is usable to the users no matter what he sits or lies. In addition, if the rear wheels of the dual-purpose wheelchair are designed as movable ones, the whole mass-center of the wheelchair can move between the rear and front wheels of the chair.
• Po Er Hsu and et al.(2013)

• He found seat adjustment design of an intelligent robotic wheelchair based on the stewart platform. A wheelchair user makes direct contact with the wheelchair seat, which serves as the interface between the user and the wheelchair, for much of any given day. Seat adjustment design is of crucial importance in providing proper seating posture and comfort.
HOSPITAL SURVEY
• Lions Hospital, Mehsana

• HCG Cancer Hospital, Ahmedabad

• Sterlling Hospital, Ahmedabad
• Sai Krishna Hospital, Mehsana

• Sal Hospital, Ahmedabad
PROJECT CONCEPTS
1. Bed & Wheel Chair With Slider Mechanism

- This concept is based on the slider mechanism of extension ladder mechanism also hydraulics provided in the bed.
2. Bed & Wheelchair with Scissor Lifter Mechanism

- This concept is containing Scissor lifter mechanism.
3. Ejectable Wheelchair From Bed

This concept is just different concept from above two concepts. In this concept the bed is fixed and chair is removed from the bed. The different position is shown in below figure.

![Schematic of Hybrid Bed/Chair System in Seated Position](image1)

![Schematic of Hybrid Chair/Bed System in Lying Position](image2)

![Schematic of Hybrid Bed/Chair System in Transit](image3)
4. Bed & Wheelchair with Fork Lifter

➢ It is also different concept from above concept. It is a concept of fork lifter mechanism.
5. Wheelchair is converting into bed by using lifting mechanism and joystick controllable

- The wheelchair and bed are very convenient for joystick controllable automatic wheelchair with side flexible portion which is different from each other and attached together with mechanism and also commode facility on wheelchair which is very convenient for Old-Age Home.
PROJECT DESIGN
• Design of wheelchair
• Design of wheelchair converted into Bed
• Design of Bed
Design of whole assembly of Wheelchair and Bed
• Dimensions of wheelchair assembly

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>(inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length</td>
<td>78”</td>
</tr>
<tr>
<td>Overall height</td>
<td>53”</td>
</tr>
<tr>
<td>Height from bottom to seat</td>
<td>30”</td>
</tr>
<tr>
<td>Overall width</td>
<td>27”</td>
</tr>
</tbody>
</table>
Animation
DESIGN CALCULATION
• Material Used for Development

1) M. S. section of 25*25 mm
2) M. S. section of diameter 30 mm
3) M. S. section 50*50 mm
4) M. S. section 66*33 mm
5) M. S. Plate of 2mm
6) Bolt and nut of 10 mm diameter and 4 inches length
7) 22 mm diameter hollow bar
8) Polyurethane
9) Spunch (foam)
10) Leather cover
11) Waterproof sheet
12) Castor
13) Wheel
14) Bearing(SKF-6204)
### M.S Material Properties

<table>
<thead>
<tr>
<th>Material</th>
<th>Mild Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>7200 kg/m³</td>
</tr>
<tr>
<td>Thermal expansion</td>
<td>10.1 - 16.6*10⁻⁶ (mm/°c)</td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>68.9-207 Gpa</td>
</tr>
<tr>
<td>Poisson ratio</td>
<td>0.23-0.3</td>
</tr>
<tr>
<td>Melting point</td>
<td>1230-1530 (°c)</td>
</tr>
<tr>
<td>Ultimate tensile strength</td>
<td>450-500 Mpa</td>
</tr>
</tbody>
</table>

### M.S Material Sections used in Development

<table>
<thead>
<tr>
<th>Cross Section (mm)</th>
<th>Kg /20ft</th>
<th>Kg/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>66*33</td>
<td>25</td>
<td>1.25</td>
</tr>
<tr>
<td>60*40</td>
<td>14.70</td>
<td>0.735</td>
</tr>
<tr>
<td>50*50</td>
<td>17</td>
<td>0.85</td>
</tr>
<tr>
<td>25*25</td>
<td>7</td>
<td>0.35</td>
</tr>
<tr>
<td>Φ25</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>
• M.S Material Sections used in Wheelchair

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Feet</th>
<th>Weight (kg)</th>
<th>Weight (Newton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60*40</td>
<td>6.54</td>
<td>4.81</td>
<td>47.19</td>
</tr>
<tr>
<td>50*50</td>
<td>3.61</td>
<td>3.07</td>
<td>30.12</td>
</tr>
<tr>
<td>25*25</td>
<td>32.79</td>
<td>11.47</td>
<td>112.58</td>
</tr>
<tr>
<td>Φ25</td>
<td>7.79</td>
<td>3.90</td>
<td>38.259</td>
</tr>
</tbody>
</table>

TOTAL WEIGHT

23.25  228.08

• M.S Material Sections used in Bed

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Feet</th>
<th>Weight (kg)</th>
<th>Weight (Newton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>66*33</td>
<td>13.69</td>
<td>17.12</td>
<td>167.92</td>
</tr>
<tr>
<td>60*40</td>
<td>24.69</td>
<td>18.15</td>
<td>178.04</td>
</tr>
<tr>
<td>50*50</td>
<td>13.30</td>
<td>11.31</td>
<td>110.91</td>
</tr>
<tr>
<td>25*25</td>
<td>4.59</td>
<td>1.61</td>
<td>15.77</td>
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</table>

TOTAL WEIGHT

48.19  472.74
### Human Weight Calculation

<table>
<thead>
<tr>
<th>DIFFERENT PART OF HUMAN BODY</th>
<th>WEIGHT IN (%)</th>
<th>WEIGHT OF HUMAN BODY PARTS (KG) (IF WE SUPPOSE WEIGHT IS 120 KG.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk (Chest, back and abdomen)</td>
<td>50.80</td>
<td>60.96</td>
</tr>
<tr>
<td>Thigh</td>
<td>9.88</td>
<td>11.856</td>
</tr>
<tr>
<td>Head</td>
<td>7.30</td>
<td>8.76</td>
</tr>
<tr>
<td>Lower leg</td>
<td>4.65</td>
<td>5.58</td>
</tr>
<tr>
<td>Upper arm</td>
<td>2.7</td>
<td>3.24</td>
</tr>
<tr>
<td>Forearm</td>
<td>1.60</td>
<td>1.92</td>
</tr>
<tr>
<td>Foot</td>
<td>1.45</td>
<td>1.74</td>
</tr>
<tr>
<td>Hand</td>
<td>0.66</td>
<td>0.792</td>
</tr>
<tr>
<td>Others</td>
<td>20.96</td>
<td>25.152</td>
</tr>
</tbody>
</table>
• Load calculations

• Load on front casters

Weight of Body = 23.25 kg

Weight of Body (Newton) = 228.08 N

Weight of Screw Motor = (2*1.25) = 2.5 kg = 24.525 N

Inclination Angle (θ) = 10°

\[ F_{\text{front (vertical)}} = [228.08 + 24.525 + 1177.20] = 476.6016 \text{ N} \]

\[ F_{\text{front (incline)}} = [F_{\text{front (vertical)}} \times \cos \theta] = [476.6016 \times \cos 10] \]

\[ = 469.36 \text{ N} \]

• Force on each caster

\[ F_{F1} = \frac{F_{\text{front (incline)}}}{2} = 234.68 \text{ N} \]
• Load on rear wheels

Weight of Body = 23.25 kg

Weight of Body (Newton) = 228.08 N

Weight of Human Body = 120 kg = 1177.20 N

Weight of Screw Motor = (2*1.25) = 2.5 kg = 24.525 N

Inclination Angle (Φ) = 20°

\[ F_{\text{rear(vertical)}} = [228.08 + 24.525 + 1177.20] = 953.203 \text{ N} \]

\[ F_{\text{rear(incline)}} = [F_{\text{rear(vertical)}} \times \cos \theta] = [953.203 \times \cos 20] = 895.71 \text{ N} \]

• Force on each wheel

\[ F_{F2} = \frac{F_{\text{rear(incline)}}}{2} = 447.858 \text{ N} \]
• Load on back rest portion

  Link inclination (α) = 30°
  Weight of Human Body (Back) = 40 kg
  Weight of Frame (Back) = 15 kg

  Force (F) = (40+15)*9.81 = 539.55 N
  Force (actual) = F * sinα = 269.775 N

• Load on leg rest portion

  Link inclination (β) = 55°
  Weight of Human Body (Leg) = 15 kg
  Weight of Frame (Leg) = 15 kg

  Force (F) = (15+15)*9.81
             = 294.3 N

  Force (actual) = F * sinβ
                 = 241.070 N
• Stress calculation

• Stress on front caster
  Front wheel shaft diameter \(d_1\) = 10 mm

• Bending stress
  \[ \sigma_b = \frac{My}{I} \]

  Moment \( M \) = \( F_{F_1} \times \left( \frac{L}{2} \right) \) = 234.68 \( \times \) 20 = 4693.6 N.mm

  \( Y = \frac{d_1}{2} = 5 \) mm

  \( I = \frac{\pi}{64} (d_1)^4 = (10)^4 = 490.625 \) mm\(^4\)

  \( \sigma_b = 47.832 \) N/mm\(^2\)

• Shear stress

  \[ \tau = \frac{TR}{J} \]

  Torque \( T \) = \( F_{F_1} \times \left( \frac{L}{2} \right) \) = 234.68 \( \times \) 20 = 4693.6 N.mm

  \( R = \frac{d_1}{2} = 5 \) mm

  \( J = \frac{\pi}{64} (10)^4 = 981.625 \) mm\(^4\)

  \( \tau = 23.91 \) N/mm\(^2\)
• Stress on rear wheel
Rear wheel shaft diameter($d_2$) = 12 mm

• Bending stress
\[ \sigma_b = \frac{My}{I} \]

Moment \( = F_{F2} \times (L / 2) = 447.858 \times 50 = 22392.9 \text{ N.mm} \)
\( Y = \frac{d_2}{2} = 6 \text{ mm} \)

\[ I = \frac{\pi}{64} (d_2)^4 = (12)^4 = 1017.36 \text{ mm}^4 \]

\[ \sigma_b = 132.06 \text{ N/mm}^2 \]

• Shear stress
\[ \tau = \frac{TR}{J} \]

Torque(T) \( = F_{F2} \times (L / 2) = 447.858 \times 50 = 22392.9 \text{ N.mm} \)

\( R = \frac{d_2}{2} = 6 \text{ mm} \)

\[ J = \frac{\pi}{64} (12)^4 = 2034.72 \text{ mm}^4 \]

\[ \tau = 66.03 \text{ N/mm}^2 \]
• Stress on back portion
Bolt diameter \((d_3) = 10\) mm

• Bending stress
\[
\sigma_b = \frac{M y}{I}
\]
Moment \(= F_{\text{actual}} \times (1/2) = 269.775 \times 20 = 5395.5\) N.mm

\(Y = d_3/2 = 5\) mm

\[
I = \frac{\pi}{64} (d_3)^4 = (10)^4 = 490.625 \text{ mm}^4
\]

\(\sigma_b = 54.98\) N/mm\(^2\)

• Shear stress
\[
\tau = \frac{\tau R}{J}
\]
Torque \((T) = F_{\text{actual}} \times (1/2) = 269.775 \times 20 = 5395.5\) N.mm

\(R = d_3/2 = 5\) mm

\[
J = \frac{\pi}{64} (10)^4 = 981.25 \text{ mm}^4
\]

\(\tau = 27.49\) N/mm\(^2\)
• Stress on leg portion
  Bolt diameter \((d_3) = 10\) mm

• Bending stress
  \[ \sigma_b = \frac{M_y}{I} \]
  Moment \(= F_{\text{actual}} \times \left( \frac{1}{2} \right) = 241.070 \times 20 = 4821.528\) N.mm
  \(Y = d_3/2 = 5\) mm

  \[ I = \frac{\pi}{64} (d_3)^4 = (10)^4 = 490.625\) mm\(^4\)

  \(\sigma_b = 49.13\) N/mm\(^2\)

• Shear stress
  \[ \tau = \frac{TR}{J} \]
  Torque \((T) = F_{\text{actual}} \times \left( \frac{1}{2} \right) = 241.070 \times 20 = 4821.528\) N.mm
  \(R = d_3/2 = 5\) mm

  \[ J = \frac{\pi}{64} (10)^4 = 981.25\) mm\(^4\)

  \(\tau = 24.568\) N/mm\(^2\)
• Factor of Safety

\[
\text{F.O.S.} = \frac{\text{Ultimate tensile stress of Material}}{\text{Maximum stress generated in material}} \\
= \frac{450}{132.06} \\
= 3.40
\]
• Speed calculation of wheelchair

Radius of rear wheel (R) = 101.60 mm

Periphery = \( 2\pi R \) = 638.048 mm

\( N_1 \) (with load) = 70 rpm

\( N_2 \) (without load) = 85 rpm

\( V_1 \) (with load) = \( P \times N_1 \)

\[ \frac{638.048 \times 70}{60 \times 1000} \]

= 0.744 m/s

\( V_2 \) (without load) = \( P \times N_2 \)

\[ \frac{638.048 \times 85}{60 \times 1000} \]

= 0.9039 m/s
• Speed of back rest portion & leg rest portion

<table>
<thead>
<tr>
<th></th>
<th>BACK REST PORTION</th>
<th>LEG REST PORTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITH LOAD</td>
<td>0.174 rad/sec</td>
<td>0.1889 rad/sec</td>
</tr>
<tr>
<td>WITHOUT LOAD</td>
<td>0.244 rad/sec</td>
<td>0.283 rad/sec</td>
</tr>
</tbody>
</table>

• Bearing material properties

<table>
<thead>
<tr>
<th>Ball Bearing Type</th>
<th>Deep Groove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore Type</td>
<td>Parallel</td>
</tr>
<tr>
<td>Cage material</td>
<td>Steel</td>
</tr>
<tr>
<td>Bore (mm)</td>
<td>20</td>
</tr>
<tr>
<td>O/D (mm)</td>
<td>47</td>
</tr>
<tr>
<td>Race Width (mm)</td>
<td>14</td>
</tr>
<tr>
<td>Load withstand (KN)</td>
<td>13.5</td>
</tr>
<tr>
<td>Limiting speed (rpm)</td>
<td>10000</td>
</tr>
<tr>
<td>Static load rating(KN)</td>
<td>6.55</td>
</tr>
<tr>
<td>Race type</td>
<td>Plain</td>
</tr>
</tbody>
</table>
### Input and Output parameter

<table>
<thead>
<tr>
<th>Input parameters</th>
<th>Output parameters</th>
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</thead>
<tbody>
<tr>
<td>Battery (24 V-150 MAh)</td>
<td>Weight can withstand and lift Up to 120 kg</td>
</tr>
<tr>
<td>PMDC motor</td>
<td>Wheelchair velocity - 3.250 km/hr</td>
</tr>
<tr>
<td>Screw motor</td>
<td>Stroke speed :- 8 mm /s</td>
</tr>
</tbody>
</table>
• Metal Joining:
  • Permanent Joining
  • Temporary Joining

  • **Permanent Joining:**
    Permanent fastening can be done by electric arc welding.

  • **Temporary Joining:**
    Temporary fastening can be done by bolt and nut.
• Equipment used

• PMDC Motor
  Voltage- 24 volt
  Ampere- 3 amp
  Power- 0.25 Hp
  Rpm without gearbox - 1440 rpm
  Rpm with gearbox - 85 rpm
  Motor shaft dia. - 10mm

• Screw motor
  Voltage - 24 volt
  Ampere - 2.5 amp
  Power - 60 watt
  Stroke length - 17 cm
  Shaft dia. - 25mm
  Output - 5mm/sec as per above input
• Problem Faced

1) The main problem we faced is, which type of material we should use, after few failure we conclude that low weight and high strength material we should use.

2) The second problem is of screw-motor(used for up and down motion of back and lower portion of wheelchair) as the fix stroke length, we cant lift the up portion as horizontal(0°).

3) The link and their arrangement.

4) The motor used for wheelchair for its motion, after a long research in market we find that, as per our requirement we should use PMDC motor(permanent magnet dc motor).
Continue...

5) The fixing of a dc motor to the wheel of the wheelchair, how to couple the both shaft of motor and wheel than we found in the market but no couple found in the market, than we made a coupling as per our requirement and solve that problem.
DEVELOPMENT
## Cost Analysis

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Price per piece</th>
<th>Total price (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMDC Motor</td>
<td>(2*8000)</td>
<td>16000/-</td>
</tr>
<tr>
<td>Screw Motor</td>
<td>(2*10000)</td>
<td>20000/-</td>
</tr>
<tr>
<td>M.S Material for different section used in wheelchair</td>
<td></td>
<td>12000/-</td>
</tr>
<tr>
<td>Wheel and Caster</td>
<td></td>
<td>3000/-</td>
</tr>
<tr>
<td>Water proof sheet (foam)</td>
<td></td>
<td>18000/-</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>6000/-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>75000/-</td>
</tr>
</tbody>
</table>

**Available wheelchair in market (only wheel motion):**

1) Wildcat folding power wheelchair (www.Amazon.com)   Price: - Rs1,20,000 /

2) Smart Chair Electric Wheelchair (www.Amazon.com)   Price: - Rs1,10,000/

3) Power Wheelchair KP 10.3 (www.Bay Hatkel.com)      Price: - Rs1,11,500/-

4) Karma Power Wheelchair KP 10.35(www.Bay Hatkel.com) Price: - Rs1,12,000/-
Conclusion

• We conclude that, on the basis of our hospital, old-age home and market survey, we made a best design of wheelchair and bed for old age home people. We also provide the up and down motion of back and leg portion and also we automate (means remote control) forward, backward motion.

• The benefits of our project is:-
  • Ease to maintain
  • Customized usability
  • Easy adjustable
  • Durable
  • High strength
  • Elegant design
  • Cost benefit

• **Power consumption:-**

\[
\text{Power} = \text{voltage} \times \text{Current} \\
\text{Input voltage}= 24 \text{ Volts} \\
\text{Input Current}= 5 \text{ Ampere} \\
\text{Power} = 24 \times 5 = 120 \text{ Watts}
\]
Market References

• Tekson Hydraulic Corporation, odhav G.I.D.C. Ahmadabad–382415, Mo. :- +919953363703

• Bharat Machinery Electric stores, 4, Maruti complex highway road, unjha, Opp. Marshal thresher, Mehsana-384170, Mo. :- +919825315216

• Libra motors, Plot No. 296, odhav road, odhav Gidc, Ahmadabad-382415

• Jacktech Hydraulic, A/433 odhav Gidc, Opp. Bhikshuk gruh, near apna bazar gas godown, Ahmadabad-382415 Mo. :- +919825199005

• Parth Steel, 3, Maruti complex highway road, unjha-384170, Mo. :- +919825577576

• Kanaiya Plywood and Hardware, Jay-vijay society road, unjha-384170, Mo. :- +919898072173

• Rushabh Bearing Company, 2, Shreeram cloth market, Relief road, Ahmadabad-380002, Mo. :- +919327054302

• Kohinur Engineering Works, near V-Mart, Opp. Pasabhai petrol pump, Mehsana-384002

• S. F. Rangwala & Co., Sahakar chambers, National highway road, Mehsana industrial estate, Opp. Pasabhai petrol pump, Mehsana-384002, Mo. :- +919825287918

• Maniar Sales, Meera chambers, Kadiakui, Relief road, Ahmadabad-380001, Ph. No. :- (079) 2213366

• Chamunda Machinery Store, G-5, Poojan Complex, Modhera road, Mehsana industrial Estate, Opp. Petrol pump, Mehsana-384002, Mo. :- +919824160793

• Patel Material Handling Equipment, D/25/2, Shreeji industrial Esate, Naroda GIDC, Opp. Madhusudan Re Rolling Mills, Sutar Karkhana, Ahmedabad-382330, Mo. :- +91982506343
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