EXECUTIVE SUMMARY

World over road construction has taken a centre stage owing to the impetus it provides to the economy. Bitumen is a black coloured, semi-solid hydrocarbon obtained as an end product during refining of crude oil and is predominantly used as binder for road pavement. With increased economic growth, infrastructure development and road network expansion, the world bitumen demand have grown by 3.3% per year and will reach to 26.8 million tonnes per year by 2021.

India is a vast country, having wide variations in climates, and traffic conditions in terms of loads and volumes. India has the second largest road network around 4.7 million km in world and about 60% of all goods and 85% of India's population use the road network. Transportation infrastructure with growing economy is rapidly expanding at a rate of 6.1% in 2017 and is expected to increase by 7.3% in 2021 with the challenging development of road networks.

Currently, roads are made up of flexible pavements with bituminous layer. However, the service life of bituminous roads is limited due to the viscoelastic properties of bitumen and the environmental factors such as temperature, air, water, binders etc. which are responsible for damaging the durability and long-term performance of pavements, causes deterioration of their road structures due to rutting failure and fatigue cracking. Thus, present study is an attempt to modify bitumen for the improvement of performance properties.

Today, world is facing huge waste production, i.e. crumb rubber and PET due to increase industrialization and modern civilization growth. Waste management is a huge problem to minimize, thus we have used this waste material, i.e. crumb rubber, PET bottles to improve the quality of bitumen for road pavement application. However, we have found that crumb rubber modified bitumen have some serious issues regarding their storage stability as crumb rubber particles settle at the bottom of the container which causes difficulty in transportation of these modified bitumen and therefore restricts their use for bitumen modification.

Therefore, the study was further enhanced to increase the storage stability, rheological and mechanical properties of crumb rubber modified bitumen by using certain quality binder using certain chemical modifiers/binders.

In the present study, we have explored amine based binders, which are known to facilitate the release of crumb rubber particles into bitumen, thus softening the overall bitumen-rubber matrix. Keeping this in view we have focused our study on utilization of long chain amines for crumb rubber anchoring to improve modified bitumen properties, since the long aliphatic chain present in amine, i.e. dodecylamine, hexadecylamine and octadecylamine is helpful in enhancement of oil portion in bitumen, which in turn increased the absorption of crumb rubber particles in bitumen with improved the storage stability (with decrease in separation value from 8.0 to 3.6 °C). Therefore, we have taken long chain amines and amide additives for CRMB anchoring.

Extending the work polyamine and fatty acid were used separately and a marginal improvement in terms of storage stability of CRMB was noticed. Combination of the two namely polyamine with fatty acid was experimented expecting the synergistic effect of the two to improve the storage stability of CRMB. This synergic combination of the additives, i.e. diethylenetriamine (DETA) and stearic acid (1:1) have drastically improved the storage stability (with decrease in separation value from 8.0 to 2.4 °C). Moreover, physical, rheological and performance properties were also improved.

Waste plastic are the major threat to environment as they are non-biodegradable. Therefore, economic and environmental friendly disposal of waste plastic bottles (PET) is essential for sustainable development. In this concern, we have for the first time reported the direct chemical conversion of waste plastic PET to amide derivative, which can be used for anchoring the crumb rubber in bitumen. The result showed that separation value of PET derivatized crumb rubber decreased from 8.0 to 4.0 °C. Moreover, when PET amide derivative was doped along with bifunctional compounds, i.e. sebasic acid, the separation value was decreased from 8.0 to 1.9 °C with improved physical, rheological and performance properties.

The insight provided in this thesis could help national/regional governments and academic/international organisations for development and promotion of cheap and safer way of disposal of waste PET and crumb rubber for road pavement. The novelty of this work will also add the knowledge to the scientific community look for future research in this area.