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[HOME](#)
[SERVICES](#)
[SOFTWARE](#)
[MMM](#)
[LTS](#)
[VDS](#)
[VDMS](#)
[TIRE MODEL](#)
[BOOKS](#)
[NEWS BRIEFS](#)
[ABOUT MRA](#)
[CONTACT US](#)
[SITE MAP](#)

MRA MOMENT METHOD, MMM

MMM Tour: SOLUTION

Since MMM deals with steady-state operating conditions there is no need for a time-based integration procedure. However, there is a need for a procedure whereby the vehicle can attain a steady-state solution in all respects. The condition of "constrained equilibrium" is attained in the simulation by means of multiple iteration procedures.

Of the six body degrees of freedom only three can be constrained if the tire loads (and hence forces) are to correspond to those experienced in operation. Vertical heave motion, roll and pitch--which produce proper tire loads including lateral and longitudinal load transfers--must be unconstrained. The lateral, longitudinal and angular yaw degrees-of-freedom are constrained for the purpose of calculating the unbalanced forces and moments -- the inertial reactions to the tire forces

There are two fundamental MMM solution-types. These are often referred to by the Force-Moment Diagram produced: CN-AY or CN-CY. These are described briefly below:

CN-AY (Normalized Yawing Moment vs. Lateral Acceleration)

- All lateral force assigned to producing lateral acceleration
- Constant Speed
- Similar to proving ground Constant Throttle test
- AY axis of Moment Method diagram also indicates path radius or path curvature
- Wheel Torque Options:
 - FWD, RWD, 4WD
 - Road Load Torque
 - Constant Torque, non-Road Load (accelerating/braking)
 - Constant Acceleration (varying torque)
 - Constant Deceleration (varying braking torque)
- These metrics can be determined from the CN-AY diagram:
 - Stability Index
 - Understeer Gradient
 - Steering Sensitivity
 - Limit Over/Understeer
 - Maximum Steady-State Lateral Acceleration
 - Maximum Lateral Acceleration
 - Control Moment Gain

CN-CY (Normalized Yawing Moment vs. Lateral Force)

- Lateral force unassigned or assigned to increasing speed on a constant radius
- Constant Radius
- Similar to proving ground Constant Radius test
- Speed varies across Moment Method diagram
- Wheel Torque Options:
 - Road Load Torque
 - Constant Torque, non-Road Load
 - Constant Acceleration (varying torque)
 - Constant Deceleration (varying braking torque)
- Special case: Infinite Radius
 - Fundamental presentation of vehicle force/moment characteristics
 - No path curvature effects

Furthermore, the Moment Method Diagrams can be used for approximate transient calculations. They have also proven themselves as an excellent tool for trim change analysis.

MMM TOUR

[<< Previous](#) | [Next >>](#)

[MMM Home](#) | [Background](#) | [Input](#) | [Solution](#) | [Output](#)

[Home](#) | [Services](#) | [Software](#) | [Books](#) | [News Briefs](#) | [About MRA](#) | [Contact Us](#) | [Site Map](#)

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