

# Tyre development



## DESCRIPTION

### **Tyre integration on vehicle**

Road vehicle global performances are affected substantially by the performance of the tyres, which transmit all the tyre contact patch inputs to the rim and chassis. However, tyre behaviour is also affected by the wheel motion which is controlled by the vehicle chassis. Therefore, tyre integration on the vehicle chassis needs to be studied carefully using all the tyre characterization activities available on the vehicle.

### **Tyre characterization with vehicle**

Applus IDIADA offers a wide range of characterization services that permit analysing subjectively and objectively the tyre's contribution to the global vehicle performance.

### **Tyre subjective evaluations with vehicle:**

- Evaluation of vehicle performances influenced by tyre:
  - Comfort
  - Noise
  - Steering
  - Longitudinal behaviour
  - Response
- Winter, wet and dry track condition testing
- Usage of different types of roads:
  - Applus IDIADA Proving Ground (Spain)
  - Winter test tracks
  - Tyre makers' proving grounds
  - Reference race circuits
  - All kinds of public road (all over the world)
- Project management: Evaluation of different sets of tyres
- Joint tests if required

Tyre objective evaluations with vehicle:

- Braking tests: Stopping distance and deceleration measurements on different surfaces with different adherences:
  - Aquaplaning
  - Ceramic tiles
  - High-friction asphalt
  - Basalt slabs
  - Treated concrete
  - Gravel safety area
- Aquaplaning tests while accelerating and in a curve
- Dynamic tests: Objective evaluation of:
  - Dry dynamics tyre efficiency:
    - Ride confort:
      - Deterministic inputs
      - Stochastic inputs
    - Handling:
      - Straight driving
      - Oscillatory input
      - Step-steer
    - Active safety
      - Lane change
      - Propensity to rollover
  - Wet dynamics tyre efficiency:
    - Steady-state
    - Transient driving
- NVH tests
  - Interior tyre noise and vibration tests
  - Exterior noise tests (coast-by)
- Running resistance and fuel consumption tests: Analysis of tyre contribution to whole-vehicle running resistance:

Tyre wear by performing vehicle durability tests on public roads in dry condition during the whole year. Test driving programme can be generated considering client's reference circuit.

**Tyre model building**

Advanced tyre parametric tyre models (such as FTire and MF-Tyre) permit Applus IDIADA chassis engineers to consider tyre performance while the vehicle is being designed without the need to be involved in tyre FEM models. Consequently, this methodology allows us the proper integration of the tyre in the chassis during the vehicle development process.

Applus IDIADA offers the service for generating two parametric tyre models which are widely used to simulate tyre performance.

- MF-Tyre: Magic Formula tyre model is a “semi-empirical” tyre model which is able to predict handling performance (steady-state and transient behaviour). Therefore MF-Tyre models permit the proper integration of the tyre in the chassis during the vehicle development process when vehicle handling needs to be simulated. MF-Tyre model is generated by means of force and moment tests such as pure cornering, pure braking and combined test which are performed with IDIADA’s skid trailer (proving ground tyre test machine).
- FTire: FTire is a short wavelength intermediate frequency tyre model. The construction of this parametric model is physically oriented and requires various measurement techniques and specific test equipment. Applus IDIADA has developed its own measurement procedure based on its laboratory and proving ground measurements in order to achieve precise and representative data of tyre behaviour. FTire’s main applications are:
  - Primary and secondary ride comfort simulations, NVH, prediction of road loads on road irregularities
  - Vehicle handling studies on flat or uneven roads
  - Real-time simulations
  - Prediction of complex tyre phenomena on a strictly mechanical and thermodynamical basis
  - Complex analyses at high frequency of the footprint shape, pressure distribution, tyre wear and combination of vertical, lateral, longitudinal dynamics

### Tyre characterization

Applus IDIADA provides the full tyre characterization service required to generate the MF-Tyre and FTire models. The activities available are:

- Measurement of the tyre contact patch
- Measurement of all the wheel centre forces under a punctual input application while the tyre is rolling in proving ground condition
- Measurement of the static tyre stiffness
- Measurement of basic tyre properties
- Measurement of tyre handling response in proving ground conditions

### Tyre testing equipment:

The basic rigs used to characterize the tyres during Applus IDIADA’s modelling phase are:

- Applus IDIADA’s skid trailer, which permits tyre dynamics characterization by controlling tyre attitude over the ground. All the motions and forces are being registered at the wheel centre when the wheel is free rolling or braking. Lateral slip, longitudinal slip tests, combined slip test or cleat tests are performed on a real proving ground. Apart from the generation of parametric models such as FTire and

MF-Tyre, the skid trailer can be used to measure tyre adherence on dry and wet condition and to characterize specific parameters of the tyre behaviour.

- Applus IDIADA's KandC rig (Kinematics and Compliance test rig) permits tyre static stiffness characterization. Tyre attitude is controlled over the ground while all the motions and forces are being registered. The tyre contact patch is placed over a platform which can be controlled with five degrees-of-freedom (vertical, longitudinal and lateral motions; steer and roll angular movement).
- Applus IDIADA's indoor tyre laboratory tests permits the measurement of rolling resistance under defined regulations.

To enquire about information please address your request to [tyrecharacterisation@idiada.com](mailto:tyrecharacterisation@idiada.com)

**Tyre Development**

**Tyre Characterization and modelling**