The Automotive Chassis

Engineering Principles

List of Chapters

Preface

1 Types of suspension and drive

- 1.1 General characteristics of wheel suspensions
- 1.2 Independent wheel suspensions general
 - 1.2.1 Requirements
 - 1.2.2 Double wishbone suspensions
 - 1.2.3 McPherson struts and strut dampers
 - 1.2.4 Rear axle trailing-arm suspension
 - 1.2.5 Semi-trailing-arm rear axles
 - 1.2.6 Multi-link suspension
- 1.3 Rigid and semi-rigid crank axles
 - 1.3.1 Rigid axles
 - 1.3.2 Semi rigid crank axles
- 1.4 Front-mounted engine, rear-mounted drive
 - 1.4.1 Advantages and disadvantages of the front-mounted engine, rearmounted drive design
 - 1.4.2 Non-driven front axles
 - 1.4.3 Driven rear axles
- 1.5 Rear and mid engine drive
- 1.6 Front-wheel drive
 - 1.6.1 Types of design
 - 1.6.2 Advantages and disadvantages of front-wheel drive
 - 1.6.3 Driven front axles
 - 1.6.4 Non-driven rear axles
- 1.7 Four-wheel drive
 - 1.7.1 Advantages and disadvantages
 - 1.7.2 Four-wheel drive vehicles with overdrive
 - 1.7.3 Manual selection four-wheel drive on commercial and all-terrain vehicles
 - 1.7.4 Permanent four-wheel drive; basic passenger car with front-wheel drive
 - 1.7.5 Permanent four-wheel drive, basic standard design passenger car
 - 1.7.6 Summary of different kinds of four-wheel drive

2 Tyres and wheels

- 2.1 Tyre requirements
 - 2.1.1 Interchangeability
 - 2.1.2 Passenger car requirements
 - 2.1.3 Commercial vehicle requirements
- 2.2 Tyre designs
 - 2.2.1 Diagonal ply tyres

- 2.2.2 Radial ply tyres
- 2.2.3 Tubeless or tubed
- 2.2.4 Height-to-width ratio
- 2.2.5 Tyre dimensions and markings
- 2.2.6 Tyre load capacities and inflation pressures
- 2.2.7 Tyre sidewall markings
- 2.2.8 Rolling circumference and driving speed
- 2.2.9 Influence of the tyre on the speedometer
- 2.3 Wheels
 - 2.3.1 Concepts
 - 2.3.2 Rims for passenger cars, light commercial vehicles and trailers
 - 2.3.3 Wheels for passenger cars, light commercial vehicles and trailers
 - 2.3.4 Wheel mountings
- 2.4 Springing behaviour
- 2.5 Non-uniformity
- 2.6 Rolling resistance
 - 2.6.1 Rolling resistance in straight-line driving
 - 2.6.2 Rolling resistance during cornering
 - 2.6.3 Other influencing variables
- 2.7 Rolling force coefficients and sliding friction
 - 2.7.1 Slip
 - 2.7.2 Friction coefficients and factors
 - 2.7.3 Road influences
- 2.8 Lateral force and friction coefficients
 - 2.8.1 Lateral forces, slip angle and coefficient of friction
 - 2.8.2 Self-steering properties of vehicles
 - 2.8.3 Coefficients of friction and slip
 - 2.8.4 Lateral cornering force properties on dry road
 - 2.8.5 Influencing variables
- 2.9 Resulting force coefficient
- 2.10 Tyre self-aligning torque and caster offset
 - 2.10.1 Tyre self-aligning torque in general
 - 2.10.2 Caster offset
 - 2.10.3 Influences on the front wheels
- 2.11 Tyre overturning moment and displacement of point of application of force
- 2.12 Torque steer effects
 - 2.12.1 Torque steer effects as a result of

The Automotive Chassis

Engineering Principles

changes in normal force

- 2.12.2 Torque steer effects resulting from tyre aligning torque
- 2.12.3 Effect of kinematics and elastokinematics

3 Wheel travel and elastokinematics

- 3.1 Purpose of the axle settings
- 3.2 Wheelbase
- 3.3 Track
- 3.4 Roll centre and roll axis
 - 3.4.1 Definitions
 - 3.4.2 Body roll axis
 - 3.4.3 Body roll centre on independent wheel suspensions
 - 3.4.4 Body roll centre on twist-beam suspensions
 - 3.4.5 Body roll centre on rigid axles
- 3.5 Camber
 - 3.5.1 Camber values and data
 - 3.5.2 Kinematic camber alteration
 - 3.5.3 Camber alteration calculation by drawing
 - 3.5.4 Roll camber during cornering
 - 3.5.5 Elasticity camber
- 3.6 Toe-in and self-steering
 - 3.6.1 Toe-in and crab angle, data and tolerances
 - 3.6.2 Toe-in and steering angle alteration owing to wheel bump-travel kinematics
 - 3.6.3 Toe-in and steering angle alteration due to roll
 - 3.6.4 Toe-in and steering angle alteration due to lateral forces
 - 3.6.5 Toe-in and steering angle alteration due to longitudinal forces
- 3.7 Steer angle and steering ratio
 - 3.7.1 Steer angle
 - 3.7.2 Track and turning circles
 - 3.7.3 Kinematic steering ratio
 - 3.7.4 Dynamic steering ratio
- 3.8 Steering self-centring general
- 3.9 Kingpin inclination and kingpin offset at ground
 - 3.9.1 Relationship between kingpin inclination and kingpin offset at ground (scrub radius)
 - 3.9.2 Braking moment-arm
 - 3.9.3 Longitudinal force moment-arm
 - 3.9.4 Alteration to the kingpin offset

- 3.10 Caster
 - 3.10.1 Caster trail and angle
 - 3.10.2 Caster and straight running
 - 3.10.3 Righting moments during cornering
 - 3.10.4 Kingpin inclination, camber and caster alteration as a consequence of steering
 - 3.10.5 Kinematic caster alteration on front-wheel travel
 - 3.10.6 Wheel travel-dependent rotation of the rear steering knuckle
 - 3.10.7 Resolution of the vertical wheel force on caster
 - 3.10.8 Settings and tolerances
- 3.11 Anti-dive and anti-squat mechanisms
 - 3.11.1 Concept description
 - 3.11.2 Vehicle pitch axis front
 - 3.11.3 Pitch axes rear
- 3.12 Chassis alignment
 - 3.12.1 Devices for measuring and checking chassis alignment
 - 3.12.2 Measuring the caster, kingpin inclination, camber and toe-in alteration

4 Steering

- 4.1 Steering system
 - 4.1.1 Requirements
 - 4.1.2 Steering system on independent wheel suspensions
 - 4.1.3 Steering system on rigid axles
- 4.2 Rack and pinion steering
 - 4.2.1 Advantages and disadvantages
 - 4.2.2 Configurations
 - 4.2.3 Steering gear, manual with side tie rod take-off
 - 4.2.4 Steering gear, manual with centre tie rod take-off
- 4.3 Recirculating ball steering
 - 4.3.1 Advantages and disadvantages
- 4.3.2 Steering gear
- 4.4 Power steering systems
 - 4.4.1 Hydraulic power steering systems
 - 4.4.2 Electro-hydraulic power steering systems
 - 4.4.3 Electrical power steering systems
- 4.5 Steering column
- 4.6 Steering damper
- 4.7 Steering kinematics
 - 4.7.1 Influence of type and position of the steering gear

The Automotive Chassis

Engineering Principles

- 4.7.2 Steering linkage configuration
- 4.7.3 Tie rod length and position

5 Springing

5.2

- 5.1 Comfort requirements
 - 5.1.1 Springing comfort
 - 5.1.2 Running wheel comfort
 - 5.1.3 Preventing 'front-end shake'
 - Masses, vibration and spring rates
- 5.3 Weights and axle loads
 - 5.3.1 Curb weight and vehicle mass
 - 5.3.2 Permissible gross vehicle weight and mass
 - 5.3.3 Permissible payload
 - 5.3.4 Design weight
 - 5.3.5 Permissible axle loads
 - 5.3.6 Load distribution according to IS0 2416
- 5.4 Springing curves
 - 5.4.1 Front axle
 - 5.4.2 Rear axle
 - 5.4.3 Springing and cornering behaviour
 - 5.4.4 Diagonal springing
- 5.5 Spring types
 - 5.5.1 Air- and gas-filled spring devices
 - 5.5.2 Steel springs
 - 5.5.3 Stops and supplementary springs
 - 5.5.4 Anti-roll bars
- 5.6 Shock absorbers (suspension dampers)
 - 5.6.1 Types of fitting
 - 5.6.2 Twin-tube shock absorbers, non-pressurized
 - 5.6.3 Twin-tube shock absorbers, pressurized
 - 5.6.4 Monotube dampers, pressurized
 - 5.6.5 Monotube dampers, non-pressurized
 - 5.6.6 Damping diagrams and characteristics
 - 5.6.7 Damper attachments
 - 5.6.8 Stops and supplementary springs
- 5.7 Spring/damper units
- 5.8 McPherson struts and strut dampers
 - 5.8.1 McPherson strut designs
 - 5.8.2 Twin-tube McPherson struts, non-pressurized
 - 5.8.3 Twin-tube McPherson struts, pressurized
 - 5.8.4 Damper struts
- 5.9 Variable damping

- 6 Chassis and vehicle overall
 - 6.1 Vehicle and body centre of gravity
 - 6.1.1 Centre of gravity and handling properties
 - 6.1.2 Calculating the vehicle centre of gravity
 - 6.1.3 Axle weights and axle centres of gravity
 - 6.1.4 Body weight and body centre of gravity
 - 6.2 Mass moments of inertia
 - 6.3 Braking behaviour
 - 6.3.1 Braking
 - 6.3.2 Braking stability
 - 6.3.3 Calculating the pitch angle
 - 6.3.4 Influence of radius-arm axes
 - 6.3.5 Anti-dive control and brake reaction support angle
 - 6.4 Traction behaviour
 - 6.4.1 Drive-off from rest
 - 6.4.2 Climbing ability
 - 6.4.3 Skid points
 - 6.5 Platform, unit assembly and common part systems

Bibliography

Glossary of symbols Index of car manufacturers Index of car suppliers Subject index