SUMMARY AND CONCLUSION

Transportation network is a measure of spatial relations between areas and therefore an essential part of Geography. Further it can be stated that transport is essentially a geographic phenomenon. Obviously, the transport network plays a vital role in the socio-economic development of an area and create new settlements and spatial linkages thus had areal interactions and their by bringing different areas into the main stream of economic and cultural life. It is pertinent to state that the transportation is becoming an increasingly important aspect in the process of urbanization, industrialization and modernisation thus which had mutual influences. The development of transport network, in short, could be made possible ever large clumps of people and economic activities and therefore contributed to a great increase in the number of larger settlements with well built up area and productivity.

In the backward areas like Anantapur district where agriculture is the predominant source of economy, the
transport network preferably road transport could do more in improving the socio-economic conditions of the people. In these areas where population is low with dispersed distribution of rural settlements called for the development of road network in order to break the traditional outlooks of the people and develop the technological insights in exchanging the functional services. It is in this direction the present study on "Analysis of Road Transport Network in the Drought Prone Area - Anantapur District" is chosen to examine the structural characteristics and development of road network in the district. The present study stressed on the spatial organisation of road transport network system consisting the accessibility, connectivity, road efficiency and traffic flow. The present attempt is likely to provide greater scope for formulating better strategy for the development of road transport system which is the main infrastructural organ for an integrative development of the district.

Locational Aspects of the Study Area:

Anantapur district is one of the most backward regions of India located in the south-western part of
Andhra Pradesh State. In terms of geographical area, it is the largest district in Andhra Pradesh with a low density of a population of 135 persons per square kilometer dwelling in 934 rural settlements and 11 urban settlements. At present for administrative convenience the district is divided into 63 mandals.

Anantapur district has an undulating terrain dotted with ridges and clusters of rocky hills which are characteristics of Deccan Plateau. Since it is located in the rainshadow belt of Western Ghats, the rainfall is very low (544 mm) and erratic. The soils are predominantly red, poor in fertility. Agriculture is the important occupation of the people but it is uncertain and precarious. The frequent occurrence of droughts, prolonged dry spells and crop failures and scanty irrigation facilities have had a shattering effect on agricultural economy of the people in the district. Groundnut is the predominant crop in the cropping pattern of the district. The district is fairly well known for some of its mineral deposits but the area lacks in a mineral based industries. In view of prevailing precarious conditions of agriculture, low irrigation development, lack of industrial base and poor socio-economic conditions as well as maximum
spacing of rural and urban settlements. It is essentially to be stressed on the development of infrastructural facilities in general, and transport network in particular. It is an established fact that the road transport network necessarily plays a key role in improving and modernising the important economic activities like agriculture and industry as well as in establishing market hierarchy to serve various functional services.

Objectives of the Study:

For providing a comprehensive plan to develop road transport network in Anantapur district, it is imperative to gain insights into various structural characteristics of road network and the changes therein. It is also necessary to understand the growth of road network and its main problems and constraints which hinder the form and function as well as efficiency of road network in the district. A study on accessibility and pattern of traffic flow help to pinpoint the problems of regional road transport. The analysis in the study is made at different points of time namely, 1961, 1971, 1981 and 1988.
Evolution and Development of Road Network in Anantapur District:

The evolution of road transport network dates back to the 17th century has revealed that there were only few trade routes and highways in the district. The important highway passed through the central part of the district was Kasi-Rameswaram Highway. In the olden times due to strategic location of this district in the Deccan plateau and mighty kingdom of Vijaya Nagar emperors, many historical, political and pilgrim places like Hemavathi, Penukonda, Gooty, Hindupur, Rayadurg, Penna Ahobilam, Tadipatri, Lepakshi and Kadiri have been connected by High Ways. Most of the roads developed during Vijaya Nagar rulers were used for the movement of troops, military and arsenals.

It is significant to note that there was not a single road fit for wheeled traffic upto 1853. During British rule some attempts have been made to widen the old tracks and construction of some rough roads in the old passes for the movement of military wheeled carriages. After the creation of Trunk Road Department in 1845, new roads have been constructed for example, the road from Bellary to Cuddapah
passing through the taluks of Gooty and Tadipatri of Anantapur district. After formation of Anantapur district in 1882, the Local Fund Board of the district took up some measures in metalling the roads. By 1881-82 the Local Fund Board was maintaining 1320 Kms., of road network in the district.

It is needless to state that during the last One Century period many remarkable changes took places at administrative level for the development of road network. Many new policies and acts have been brought for the growth and maintenance of roads. During 1931-32 construction of bridges and cause ways were taken up systematically over the major rivers and streams in the district. For example, the cause ways across the river Pennar at Pamidi and at Penna Ahobilam and cause way across the river Papagni at Bala Samudram and the cause way across the river Chitravathi near Kadiri were completed during this period. During 1940's few more cause ways and bridges have been constructed across major rivers and streams in the district. Due to the second world war all roads except Trunk roads were mostly deteriorated due to the diversion of all steam road rollers for military works. During the First and Second Five Year
Plans after the Independence the important roads were widened and black topped.

At present, the road network in Anantapur district is consisting of 860 Kms., of High Ways and 7160 Kms., of all other types of roads. This comes to around 42 Kms. per 100 Sq.Kms. of geographical area; and 3.2 Kms for every 1000 population in the district. Now the district is traversed by only one National Highway No.7 which is running north-south direction. It is called Banaras-Cape Comorin National High Way connects Anantapur with many important nodes like Kurnool, Hyderabad, Nagaipur and Bangalore in outside the region. Within the district the National Highway also connects important urban nodes like Gooty, Pamidi, Penukonda and Hindupur.

Between 1976 and 1986 there was a significant increase of road length in different types of roads in the district as it is evident from the fact that the state highways increased by 1004 Kms; Zilla Parishad roads increased by 593 Kms; and the Panchayat Samithi roads increased by 1000 Kms. of road length.
Density of Road Network:

The density of road network indicates the length of road per unit of geographical area which discerns the degree of connectivity and accessibility of road network system. In the present study the road density is calculated by taking mandal as an unit of analysis. The average density of road network in Anantapur district accounted for 0.4 Kms/Sq.Km. The highest density of road network noticed in Amarapuram while the lowest density in Kudair mandal. There are 28 mandals showed the road density of more than the district's average while 35 mandals have below the average road density of the district. The mandals located in northern and southern parts of district consisted low density of road network of less than 0.3 Kms/Sq. Km. It may be due to dispersed distribution of settlements and hilly terrain conditions.

Changing Spatial Pattern of Structural Characteristics of Road Network:

The spatial structure of road network is analysed in terms of topologic and geometric components (graph-theoretic measures). In the present study all the urban settlements, administrative centres and the settlements having
more than 5,000 population have been taken as vertices which come to 63 nodes. The National and State highways, major district roads and other district roads are considered as edges. The changes in the structural characteristics of road network of Anantapur district are measured during the period between 1961 and 1988. The graph theoretic measures such as Alpha, Beta, Gamma, Pie, Eta, Theta, Cyclomatic number and Pie indices as well as Binary, Shortest path Matrices, König number, Shimbal Index and Detour indices are measured.

The study has revealed that there has been an increasing degree of connection from poor to complex pattern of road network in the district in the last 17 year period. The Alpha and Gamma values represented a significant change in the structural pattern of road network from Grid to Delta Pattern. The lower values of Eta and Theta showed an improvement in the degree of connectivity. As increasing the values of Pie index from 5.6 in 1961 to 11.6 in 1988 indicating considerable increase in the compactness of the road network structure in the district.

The node and link ratio assessment has been measured by employing Binary, König, Shimbal and Detour measures. In
the year 1988, the Binary Matrix revealed that Tadipatri is identified as the most connective settlement with 8 direct linkages followed by Kalyandurg, Uravakonda, Anantapur, Rayadurg, Kadiri and Penukonda nodes. It is inferred that the urban settlements showed more nodal relationship than the rural nodes in terms of direct road linkage.

The degree of centrality which is measured with the help of Konig number has revealed that N. Gate, Anantapur, Pamidi are identified as the most central nodes since they have the low value of Konig number 7. Virtually, all these nodes with high centrality are located in the central part of the district. In contrast, Pedda Vadaguru, Kokanti and Valsa are identified as the least central nodes due to high values of Konig number. From the present study it is inferred that the nodes which are located in the central part of the district have consisted more centrality irrespective of their rural or urban characteristics. The large urban settlements like Anantapur, Dharmavaram, and Penukonda have also consisted more centrality and connectivity because of their urban characteristics and higher-order service system.
The vertex detour index analysis has revealed that Kadiri node showed the lowest Detour index value of 118 indicating the high nodal efficiency in saving journey time. The higher Detour index value areas are found in Putlur and Yellanur nodes. The nodes located in the northeastern and western parts of the district have shown high Detour index values indicating low nodal efficiency. Here, it is stated that the transport road network in terms of directness is much influenced by physiography and spacing of settlements in the district.

The application of Shimbel index with the help of Shortest Path Matrix has revealed that Anantapur and Bathalapalli nodes are identified as the most connective nodes in the district. In contrast, Valsa node with a maximum value of 592 has been identified as the least connect node because it is located in the foremost corner of the district. From the analysis of Shimbel index it is observed that the urban settlements possessing lower values indicating higher connectivity than the rural places. The towns located at the centre of network system have witnessed with great connectivity than the towns located at the peripheral areas.

For example Hindupur urban node located at the peripheral
part has witnessed with a high value of Shimbel index indicating the low connectivity. Anantapur town which is identified as the most central node with high connectivity is not only due to its central location but also due to higher-order functional service system.

The efficiency of road network also depends on direction and shape of the route or an edge. The 'Straight' line is the most efficient route that any edge of the network can make. In the present study, the route shape analysis is made for 11 urban nodes with an aim to measure the regularity and shape efficiency of road in terms of direct connection with the other neighbouring nodes. From the analysis, it is noticed that Hindupur node with a low mean value of 1.5 indicating the routes directly connecting the other nodes are regular and high efficient in their route shapes followed by Uravakonda, Penukonda and Anantapur nodes with low mean values. In contrast, Dharmavaram, Guntakal, Tadipatri and Gooty with high mean values indicating the low efficiency and irregularity or route shapes in the district.
Spatial Pattern of Accessibility and Traffic Flow:

In the present study, the accessibility of road network is also measured with the help of Isodromes at 2 Kms., 5 Kms., and more than 5 Kms., distances from the edges. The settlements which are located beyond 5 Kms. are considered as the most inaccessible areas while the settlements located between 2 and 5 Kms., Isodromes considered as moderate accessible areas and settlements within 2 Kms., isodromes considered as the most accessible areas. The study has revealed that 42 per cent of the total settlements of the district are located within 2 Kms., isodrome showing the most accessible parts from the point of road facility, 24 per cent of the total settlements in the district are located between 2 and 5 Kms., isodromes indicating moderate accessibility of the settlements in terms of road facility. About 34 per cent of total settlements are located beyond 5 Kms., isodromes indicating the most inaccessibility in terms of road facility. The settlements located in the north, north-eastern and south-eastern parts of the district have consisted low accessibility in terms of road facilities. Owing to thin distribution of population dispersed and isolated distribution of rural settlements, lack of sufficient
and required cause ways and bridges across the rivers and streams and poor traffic flow have had a bearing influence on arrangement of road facilities to each and every corner of the place in the district. However, the inaccessible areas which are identified in the district are also to be well connected for overall development of the region.

Traffic flow means simply the volume of movement of goods, people and message. It is the core element of circulation system which reflects the complex nature of economic interdependence. In the present study, the flow analysis is made on the basis of passenger traffic flow on road network. The data is based on the number of trips plying on different routes which cover the public transport system only. It is observed from the study that high volume of bus traffic flow noticed on the National Highway connecting important urban centres in the district. The highest passenger flow is observed on Anantapur to Bathalapalli route. The low volume of bus traffic flow is noticed in north-western and south-western parts of the district because those areas are at the marginal ends of not only Anantapur district but also Andhra Pradesh State. The movement of people may be
less from such marginal ends towards the district head quarter and other important urban settlements in the interior parts of the district for daily services because many of the daily services would be served by the important settlements in the neighbouring states. Another important reason that a low traffic flow in the western border of the district is due to poor socio-economic conditions of people and frequent occurrences of drought and famine conditions. Very low distribution of population and dispersed pattern of settlements, Poor economic conditions of people have had a shattering effect on road traffic flow system in the western part and in some other areas of the district.

Problems and Planning of Road Development:

The ultimate aim of the study is to forecast the structure of transport network for overall development of the region.

The problems of the road transport development are the construction and widening of the transportation lines in an undulating terrain; bridging the streams, surfacing of roads with black top to cope up with the heavy traffic. The
old causeways and culverts which were constructed years before have not been useful for present requirements.

To overcome some of the shortages of road network, an effective plan has to be made for well distribution of roads in order to improve connectivity and accessibility of the places in the district. Construction of new roads in the inaccessible area, widening of the roads in the heavy traffic zones, repairing of old bridges, causeways at important junctions, reducing the steep gradient on the edges of routes, development of plantation along the road sides, construction of bus stations with minimum facilities at important nodal centres, metalling of panchayat samithi roads and Zilla parishad roads, development of road linkages at different hierarchical levels namely, linkages between first-order, second-order and third-order settlements for administrative convinience and for functional services; and proper maintenance of road signal system are necessarily be taken up in the drought prone Anantapur District.

A well distribution of road network in the drought prone Anantapur district enables to serve for the development of agriculture, industry, and commerce and trade and
to create growth pole centres for well functioning of various services for the native people to take part actively in the development of regional economy. Lastly, it is pertinent to state that the roads are the only means linking all types of settlements, people and services and bringing into the mainstream of economic life of this backward region.