Executive summary (not exceeding 500 words)

It is well known that bogie design, characteristics of primary and secondary suspension and damping elements, wheel profile, rail profile, and tribological conditions at rail-wheel interface directly influence the coach vehicle dynamics, passenger comfort, wheel and rail wear, vehicle stability, and noise (particularly from rail-wheel interface) in metro cars. Thus, development of a reliable vehicle dynamics model is essential to refining bogie and suspension designs, wheel and rail profiles, and obtaining more favorable tribological conditions at rail-wheel interface for variable operating conditions such as payload, environment, and speed. However, lack of complete information over behavior of various design elements is a challenge that needs to be overcome for model development. In this work, field trials employing instrumented wheel sets, bogies, and coaches, along with wheel wear and damage evolution estimated under different operating conditions using a twin disc test set up, will be used to calibrate vehicle dynamics and wear models to predict passenger comfort and wheel wear under different running conditions.

The bogie frame and its components are subject to cyclic forces. Over several million cycles these forces result in structural fatigue. The European Standard EN 13749 codifies fatigue load cases which need to be considered in bogie design. However there is no standard computational procedure to calculate high cycle fatigue strength and recent research suggests that the methods currently in use can be improved. Development of such an improved procedure will be an additional goal of the project. The procedure, once validated with experimental results, will reduce the need for expensive experimental fatigue tests. In addition, by enabling more exhaustive fatigue testing through simulations, it can contribute to the development of more fatigue resistant designs.

Background and motivation (not exceeding 500 words)

Wheel and rail wear, life of suspension and damping elements, passenger comfort and safety are important aspects for initial design and maintenance of metro and rail coaches. To maximize life, passenger comfort and safety of the metro cars and passenger coaches need to be designed by keeping in view the operating conditions (weather, track profile, operating speeds, etc.). However, for lack of reliable models that incorporate validated characteristics of various mechanical design elements used in metro cars and coaches, this is currently not done. This work aims to address this lacuna through simulation and experimental works.

This project plays an important role in the following sense in a broader setting. The Delhi Metro system was successfully implemented with rolling stock complying to international standard. This international standard was followed in subsequent metro projects. Today many of the important components that go into building metro rolling stock meet the stringent specification of set by Delhi metro are imported. There is need to develop indigenous technology to reduce the initial and recurring cost of rolling stock. With so many new metro projects planned for the near future in our country, investment to develop indigenous technology will help save foreign exchange and boost growth of ancillary industries that can supply vital components for the metro rolling stock. Today BEML is the only "Indian company" that is able to manufacture metro rolling stock meeting the required specification even though many of the vital components are either imported or developed using licensed technology from abroad. IIT Kharagpur with its R&D experience in railway technology and BEML with its design and manufacturing experience will form a team to drive development of much needed indigenous technology for manufacture of metro rolling stock in the country.

Project outcomes (please list specific objectives): *The project should address a specific need of the industry/industries and there should be clear expected outcomes from the project. It is expected that joint patents will result from this project.*

The project has the following objectives:

- Generate database for dynamic load factors for forces acting at rail-wheel interface, accelerations experienced by axle, bogie, and coach, and slip at rail-wheel interface as a function of operating conditions, track layout, and coach design using instrumented field trials.
- Design, develop, and validate a twin disc set up to experimentally characterize wheel wear, traction and brake block characteristics, and wheel damage under different operating conditions.
- Develop analysis procedure to yield more accurate predictions of high cycle fatigue life for structural components
- Optimize wheel profile to reduce wheel wear and increase wheel life.
- Identify suitable lubricants (friction modifiers) to reduce wheel wear and noise generated at wheel-rail interface
- Identify wheel profile, bogie, and suspension design to increase passenger comfort, vehicle safety, and reduce recurring costs associated with rolling stock

Scope (not exceeding 1500 words): *The scope should clearly lay out the contributions of the academic partner and the industry partner.*

Contributions of the academic partner:

(1) Design, develop, and validation a twin disc set up to experimentally characterize wheel wear, traction and brake block characteristics, and wheel damage under different operating conditions,
(2) Development of analysis procedure to yield more accurate predictions of high cycle fatigue life for structural components
(3) Optimization of wheel profile to reduce wheel wear and increase wheel life
(4) Identification of friction modifiers to reduce wheel wear and noise generated at wheel-rail interface, and
(5) Identification of wheel profile, bogie, and suspension design to increase passenger comfort, vehicle safety, and reduce recurring costs associated with rolling stock

Contributions of the industry parter:

(1) Instrumented wheel set, bogie, and coach field trials to collect data on dynamic load factors for forces acting at rail-wheel interface, accelerations experienced by axle, bogie, and coach, and slip at rail-wheel interface as a function of operating conditions, track layout, and coach design.