

Suspension Loads: Jounce, Rebound & Design

Tire-patch load cases for braking, cornering, rollover and bumps, with full-size truck examples

Key Terms

Jounce	Upward travel that compresses the spring and shock (hitting a bump).
Rebound	Downward travel that extends the spring and shock (dropping into a pothole).
Road disturbances	From high-magnitude, low-frequency (off-road) to small, high-frequency (paved road imperfections).
Load disturbances	Forces from acceleration, braking and cornering.
Requirements	Strength: braking, cornering, rollover, vertical bump. Stiffness: vibration isolation, handling.
BIW deformation limit	Permanent set at the suspension interface limited to what realignment can fix, typically 1-2 mm.

Tire-Patch Load Cases (per the worked truck examples)

Static (per front tire)	$R_f = W b / (2L)$	W = vehicle weight, b = CG to rear axle, L = wheelbase.
Braking vertical	$R_{f,brake} = W (b + n h) / L$	n = deceleration in g, h = CG height. Weight transfer forward (nose dive).
Braking fore-aft	$F_f = \mu \cdot R_{f,brake}$	Carried mainly by the lower control arm ball joint (A_{fa}).
Incipient rollover lateral	$L_o = (W b / L) \cdot t / (2h)$	t = track width. Carried mainly by the lower control arm (A_L).
Bump vertical	$R_f \rightarrow S_v$ (spring/shock)	Reacted mainly through the strut; λ = lever ratio on SLA designs.
Dynamic design load	Dynamic = $r \times$ (static maximum load)	r = design load factor for shock/impact effects.

Load Symbols

A_{fa}, A_L, A_v	Lower control arm load at the body: fore-aft, lateral, vertical.
S_{fa}, S_L, S_v	Strut attachment load: fore-aft, lateral, vertical.
r, c, d	Tire radius · wheel center to lower arm · lower arm to upper body attachment.

Example: Front Suspension Loads, Full-Size Trucks (m, N)

Parameter	1988 Chevy C10	1987 Ford F150	1987 Dodge Ram
Wheelbase L	2.985	2.959	2.78
CG height h	0.604	0.669	0.77
Weight W	18,180	16,885	20,088
CG to front / rear axle (a / b)	1.169 / 1.816	1.145 / 1.814	1.231 / 1.549
Track width t	1.618	1.657	1.727
μ / braking n	0.7 / 1.0 g	0.7 / 1.0 g	0.7 / 1.0 g
Static vertical	5,530	5,176	5,596
Braking: fore-aft / vertical	10,317 / 14,739	9,918 / 14,169	11,730 / 16,757
Cornering: lateral / vertical	1,445 / 2,065	1,463 / 2,090	1,747 / 2,496
Incipient rollover lateral	14,814	12,819	12,552
Design load/tire: lat · F/A · vert	7,407 · 7,369 · 8,295	6,410 · 7,084 · 7,763	6,276 · 8,378 · 8,395

Suspension Types

Type	Key points
MacPherson strut	Most common; cost-effective, space-efficient, durable. Check struts about every 50,000 miles.
Double wishbone (SLA)	Excellent road holding, camber control and low roll center; upper arm uses wheel-well space; costlier.
Trailing arm (rear)	Rugged, low-cost, common on FWD; good rear packaging.
Active suspension	Senses wheel forces and adjusts links continuously to keep the chassis level.