Expert Tips and Hints

Off-Road Performance – Tyres & Suspension
Off Road Performance

There are 2 Main Chassis Systems That Affect a 4x4 Off Road Performance

1. Tyres
2. Suspension
Tyres

What’s important

**Diameter**
- Rolling resistance
- Ability to climb obstacles
- Contact patch length

**Profile / Sidewall height**
- Resistance to rim damage
- Contact patch length at lower pressures

**Tread Pattern**
- Grip ‘Digging’

**Width**
- Sinkage
- Rolling resistance

**Pressure**
- Sinkage
- Rolling resistance
Tyres
Diameter

If tyre pressure, ground strength and width are equivalent, then contact patch length must be equal.

For equivalent contact patch lengths, there is more sinkage on the smaller wheel, therefore it has more rolling resistance.
Tyres

Diameter

If \( \tan \partial \) is greater than the contact patch friction level then the wheel will not be able to generate sufficient self traction to climb over the obstacle and so will slip.

If there is insufficient self-traction, then excess traction from the other wheels is required to help push the wheel onto the obstacle to generate more traction, and help push the wheel over the obstacle.

The larger ‘\( h \)’ is the more effective any pushing force is at pushing the wheel over the obstacle.
Tyres
Profile / sidewall height

Higher sidewall tyre has more capacity to squash at lower tyre pressures so contact patch length increase is greater.

Greater chance of rim stone / rock damage during dynamic tyre squash with smaller sidewall.
Tyres
Width

Wider tyre spreads the load better so reduces sinkage

Equal contact patch areas

Longer contact patch front

Despite less sinkage on the wider tyre, longer contact patch front may increase rolling resistance
Tyres
Tread Pattern

Aggressive tread pattern engages with the ground so grip is a function of ground strength not tyre to ground friction

If the ground has a low strength (sand) then the tyre can dig in if it slips.
Reducing the tyre pressure lets the tyre
- squash
- increases the contact patch area
- reduces sinkage may reduce rolling resistance

Increased contact patch area

No increase in contact patch front length
Suspension

Articulation – What is articulation

The ability of adjacent wheels to move in opposite directions to maintain ground contact
Suspension

Factors affecting articulation - Suspension type

Beam Axle

Articulation > Parallel Wheel Travel

Independent Axle

Articulation = Parallel Wheel Travel
Suspension
Factors affecting articulation - Suspension type

Beam Axle

Independent Axle

C of G

Roll Moment Arm

Roll Centre

C of G

Roll Moment Arm

Roll Centre

Longer Roll Moment Arm

More Roll Stiffness Required To control Roll Therefore

Greater Articulation Stiffness
Suspension

Ground Clearance – Lateral profile

1. Discrete features - boulders / tree stumps

Two cases to consider

2. Linear features - ruts

Discrete feature
The Vehicle can be manoeuvred to take full advantage of the vehicle’s ground clearance

Linear feature
Little or no ability to manoeuvre the vehicle

Particularly advantageous if the differential is off-set
Suspension
Ground Clearance – Suspension type

Change in ground clearance with suspension deflection

Beam axle

Independent suspension

Ground clearance changes as suspension moves up and down
Suspension
Ground Clearance – Suspension type
Change in wheel load with suspension deflection

Beam axle

Independent suspension

Wheels Lift When Grounding Occurs
Traction is Lost

Wheel Loads Reduce When Grounding Occurs
Traction is Reduced
Suspension

Ground Clearance – Suspension type

Ground clearance whilst articulated

Beam Axle - Ground clearance is maintained during articulation

Independent suspension - Ground clearance reduced during articulation