Chapter 11.

New trunk highways exploiting the advantage of New Malsej Chat.

The table has revealed the significant potential distance saving impact of Malsej Chat with reference to traffic between Greater Bombay and important focal towns in Marathwada viz. Aurangabad, Jalna, Nanded, Latur, Bhir Omerga. The table has also revealed this distance saving impact with reference to towns in Vidarbha region viz. Nagpur, Amaravati, Akola. This particular distance saving impact is not confined only to above mentioned towns but many other villages and towns would be benefited. But lack of data has compelled us to restrict the analysis with reference to very few selected focal points.

Nobody would suggest the separate direct linear highways from all these focal towns to Malsej Chat for Greater Bombay traffic. As revealed in the map we can group complementary towns for which one trunk highway can be proposed and optimum roads linking this trunk road and towns can be suggested with the help of the optimum highway model.

The following complementary towns for new roads can be grouped as follows:

a) Nagpur Amaravati Akola from Vidarbha
   Aurangabad Jalna from Marathwada.

b) Nanded Parbhani Bhir from Marathwada.

c) Latur Omerga from Marathwada
Estimation of vehicle linkage intensity between Greater Bombay and Nagpur, Amaravati, Akola, Aurangabad.

Vehicular traffic between Nagpur and Greater Bombay:

The estimation of predicted vehicular traffic between Nagpur and Greater Bombay in 1985 is based on Origin-Destination (O-D) survey of selected towns in Maharashtra State in 1964\(^1\) and point density of vehicles on the road\(^2\).

Nagpur-Greater Bombay traffic includes the O-D traffic between these two cities and transit traffic on the National Highway between Greater Bombay and Central, Northern and Eastern India, which includes important cities like Calcutta and Jabalpur. Origin-Destination survey of Maharashtra State has not given details about originated and terminated traffic of towns out of Maharashtra State. This traffic has been included in transit traffic. As National Highway carries traffic from other states, for the estimating the traffic between Nagpur and Greater Bombay, transit traffic is to be taken as basis for estimating the vehicular traffic between Greater Bombay and Nagpur. The transit traffic at Amaravati with reference to Amaravati-Murtizapur section includes Bombay traffic originated and terminated at Nagpur and transit Bombay traffic related to other towns from Northern, Central and Eastern India. The minimum transit traffic with reference to Amaravati Murtizapur section at Amaravati indicates the maximum range of traffic between Nagpur and Greater Bombay.

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Bombay. From this the short distance local traffic is to be excluded. The estimated short distance local traffic is 86 tonnes. The total maximum transit traffic at Amaravati was 222 tonnes in 1964. So estimated per day average traffic between Nagpur and Greater Bombay was 136 tonnes. On the basis of this total traffic, assuming 5 tonnes equivalent to 1 vehicle, the estimated average per day vehicular traffic between Greater Bombay and Nagpur would be 27.5 vehicles i.e. 28 vehicles in 1964. Percent growth rate per annum on the basis of point vehicle density in 1965 and 1970 is estimated. This estimated growth rate is 3.6 percent. On the basis of this growth rate predicted vehicular traffic between Greater Bombay and Nagpur would be 49 vehicles in 1985.

(Table 10.1)

Vehicular traffic between Amaravati and Greater Bombay.

The vehicular traffic between Amaravati and Bombay on the basis of origin destination survey in 1964\(^1\). According to this survey total tonnes originated and terminated between Amaravati and Bombay was 59 tonnes. This gives us vehicles equivalent to \(59/5 = 11.8\) i.e. 12 vehicles. With the growth rate of 3.6 percent per year, the predicted vehicular traffic for Amaravati Greater Bombay would be 21 vehicles in 1985. The total traffic including transit traffic between Nagpur and Greater Bombay would be equal to 49 + 21 = 70 in 1985.

Traffic between Akola and Greater Bombay: The origin destination survey indicates that the 0-7 traffic between Akola and Greater Bombay is 47 tonnes so it means it is about 10 vehicles in 1964. At the growth rate at 3.6 per cent per annum, the predicted traffic would be 13 vehicles in 1968. The total traffic between Akola and Bombay would be equal to 33 vehicles comprising 70 as a transit traffic and 13 vehicle as 0-7 traffic. As bus and Car traffic is assumed negligible this does not include bus and car traffic.

Aurangabad-Greater Bombay traffic: Origin destination survey give the terminating and originating traffic Greater Bombay and Aurangabad - Jalna traffic equal to 134 tonnes, per day 1964. It would be equal to 37 vehicles per day. The estimated bus traffic is 3 car and jeeps in terms of heavy vehicles are equal to 3. So the total vehicular traffic between Bombay and Aurangabad including Jalna traffic is estimated equal to 52 vehicles in 1964.

The growth rate estimated on the basis of point vehicle density in 1965 and in 1974. This gives us the growth rate equal to 11.69 percent per annum so on the basis of this growth rate the traffic in 1985 would be equal to 180 vehicles between focal point Aurangabad and Bombay.

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2. Ibid. pp. 264-265
3. Ibid pp. 242-245
For new trunk highway, Nagpur Amaravati Akola from Vidarbha and Aurangabad, Jalna from Marathwada are complementary towns as revealed in the map. The selection of Akola as a starting node for this trunk highway is based on the comparative study of highways from Nagpur, Amaravati and Akola. It has been revealed that the distance saving from Nagpur to Malsej Ghat Road is not significant as compared to the Additional construction of new road length. These figures are revealed in the table. 11.1 The same is the case with Amaravati. Hence Akola is suggested as a starting node for new trunk highway. This particular trunk highway provides the advantage for heavy traffic between greater Bombay and Northern Central and Eastern India on the national highway in addition to the many towns from Vidarbha and Marathwada. Question may be posed what is the revlevance of this trunk road for optimising road system with reference to towns in Marathwada. If we take independently the vehicle intensity between Aurangabad, Jalna and Greater Bombay this vehicle-intensity may not be sufficient for justifying the additional capital investment in the roads so it would be desirable to explore the complementarities in the distance-saving phenomenon with reference to the traffic from other regions on the important national and state highways having the significant vehicular traffic.
Table 11.2

Vehicular distance saved in kilometres with reference to Greater Bombay

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Distance with existing route</th>
<th>Distance with new optimum roads</th>
<th>Distance saved</th>
<th>Estimated vehicles for 1985 per day</th>
<th>Vehicular distance saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagpur</td>
<td>822</td>
<td>722</td>
<td>100</td>
<td>49</td>
<td>4900</td>
</tr>
<tr>
<td>Amaravati</td>
<td>691</td>
<td>617</td>
<td>74</td>
<td>21</td>
<td>1554</td>
</tr>
<tr>
<td>Akola</td>
<td>605</td>
<td>571</td>
<td>34</td>
<td>13</td>
<td>612</td>
</tr>
<tr>
<td>Aurangabad</td>
<td>No advantage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total vehicular distance saved in Kms. = 7036 Kms.
New road length to be constructed = 458 Kms.
Ratio of vehicular distance saved to new road length = \( \frac{7036}{458} = 15.36 \) Kms.
Fortunately as map has revealed that the Greater Bombay traffic on the national highway can be diverted to this new road which passes nearer to Aurangabad. The existing road link from Aurangabad crosses this new proposed road that can be used as trunk road for optimum road from Aurangabad.

Ratio of operating cost saved to capital cost is 2.62 which indicates that this suggested optimum highway with link road would generate surplus. Table reveals the comparative position of different trunk highways. The brief discussion of all three highways is as follows.

The suggested highways are as follows:
1) Nagpur - Malsej - Ghat optimum Trunk Highway.
2) Amaravati - Malsej Ghat Optimum Trunk Highway.

Estimated vehicular traffic between Nagpur and Bombay is 49 vehicles per day in 1985 so the optimum angle suggested by optimum model on the basis of this vehicular traffic is 44.48 i.e. 45. So the new road is to be constructed with this particular angle as shown in the figure from Nagpur towards Malsej Ghat. This road joins the existing Ahmadnagar Malsej Ghat Road.
The length of this new optimum trunk road is 468 Kms. This road provides the distance saving advantage to other complementary focal points viz. Amaravati and Akola with the existing roads as revealed in the map. The one section of existing road from Amaravati joins this suggested trunk road with angle 140°. The road from Akola also joins the same existing road. The estimated separate traffic between Amaravati and Akola in 1985 is estimated 21 vehicles between Greater Bombay and Amaravati and 18 vehicles between Akola and Bombay.

Critical break even number of vehicles with reference to angle 140 is 319 vehicles. An actual number of the vehicles plying between concerned nodes is not expected to reach this number; so no new separate optimum roads for Amaravati and Akola traffic with reference to new trunk road can be justified.

This new highway does not give distance saving advantage for Aurangabad focal point.

The ratio of vehicular distance saving to new road length is 15.36 as revealed in the table. 11.1

This ratio is lower than the ratio with reference to trunk highway from Akola. So on the comparative basis this new optimum trunk road cannot be finally accepted.
The estimated traffic excluding transit traffic between Amaravati and Bombay is 21 vehicles. This Amaravati focal point that includes the traffic between Nagpur and Bombay as transit traffic so the estimated total traffic between Amaravati and Greater Bombay is equal to 70. On the basis of this vehicular traffic, the optimum angle is 51°. The new road from Amaravati with the optimum angle 51° joining Nagpur Malsej Ghat Road is to be suggested. The length of the new road is 425 Kms. This road provides the additional distance saving advantage to Akola from Vidarbha and Aurangabad from Marathwada. The existing road from Akola joins this new trunk road making angle 125° estimated vehicular traffic in 1985 is less than critical break number of the vehicles as revealed in the table and so new roads from Akola cannot be justified.

The existing road from Aurangabad joins the new optimum road making angle 120°, the anticipated traffic between Bombay and Aurangabad focal point is 180 vehicles which is greater than the critical break even number of the vehicles i.e. 136 vehicles. So new optimum road of 63° can be suggested as shown in the map. The length of this new road to be constructed from Aurangabad would be 23.1 Kms.

The distance saving impact is revealed with reference to different focal points in Table 11.2. The ratio of vehicular distance saving to new road length is 42.27. It is less than the ratio with reference to Akola trunk road.
Table 11.3
Vehicular distance saved in kilometres with reference to Greater Bombay

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Distance with existing route</th>
<th>Distance with new optimum roads</th>
<th>Distance saved</th>
<th>Estimated vehicles for 1985 per day</th>
<th>Vehicular distance saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagpur</td>
<td>822</td>
<td>691</td>
<td>131</td>
<td>49</td>
<td>6419</td>
</tr>
<tr>
<td>Amaravati</td>
<td>691</td>
<td>561</td>
<td>130</td>
<td>21</td>
<td>2730</td>
</tr>
<tr>
<td>Akola</td>
<td>605</td>
<td>481</td>
<td>124</td>
<td>18</td>
<td>2232</td>
</tr>
<tr>
<td>Aurangabad &amp; Jalna</td>
<td>344</td>
<td>302</td>
<td>42</td>
<td>180</td>
<td>7560</td>
</tr>
</tbody>
</table>

Total vehicular distance saved in Kms. = 13941 Kms.
Total road length to be constructed = 448 Kms.
Ratio of vehicular distance saved to new road length = \( \frac{13941}{448} = 42.27 \)
so, this road cannot be accepted on the basis of comparative analysis.

**Akola Malsej-Ghat Optimum trunk highway.**

The estimated individual traffic between Akola and Greater Bombay is 13. But for this focal point the traffic between Nagpur, Amaravati and Bombay can be considered as transit traffic. So the total traffic between Akola focal point and Bombay is 33. The optimum angle on the basis of this 33 vehicle traffic is $54^\circ 30'$ i.e. $55^\circ$. So the new optimum trunk highway of this angle is to be suggested. The road length of this trunk highway is 347 Kms. Surprisingly this highway joins Ahmednagar Malsej Ghat Road at Malsej Ghat. Thus the optimum road coincides with minimum distance direct road. This implies that even though there are more vehicles than 33 vehicles these additional vehicles would have no impact on the optimisation of the new highway.

The ratio of vehicular distance saved to new road length is 53.76. This is the maximum ratio as compared to ratios with reference to Nagpur Malsej Ghat trunk highway and Amaravati Malsej Ghat trunk highway. So this trunk is to be preferred. This road proves also the distance saving impact for Aurangabad focal point in Marathwada. The estimated traffic from this Aurangabad focal point is 180 vehicles per day, in 1985. This focal point traffic includes traffic between Jalna and Bombay. The existing road link crosses the new road with angle $120^\circ$. 
Table 11.4

Vehicular distance saved in kilometres with reference to Greater Bombay

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Distance with existing route</th>
<th>Distance with new optimum roads</th>
<th>Distance saved</th>
<th>Estimated vehicles for 1985 per day</th>
<th>Vehicular distance saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagpur</td>
<td>822</td>
<td>693.2</td>
<td>128.8</td>
<td>49</td>
<td>6311.2</td>
</tr>
<tr>
<td>Amravati</td>
<td>691</td>
<td>562.3</td>
<td>128.2</td>
<td>21</td>
<td>2392.2</td>
</tr>
<tr>
<td>Akola</td>
<td>605</td>
<td>476.0</td>
<td>129.0</td>
<td>13</td>
<td>2451.0</td>
</tr>
<tr>
<td>Aurangabad &amp; Jalna</td>
<td>344</td>
<td>292.7</td>
<td>51.3</td>
<td>130</td>
<td>9234.0</td>
</tr>
</tbody>
</table>

Total vehicular distance saved in Kms. = 20688.4 Kms.

New road length to be constructed = 334.4 Kms.

Ratio of vehicular distance saved to new road length = 20688.4 = 53.76 Kms.

Ratio of operating cost saved to capital cost in rupees = 2.62
The critical break even number with reference to angle 120° is 134 vehicles. It is less than estimated vehicles i.e. 180. So new optimum road from Aurangabad joining the new Akola trunk road with optimum angle 64° is to be suggested. The road length of this new road from Aurangabad is 38.6 Kms. This new optimum road reduces the distance between Bombay and Aurangabad to the extent of 51.3 Kms. with reference to shortest route via Malsej Ghat with the existing road links. The distance saving impact is revealed in the table. 11.3
Parbhani - Ahmednagar Optimum Trunk highway.

The distance reducing impact of Malsej Ghat cannot be realised in case of Nanded owing to highway circuitous and detouring road links, between Nanded and Ahmednagar. The same trouble lies with Parbhani, Bhir in Marathwada. So the feasibility of road providing advantage to Nanded, Parbhani Bhir can be scrutinised. As revealed in the map the new road is to be suggested from Parbhani as the saving due to direct road from Nanded to Ahmednagar is not significant. The existing road link between Nanded and Parbhani can be taken as link road for joining this new road. This new road would reduce not only the distance between Nanded, Parbhani, Bhir and Greater Bombay but also the distance between Poona and Nanded, Parbhani, Bhir.

The same new trunk highway would provide the advantage to important towns from Yeotmal and Chandrapur Districts of Vidarbha region for traffic between these districts and Greater Bombay and Poona.

Estimation of traffic between Nanded and Greater Bombay.

The Regional transport Survey of Maharashtra State appears to have under-estimated the vehicular linkage between Greater Bombay and Nanded, on the basis of data presented in the report, estimated traffic was only 3 vehicles in 1964 but the data from Octroi Naka of Nanded town indicates that the vehicular traffic between -
Greater Bombay and Nanded was at higher level. On the basis of data from this source the estimated average traffic between Nanded and Bombay was 3 vehicles per day in 1964. The transit traffic at Nanded was estimated 3 vehicles per day. The reported bus traffic was only 2 vehicles. On the reasonable guess the cars and jeep traffic was estimated equal to 2 heavy vehicles. So the estimated total traffic between Greater Bombay and Nanded was 15 vehicles in 1964. The data from Nanded Naka for truck traffic in 1970 is used to estimate the growth rate. The data have indicated that the average rate of growth of truck traffic was 7.77 percent per annum. On the basis of this rate of growth the estimated total vehicular traffic would be 40 vehicles per day between Nanded and Greater Bombay in 1985.

Estimation of Parbhani Bombay Traffic and Optimum Highway.

Regional Transport Survey of Maharashtra State reports no traffic between Parbhani and Greater Bombay. This cannot be taken as reliable owing to the inherent deficiency in survey. So on the reasonable guess as revealed in the table, traffic of 11 vehicles in 1985 is predicted. So the traffic between Parbhani and Bombay would be 51 vehicles which 40 as a transit traffic and 11 as terminating and originating traffic between Parbhani and Greater Bombay.

1. It was survey of a week so within survey period no traffic between Greater Bombay and Parbhani was likely to be noticed. This ultimately resulted into under-estimation of the traffic of entire year.
On the basis of predicated vehicular traffic, the optimum road with optimum angle $45^\circ$ is to be constructed from Parbhani as revealed in the map. But there is missing link so this is the case of modification of optimum model. The modification suggests that the direct linear road between Parbhani and Ahamadnagar is minimum cost road. The new road length of this direct road is 213.9 Kms. i.e. 219 Kms. This direct road between Parbhani and Ahamadnagar can act as trunk road for Bhir Bombay traffic.

Estimation of the traffic between Bhir and Bombay and optimum link - road.

Maharashtra Regional Transport Survey provides the total tonnes traffic between Bhir and Bombay. The reported per day average originated and terminated traffic was 22 tonnes. The growth rate from Nanded traffic is taken for the forecasting the traffic in 1935 on the basis of the rate of growth equal to 7.77 per cent per annum. The estimated traffic in 1935 would be 43 vehicles per day as shown in the table.

The existing road crosses the new trunk road with the angle of $30^\circ$. The critical break even number of vehicles for existing roads with this angle is 33 vehicles. The predicated vehicular traffic in 1935 is 43 vehicles. The predicated vehicular traffic in 1935 is greater than critical break even number of vehicles. So new optimum road with the angle $43^\circ$ can be suggested as shown in the map. The length of this road is 27.75 Kms. This new route reduces the distance
### Table 11.5

**Vehicular distance saved in Kilometres with reference to Greater Bombay**

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Distance with existing route</th>
<th>Distance with new optimum roads</th>
<th>Distance saved</th>
<th>Estimated vehicles for 1985 per day</th>
<th>Vehicular distance saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanded</td>
<td>646</td>
<td>512.1</td>
<td>133.9</td>
<td>40</td>
<td>5356.0</td>
</tr>
<tr>
<td>Parbhani</td>
<td>506</td>
<td>424.1</td>
<td>81.9</td>
<td>11</td>
<td>974.6</td>
</tr>
<tr>
<td>Bhir</td>
<td>396</td>
<td>344.3</td>
<td>41.7</td>
<td>43</td>
<td>1793.1</td>
</tr>
</tbody>
</table>

Total vehicular distance saved in Kms. = 3123.7 Kms.

Ratio of vehicular distance saved to new road length = $\frac{3123.7}{218.95} = 37.1$

Ratio of operating cost saved to capital cost = 1.81
between Greater Bombay and Bhir to the extent of 41.7 Kms.
in addition to the distance reduced by Malsej-Ghat with
the existing route.

The trunk road and this optimum road from Bhir
gives the ratio of vehicular distance saved to additional
new road length equal to 37.1 Kms (Table 11.3). The ratio
of operating cost saved to capital cost is 1.31 which is
greater than 1 which indicates that on the basis of above
analysis the suggested optimum roads would generate surplus.
The excluded complementary effects are expected to be
significant. For instance this road link reduces the
distance between Poona, Nanded, Parbhani, Bhir and many
towns from Vidarbha.
Omerga Ahamadnagar Trunk Highway:

Omerga has a crucial importance in our highway layout planning because its location on the Bombay-Hyderabad National Highway. The distance saving impact of Malsej Chat cannot be secured due to circuitous road between Omerga and Ahamadnagar. The road from Omerga with reference to Ahamadnagar-Malsej Chat road can be suggested, but proposed Colegaon-Ahamadnagar road can be taken linear extension of this road. So Colegaon-Ahamadnagar road is to be taken as reference road. This road would provide the advantage to Latur, Udgir, Osmanabad, towns from Marathwada region. The traffic on National Highway between Greater Bombay and southern India can be accrued the advantage of the saving in distance.

As said earlier, the existing road from Colegaon to Ahamadnagar is to be taken as reference road for the optimum trunk highway from Omerga to Ahamadnagar for Omerga-Bombay traffic. There is missing link between this reference road and Omerga as revealed in the map. The extended representative linear line of existing reference road as shown in the map touches focal point Omerga. The necessary perpendicular line cannot be drawn. The direct road from Omerga to Ahamadnagar just coincides with the representative extended line of the reference road. Colegaon-Ahamadnagar road can be taken as linear extended road of Ahamadnagar-Malsej Chat Road. Thus, the location of Omerga, Ahamadnagar and Malsej-Chat can be taken as almost on the same linear line (by passing circuitous road section near to Colegaon).
This provides us the illustration of exceptional case of minimum total cost direct road with zero angle between focal point and extended reference road-line. Though in this exceptional context, for application of modification of optimum nodal the estimation of vehicular linkage intensity is not necessary, the vehicular traffic between Omerga and Bombay is estimated to ascertain the magnitude of vehicular distance saving impact and ratio of operating cost saved to capital cost of optimum trunk highway from Omerga.

Estimation of vehicular traffic between Omerga and Bombay.

The traffic between Omerga and Bombay mainly comprises transit traffic between Bombay and Southern India. The important city in this particular context is Hyderabad. Omerga has been not included as a focal point in the O-D survey conducted in 1964. Hence transit traffic at Sholapur with reference to Sholapur Omerga section of Hyderabad-Bombay National Highway provides a maximum range of traffic between Greater Bombay and towns from Marathwada as well as towns from Southern India. On the basis of discussion with concerned persons at Sholapur Naka, 50 per cent of this transit traffic is taken as traffic between Omerga and Greater Bombay. According to origin destination survey 1964, average per day transit traffic at Sholapur with reference to above-mentioned road section was 423 tonnes, 50 per cent of this transit traffic gives us 43 vehicles per day traffic between Omerga and Greater Bombay in 1964.
Owing to non-availability of data the growth rate on the basis of data relevant to this section cannot be estimated. Hence the estimated growth rate with reference to Nagpur Amaravati section on National Highway is to be used for estimating the future traffic in 1985. This estimated rate is 3.56 per cent per annum. On the basis of this rate the estimated vehicular traffic between Omerga and Greater Bombay would be 75 trucks in 1985. On the basis of reasonable guess, car traffic is taken equivalent to 5 vehicles hence the total vehicular traffic between Omerga and Greater Bombay would be 80 vehicles in 1985.

The construction of 109 Kms. from Omerga as additional road length provides the optimum link. The distance saved between greater Bombay and Omerga is 62 Kms. The distance saving impact is revealed in the table.

Estimation of traffic between Latur and Bombay.

According to O-D Survey in 1964, Latur and Greater Bombay traffic was 7 tonnes per day. This gives us two trucks traffic per day. One truck can be taken as a transit traffic. So total trucks traffic between Latur and Bombay would be equal to 3 trucks. On the basis of information sought, the traffic between Latur and Bombay was 2 vehicles. On the basis of guess, car traffic can be taken equivalent to 2 vehicles. So total traffic between Latur and Greater Bombay was estimated equal to 7 vehicles.
Table 11.6

Vehicular distance saved in kilometres with reference to Greater Bombay

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Distance with existing route</th>
<th>Distance with new optimum roads</th>
<th>Distance saved</th>
<th>Estimated Vehicular vehicles distance for 1985 saved per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omerga</td>
<td>521</td>
<td>459</td>
<td>62</td>
<td>30</td>
</tr>
<tr>
<td>Latur</td>
<td>511</td>
<td>443</td>
<td>63</td>
<td>25</td>
</tr>
</tbody>
</table>

Total vehicular distance saved in Kms. = 5360 Kms.

Ratio of vehicular distance saved to new road length = \( \frac{5360}{109} = 53.76 \)

Ratio of operating cost saved to capital cost = 2.62
Owing to inadequacy of data growth rate based on traffic on Latur Barshi section cannot be estimated. Hence growth rate related to Aurangabad traffic on the State Highway is used as traffic between Latur Barshi is on the State Highway. The estimated annual per cent growth rate of this traffic is 11.7. On the basis of this growth rate, the traffic between Latur and Bombay would 25 vehicles in 1985. (Table 11.4)

Latur gets the advantage of this new trunk Highway from Omerga. The existing road from Latur to Barshi crosses this new road with the angle of 120°. The critical break even number of vehicles for this angle is 134 vehicles for 1985. The predicted estimated traffic between Latur and Bombay is 25 vehicles. No reliable data is available, but on the basis of reasonable guess, it can be said that vehicular traffic is not sufficient to justify the new road from the relevant section of Latur Barshi Road. The new optimum trunk highway reduces the distance between Latur and Greater Bombay to the extent of 68 Kms.

The estimated ratio of vehicular distance saved to new road length is 53.76. The ratio of operating cost saved to capital charged is 2.62 which is greater than 1. It indicates that the new optimum highway is likely to generate surplus.
SUMMARY AND CONCLUSIONS

1. The positive correlation between the National income and mobility is shown.

2. Road transport has its own distinctive qualities providing superiority over railway in certain fields.

3. The road accessibility may have one of the following effects on the regional development.
   a) Positive stimulating effect
   b) Deceleration effect
   c) Negative retrogression effect

4. The road accessibility is necessary condition for the regional development, but it is not sufficient condition.

5. Theoretically there can be region having adequate and efficient road system with lower level of economic development. But, there exists hardly any developed region with poor road system.

6. The probability of transmission of detrimental backwash effects cannot be ignored. But this possibility does not suggest the deliberate policy of keeping regions lacking in efficient road system. On the contrary, it suggests planned industrial development with efficient road system.

7. The supply effect on price is influenced by relative accessibility. The inverse supply effect on price is more in the market having inadequate and inefficient accessibility. This is particularly pertinent to agro-products.

8. There is a need for sector-wise analysis of accessibility impact.
1) For agricultural sector the following effects are conceived:
   a) Positive acreage extension effect.
   b) Positive physical yield effect.
   c) Positive marketing density effect.
   d) Crop pattern improvement effect.
   e) Spatial crop concentration effect.

ii) For industrial sector following aspects deserve special attention:
    a) Road accessibility and spatial concentration of industrial activity.
    b) Accessibility and technological transformation process.
    c) Accessibility, excess capacity and over capitalization.

iii) Road accessibility impact on village and market.

PART II

Underdevelopment of Marathwada is mainly caused by lack of efficient road system, as it is mainly agriculture dominated region. But, the effects of road accessibility are found qualitatively different in the case of different sectors.

The estimations indicate that demand for transportation in Marathwada is significantly lower for mechanical transportation.

The lower demand for mechanical road transport is mainly attributed to lower density in Marathwada as all estimated multiple equations have substantiated the positive effect on the demand. It points out that additional roads tend to generate traffic for road transportation.
The inter district variations in demand can be explained as caused by variation in level of industrialisation and road density, but short run intertemporal changes in demand cannot be attributed to changes in manufacturing activity.

The demand for truck transportation express in terms of tonnes is mainly generated by population of the town. Comparatively truck transport tonnage intensity of population of towns in Marathwada is lower as same in West Maharashtra and Bombay. The towns having no broad gauge railways has relatively higher demand for truck transportation.

In the case of agricultural sector strong positive stimulating impact of road density on average physical yield of Jowar, Cotton, Groundnut is substantiated by multiple regression analysis.

The empirical analysis shows that the average physical yield of major crops with greater transport intensity are more sensitive to level of accessibility. The relationship is positive. In the case of acreage extension impact, the mild positive effect has been revealed. But surprisingly the anticipated road accessibility effect on crop pattern is not substantiated.

In the case of Marketing surplus density, and revenue productivity per acre, the stimulating positive road accessibility has been revealed. Thus, barring crop pattern, lower level of agro productivity in Marathwada can be convincingly attributed to the lower road density in the region. These findings are highly instructive as agro-productivity is mainstay for income generation in the region.
On the contrary in the case of industrial sector back-wash effects through road accessibility are identified.

a) In the case of industrial spatial concentration the analysis demonstrated that road accessibility has discouraging impact on spatial concentration in developed as well as under-developed region. But the magnitude of the negative impact is higher in the case of Marathwada. This may be attributed to greater degree of under-development. The negative impact is mainly explained as owing to excessive industrial concentration in Greater Bombay. In the case of railway accessibility the positive effect is confined only to broad gauge railway. Meter gauge railway has discouraging impact. The negative impact of road density does not suggest that the lower level of road density is allowed to perpetuate in Marathwada on the other hand it recommends the improvement in road facility with purposeful planned efforts for industrial development of the region.

In the context of technological transformation with special reference to cotton textile industry, road density appears to have no influence. This suggest that the backward technique of production in the region cannot be attributed to lack of road facilities. But, in this context, the distance from Greater Bombay has been emerged as a very important powerful determinant having negative effect. This finding is highly pertinent as the existing road system provides highly circuitous and detoring roads between Bombay and focal points in Marathwada resulting into excessive distance between focal points and Greater Bombay. Reduction in economic distance would accelerate technological transformation in the region.
Road accessibility effect on the modern sector in textile industry failed to emerge. Same is the case with traditional sector of textile industry.

A very important finding in the context of excess capacity and probable over capitalization in agro processing industries viz. Ginning, Pressing and Oil Mills has been found out. The finding suggest that greater and greater road accessibility would tend to eliminate the number of processing factories in the region increasing average supply area of the concerned productive units. From the dynamic point of view, inaccessibility creates forces to induce excessive investment, in the form of more number of factories, after increase in the road facilities. This excessive number gets reduced. This suggest that increase in road facilities at early stages save the capital which is highly scarce in the country like India and region like Marathwada.

The positive relationship between average size of the village and degree of road accessibility is evidenced. This implies more and more road would tend to increase the size of the village. The same inference can be applied to Urban centres. Big villages and Urban centres are prerequisite for efficient process of economic development of the region. In this context the indirect effect of road accessibility is crucial.

Very interesting observation has been revealed; the distance between villages and marketing centres appears to be insensitive to the lack of road facilities. The explanation lies
PART III

Present lay-out planning ignores the implication of operating cost of the vehicles of given inter nodal transportation.

Inter-nodal cost function is relevant.

The new optimising model taking into consideration construction cost as well as operating cost of the vehicles has been developed. This model gives the optimum angles for linking the new road to the existing roads so that the total cost comprising construction as well as operating cost for given inter nodal traffic would be minimum.

The model for critical break even angle has been developed for suggesting the distance saving roads linking existing road system. This critical break even angle gives critical break even number of vehicle with given track cost and operating cost. This critical break even angle is also optimum angle but optimum angle may not be necessarily critical break even angle. The critical break even number of vehicle indicates whether with the given existing vehicular traffic new road would be break even or otherwise. This saves the number of alternatives for cost benefit analysis. Cost benefit analysis can be confined for only a few alternatives. If existing vehicular traffic is less than critical break even number of vehicles readily we can save no road would be break even.
The optimising model requires modifications in the context of missing road density. Length of the optimum roads, direct roads and reference roads.

The existing zigzag and circuitous roads create difficulties in the application of the models. For multiple nodes, comparative analysis is required. The ultimate choice is to be based on the ratio of vehicular distance saved to additional length of optimum roads. The alternative having highest ratios is to be preferred.

In the context of Marathwada, the road system suffers from the deficiencies in the form of missing links, circuitous and detouring roads. This provides the opportunities for application of the models for optimising highway system in Marathwada taking into consideration complimentarities between intra as well as inter-state traffic.

New construction of Malsej Chat provides potential distance saving for many focal points in Marathwada as well as in other regions. This is pertinent especially for traffic between Greater Bombay Marathwada and Vidarbha. From official quarters and reports, astonishingly it appears that distance saving impact of New Malsej Chat has not received a serious and due attention. So, in the proposals of optimising road system with special reference to Marathwada new routes for Greater Bombay via Malsej Chat has been given exclusive importance.

Owing to lack of data analysis of only three new trunk highways have been attempted. These proposals are
also highly tentative. After comparative analysis the final choice of the new optimum highways are as follows:

a) Akola - Malsej Ghat - Greater Bombay
c) Omarga - Malsej Ghat - Greater Bombay.

While proposing new optimum highways it is not the financial cost but the economic cost based on accounting prices of factor inputs has been taken as the basis.

The study suggests that the present approach of highway and road planning in India is to be completely changed. The same conclusion is applicable to labour surplus economies. Many more new highways and roads can be added having rational economic ground. The construction of new roads would provide employment to surplus labour and also saves the foreign exchange. Road construction is import substitution activity using the surplus labour in India. Thus, it has highly significant practical bearings in the policy formation of planned road development in the India.