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HISTORICAL SKETCH OF ROADS

Roads are pathways used through a country to facilitate the movement of persons and exchange of commodities. They range from crude paths made passable by pedestrians to a perfect modern road passable alike by persons and vehicles.

The necessity of roads arose due to the desire of man (1) to mix with his fellowmen, (2) obtaining provisions for his sustenance in times of scarcity and (3) to gratify his fancies with the products of other localities.

Roads did not exist in very old times in the same shape and form in which we see them today, but they were in the form of small tracks and paths. In pre-historic times there may not have been even regular paths. People lived in caves, on tops of trees and their need was only food which they got about easily by just wandering hither and thither, gathering wild fruits and by hunting.

Then perhaps an urge for a social life, or the fear of wild animals drove them to live together in small separate groups. People from one group began paying courtesy calls or business visits to people in the near-by groups. Man afterwards followed the same paths, leaving behind a track, and that was the first stage of a road.

These paths were, however, wiped out by floods or a heavy snow-fall and people were compelled to explore other tracks.

These tracks were comparatively easy in plains but not so in thick jungles, where the task of even locating the proper direction was quite difficult. So people there thought of marking out the trees that came along the route. People would then follow up these marks. These paths were necessarily long and circuitous, so they began straightening them out by cutting and removing any obstructions that came in the way.

The alignment was thus a bit improved. The paths, however, remained just enough wide to admit only one man to pass through. As the necessities of the people increased, they began carrying their goods by pack animals and later on by carts. That automatically made them feel the necessity of wider roads. Hence one extra line or two of trees were cut by them and the road was widened.

Levelling up of the surface was also attempted. Now both the animals and carts required rather smooth surface. This, however, was not enough. In rains long reaches of roads got flooded and the surface became rather muddy thereafter.

Raising of roads was then considered necessary. To such roads we now give the name of FAIR-WEATHER ROADS. Even now-a-days they form the basis of metalled roads.

As cities began to grow at important trade centres and along river banks, traffic naturally increased. Agricultural produce had to be moved from inside the country to the centres of the populated areas. Heavier types of carts and carriages had to be employed and that led to the necessity of harder surface.

Advantages of Roads

1. Roads are the chief modes for the advancement of a community.

2. Without roads the interchange of advantages moral, intellectual and physical, which now take place between the rural and urban population, would not exist.

3. The rural supplies agricultural wants to urban population, while urban population supplies various articles of luxury obtained by commerce from every part of the globe.

4. They supply military transport and routes for armies for self-defence.

5. The rail-roads are like the arteries of a living body, while the common roads are the veins and each is equally necessary in quickening and communicating life to the parts they lead.

6. Growth of towns and villages depends on roads.

7. Growth of markets and consequently growth of trade depend on road.

8. Development of education in backward places, of railways, waterways and airways all depends on roads.

Growth of Roads in Western Countries

In western countries, Romans were the pioneers of scientific road making. Their activity being necessitated by their military campaigns. The first of the great Roman road 'Appean Way' (after the name of King Appean Claudius) was begun in 312 B.C. which was 576 km. long. The chief characteristics of Roman roads were :

1. They were very thick. In some places the road was as much as 1·22 metres thick.

2. They were usually made for military purposes.

3. They were not banked but were built up after all loose soil had been removed and a solid substratum reached.

4. They were straight and regardless of gradients.

The Construction was as follows

Two parallel trenches were dug along the proposed alignment, marking the width of the road way. The soil was then excavated between the trenches until a solid stratum was reached. Upon this were placed large flat stones 3 m long in lime mortar followed by smaller stones 25 cm thick in lime mortar and on top was usually placed a kind of pavement of large stones fitted together with the joints filled in with mortar.

The thickness of the Roman construction was often as much as 1·22 m. and the width of surfacing rarely exceeded 4 m. (See Fig. 1·1)

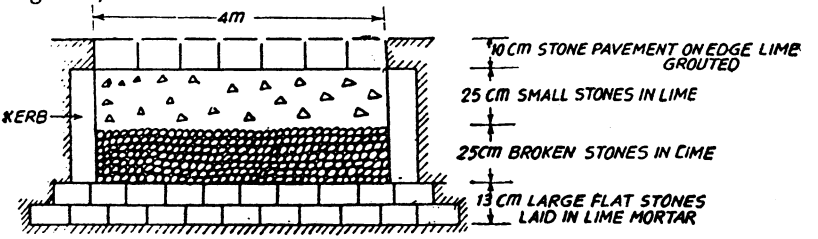

Fig. 1·1. Roman road.

When marshy ground was encountered, piles were provided as per section shown below :

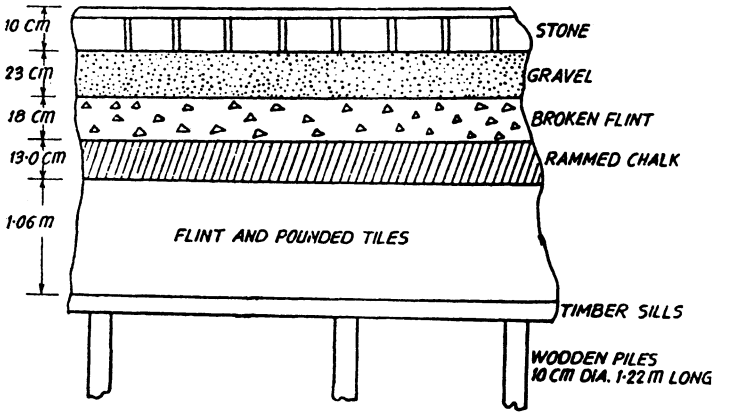

Fig. 1·2.

In most cases the Roman roads were raised above the level of the adjacent ground to facilitate drainage. In the 17th century the roads of Europe were in a very bad condition only 2 m to 3 m wide with considerable camber, which forced vehicles to be in the centre and hence developed ruts.

In (1716-1796) a French Engineer P. Tresaguet introduced his design. He stressed the necessity of draining the foundation and top surface.

The chief characteristics of Tresaguet's design were :

1. He improved the drainage by the formation of convex base.
2. Thickness of courses was equal throughout the width.
3. Depth of broken stones was 26 cm.
4. The camber provided was 1 in 36. (See Fig. 1·3)

With the growth and improvement in traffic, various minor improvements were carried out from time to time. Then followed Thomas Telford (1754-1834) the founder of the Institution of Civil Engineers, who introduced his design in Scotland in 1803.

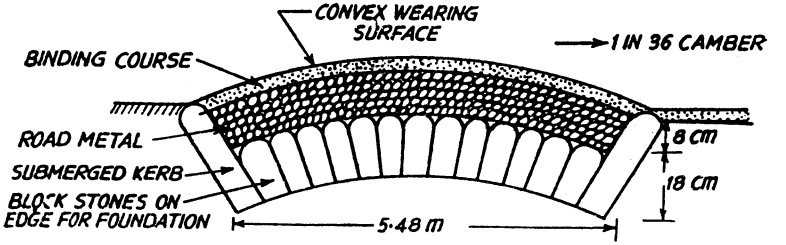

Fig. 1·3. Tresaguests design 1775.

He excavated a trench of the width desired for the roadway but retained a horizontal bed. Upon this he placed a hard set soling consisting of stones 18 cm to 23 cm deep in the centre and 13 cm at the margins, set on edge. These stones were not more than 10 cm wide on top. All the projections of the upper surface were broken off and the interstices were well-rammed with small stones. By this means he obtained a foundation of a convexity of 1 in 45. Upon this a light cushion of sand and a 15 cms thick layer of hard stones broken so as to pass 6·35 cm ring was placed. On top of this he placed 4 cm thick layer of good gravel, free from clay and earth. (See Fig. 1·4)

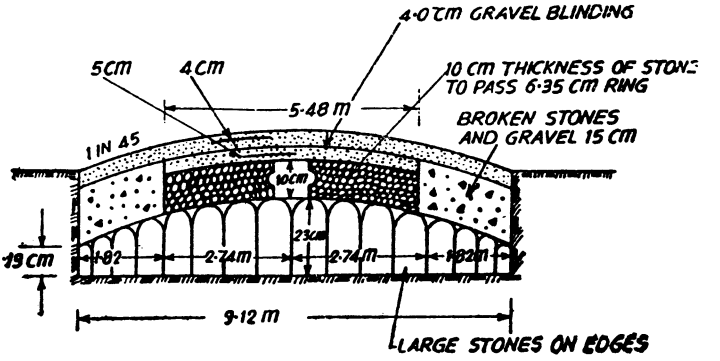

Fig. 1·4. Teleford design 1803.

According to the Telford theory, it was essential that each stone of the base course should be laid perpendicular to the finished surface or subgrade.

The middle 5·48 m of pavement was coated with hard angular stones to a depth of 15 cm. Of these 10 cm were first put on and worked by the traffic after which the remaining 5 cm were placed with the stones to pass 6·35 cm ring weighing about 8 oz. The paved surface on each side of 5·48 m were coated with broken stones or well cleaned gravel upto foot path. Finally on top 4 cm thick good gravel was laid.

He insisted on complete separation of road metalling from the subsoil by a firm and regular bottoming to prevent it coming in contact with clay. Hence it is not unusual to find road with a foundation spoken of as Telford Road and without foundation as a Macadam Road.

Macadam Roads

At the same time as Telford was working out designs, another British Road Builder John Louden Macadam (1756-1836) developed slightly modified specifications.

He recognised that the earth on which the road was built ultimately carried the load and he believed that any reasonable good soil well-drained needed only comparatively a thin wearing coat of broken stones to carry the heaviest load.

As regards structural stability, he achieved it by mechanical inter-locking of small cubical stones forced into position by the wheels of traffic and later by rollers. His road was built in layers, succeeding layers being applied only after the preceding ones were firm and dense. Macadam relied upon the road metal to produce, under the action of traffic, sufficient fine particles to fill the interstices and bind the whole together.

Macadam's Theory

His reason for providing 2 cm stones for the top layer was that the size of a stone used on a road must be in the due proportion to the space occupied by a wheel of ordinary dimensions on a smooth level surface. The point of contact will be found to be longitudinally about 2 cm and every piece of stone exceeding 2 cm in any dimension was considered mischievous. (See Fig. 1·5)

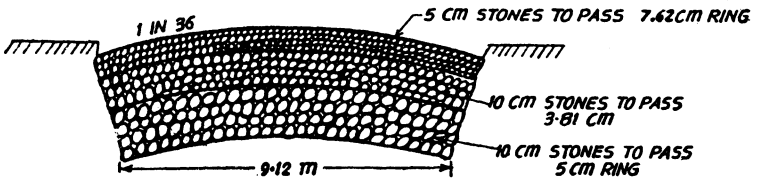

Fig 1·5

Comparison between Macadam and Teleford type of construction.

Telford construction	*Macadam construction*
1. He interposed a hard unyielding soling foundation.	1. He founded his road on a yielding or elastic sub-grade of stable and well-drained natural earth.
2. Sub-grade was made horizontal.	2. The slope was given to the sub-grade.
3. The sizes of stones in different layers were not given sufficient importance.	3. He stressed that bottom layer stones should pass 5 cm ring while second layer stones to pass 1·9 cm ring.
4. The cost was 1½ times that of the Macadam Road.	4. They were cheaper.
5. When the top layer began to wear, it required entirely a new surface since the large hand set stones protruded resulting in a very rough surface.	5. This is done by adding a new layer after interlocking.
6. Cross slope of 1 in 30 was given to bottom soling.	6. Cross slope of 1 in 36 was given to the sub-grade and then uniform thickness laid just sufficient to cause rain water to run easily off the surface.
7. Good for permissible load of 2·54 quintals per 2·54 cm width of tyre.	7. Good for 4·57 quintals per 2·54 cm width of tyre.
8. Water gets into the road bed from top (more porous).	8. Water does not get into the road from top.

Tar Roads

Water bound roads, as they were called, were all right for slow-moving and animal drawn traffic but rapidly gave way under fast-moving and rubber tyre traffic. The surface quickly went to pieces and the dust nuisance became rather intolerable. A thin carpet of tar over a water-bound surface was tried. This was quite good for light motor cars with pneumatic tyres but the development of mechanical transport for commercial purposes and the advent of steam and motor lorry carrying heavy load tyres demonstrated that this thin film of layer was not an effective remedy and afforded no lasting protection against the disintegration of roads.

Tar and Bitumen Roads

The next step lay in applying tar mixed with bitumen as a grout to the raw material in order to form a homogeneous mass.

A further improvement was made on this too. The aggregate was pre-mixed with tar or bitumen to form a concrete that goes by the name of Tar Macadam or Bituminous Macadam. This coat was followed by another coat of same nature and of a thickness varying from 4 cm to 10 cm.

Concrete Roads

For streets which are subjected to heavy traffic and industrial centres, Tar roads were ineffective. Cement concrete roads were introduced. Though the initial cost was great still great saving was effected in maintenance. They were tried in America and Great Britain and also in India with success.

R.C.C. Roads

Cement roads have been replaced by R. C. C. roads 23 cm thick where the traffic is heavy or the soil is soft and marshy. This takes up to the climax of present day road making. Water bound roads will continue for long in India due to their cheapness over other types of roads.

Conclusion

Any history of development of road making is incomplete without a mention of the machinery of their maintenance.

In Medieval times, tax used to be levied on farmers, who instead of paying in cash, would always work instead. This method was not very successful because of lack of proper supervision. This system was then abolished and tax was collected in cash. With the introduction of this system regular road engineers were employed in various countries for the purpose of up keep of roads. This system of maintenance was found to be much better and is still prevalent in most of the countries including India where every state has its own P.W.D.

Characteristics of Old Roads

1. They were very thick and therefore costly.
2. There was much waste of material.
3. In swampy places wooden piles were driven to the hard base to ensure the stability of roads.
4. The roads were narrow 6 m to 12 m and too much convex on top. The result was rutting which prevented drainage.

Growth of Roads in India

In India record of roads is mentioned in Rig Veda and the highways were called "Mahapatha".

Roads used chiefly by Military were named 'Rajapatha' Royal Roads, which used to be 21 m wide. Those used for commercial purposes were named 'Matrakala'.

The principal Military road of Chandra Gupta's Empire 332—298 B.C. was that which passed through Patna and continued upto N.W F. Provinces. Along these routes trees were planted, wells dug at regular intervals and pillars were fixed at every 2 km to mark distances and police stations. Imperial and Provincial officers

looked after their up-keep and repairs and villages through which they passed provided labour and were exempted from taxation.

Roads were made with a convex surface with drains on both sides, and were repaired every year at the cost of Royal treasury. Bridges were provided at crossings.

The width of various types of roads were as follows :

(*i*) 1·22 m for footpath.

(*ii*) 11 m for other roads (cattle track).

(*iii*) 21 m for Royal roads.

Emperor Babar and Shershah paid special attention to the maintenance of roads in 16th century which connected Patna to N.W.F. Province.

Common Improvements Affected by Telford and Macadam

1. Roads were made straight in plan instead of curved.
2. Improvement of road surface.
3. All dangerous corners were done away with and made safe.

Macadam observed that

1. There was total lack of science in the construction of Macadam roads.
2. Roads materials were loosely applied, and carriage instead of passing ploughed them. This being due to bad selection of materials and bad laying.

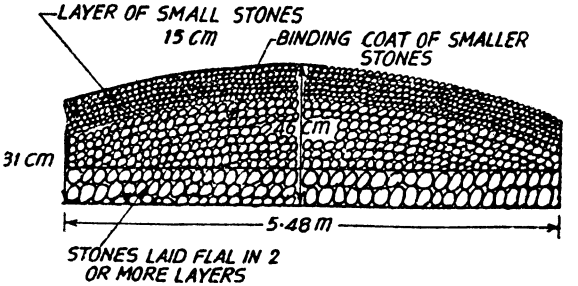

Fig. 1·6. Cross-section of metalled road in France before 1764.

Roads in France were 46 cm thick because they were repaired only twice a year :

After 1764 the system of constant maintenance and repairs was employed, hence depth reduced to just sufficient size as to resist the weight of traffic, thereby cost reduced to less than half and it lasted for ten years. A brief history of the development of roads from the period the East India Company was in India up to the present time will show the importance attached to road development programme and the extent of progress during this period.

It was Lord William Bentick who initiated reforms in the field of road making whereas East India Company was indifferent and took no interest whatsoever in road development programme. The Central Public Works Department was created in the days of

Lord Dalhousie with the object of constructing and maintaining roads in India. Subsequently such departments were also created in provinces. The Government of India Act of 1919 transferred the subject of roads from the Central Government to the Provincial Government as the Central Government concentrated more on development of railways than on roads. The work of supervising and maintenance of roads was divided between the Central Government, Provincial Government and the Local Bodies. The Central Government looked after important military roads, while the Provincial and Local bodies looked after the roads in their respective beats. But due to World War I, it was realized that the present roads could not withstand the heavy vehicular traffic needed for carrying war materials. In 1928 a committee headed by Dr. M.R. Jayakar was appointed to report on the condition of roads and to suggest improvements Due to his report the control of all roads was again taken up by the Central Government as the provincial and local bodies were reported not being able to realize the importance of road making. A Central Road Fund was created in 1929 and the revenue in this fund was obtained by levy of 2 annas petrol tax surcharge on every gallon of petrol consumed. Part of this amount was spent annually by the Central Government on the establishment and the rest was given to the Provincial Governments.

In 1930 a Central Road Organization Committee was created and immediately after 5 years a Transport Advisory Committee was also constituted to discuss the road development of India. In order to exchange ideas and experience of all those members interested in roads and also to recommend specifications and standard of road design a semi-official body called the Indian Roads Congress was set up in 1934.

Nagpur Plan

In the year 1943 a ten year plan was drawn up at Nagpur by a Board of Chief Engineers of all the provinces on the advice of the Indian Roads Congress for preparing a programme for construction and development of roads. The programme included construction and development of about 5,29,600 km. of all types of roads including bridges at an estimated cost of Rs. 448 crores. Under the Nagpur plan, the roads were classified in 5 categories.

(*a*) National highways N.H.
(*b*) State highways S.H.
(*c*) Major District roads M.D.R.
(*d*) Other District roads or O.D.R.
Minor District roads
(*e*) Village roads V.R.

Target was set to have 16 km of road per 100 sq. km of area during 1943—1963 period. Also central Government was made responsible for maintenance of National highways. It was also decided to bring farthest point in developed and agricultural area withen reach of 8 km of methalled roads. In 1950 the central road research institute was also started.

In the year 1950 a Research Institute known as the Central Research Institute was started at Delhi with the object of conducting research work on roads and to advise the Government on problems concerning roads. The development of village roads was an essential item of the First Five Year Plan (1951—56). About 4800 km of high class roads and 26,200 km of village roads were to be constructed during the First Five Year Plan. The village roads were to be constructed partly from the funds to be borne by the villagers and about 60% of cost to be shared by the Central and the Provincial Government. By the end of the First Five Year Plan the mileage of surfaced roads increased from 155200 km. to 193600 km. while that of the unsurfaced roads increased from 2,41,600 km. to 312000 km. The aim of Second Five Year Plan was to have about 2,30,400 Km. of surfaced roads and 3,76,000 km. of unsurfaced roads. The ultimate aim being to connect all villages having population of 1,000 people with main roads where the village is only 8 km away from the main all weather roads.

A twenty year plan (1961—81) is under the consideration of the Government wherein, it is proposed to have a total kilometre of 10,51,200 km. consisting of all types of roads as under :

	Nagpur plan miles		*Proposed target under 20 year plan (1961—81)*	
National Highways	20,000 miles	or 320,00 km	32,000 miles	or 51,200 km
Provincial Roads	53,000	or 848,00 km	70,000	or 112,000 ,,
Major District Roads	50,000	or 800,00 km	1,50,000	or 240,000 ,,
Minor District Roads	70,000	or 1120,00 ,,	1,80,000	or 288,000 ,,
Village Roads	1,38,000	or 2208,00 ,,	2,25,000	or 360,000 ,,
Total	3,31,000 miles	or 529600 km	6,57,000 miles	or 1051,200 km

Questions

1. Describe briefly the pioneer contribution of Tresaguet, Telford and Macadam to road improvement of a Scientific Nature. (*U.R. 1950*)

2. Bring out the difference between the following in a road construction :

Macadam Road construction and Telford type of construction.

3. What is the basic construction of Telford and Macadam road ?

Describe briefly the method of water bound stone consolidation.

4. Write short note on Nagpur plan.

5. Describe the history of highways development abroad and in India

6. Write short notes on :—

(*i*) classification of roads.
(*ii*) obligatory points.
(*iii*) different modes of transporation.