# Suspension

The rover utilizes a **passive rocker-bogie suspension architecture** coupled with a top-mounted **differential rocker mechanism**. This mechanical design allows all six wheels to maintain continuous contact with uneven terrain without relying on active electronic stabilization or heavy spring-damper assemblies.

## System Architecture & Components

The suspension relies on purely kinematic links to distribute weight evenly and isolate the central payload chassis from violent pitching when traversing obstacles.

- **Rocker-Bogie Side Linkages:** Two independent side linkages (left and right). Each main rocker pivots relative to the chassis, while the rear bogie links pivot relative to the main rocker, allowing the wheels to contour over rocks and dips.
- **Chassis Pivot Mounting Assemblies:**
  - Located on the left and right side plates of the chassis frame to serve as the primary structural attachment points for the main rockers.
  - Utilizes heavy-duty bearings housed in a bearing houising unit. These housing units are then bolted to the side of the chassis.
  - The main tube that runs into the housing unit is clamped to the rest of teh suspension system using locking bushings. These bushings, when tightened, shrinks radius of the inner cutout, clamping down on the tube. Two lasercut parts flank either side of the bushing, connecting everything together.
- **Top-Mounted Differential Rocker Arm:**
  - A rigid cross-bar mounted horizontally over the top deck of the chassis, rotating around a central vertical plane pivot pin.
  - Connects the left and right main rocker arms using vertical tie-rods (turnbuckles) with spherical rod ends (heim joints). These rod ends can both piviot up and down, and side to side, providing the degrees of freedom needed to make this system work.
  - Enforces anti-phase motion between the left and right suspension sides: as one side lifts over an obstacle, the top rocker pivots and forces the opposite side downward.

## Design Rationale & Kinematic Mechanics

More specifics of the construction can be found in the [drive system report]

1. **Equalized Wheel Loading & Traction:** In conventional spring suspension systems, climbing a large step severely compresses one corner, shifting the vehicle's center of mass and reducing ground pressure on the remaining wheels. The passive rocker-bogie

geometry mechanically balances vertical loads so that all six wheels share traction equally, minimizing wheel slip on loose terrain.

2. **Chassis Pitch Averaging (Differential Kinematics):** Without a differential linkage, the chassis body would freely tilt to extreme angles whenever a single side encountered an obstacle. The top-mounted differential arm acts as a mechanical motion-averaging box. If the left rocker rotates 10° over a rock, the top bar forces the right side down, holding the body deck at a stable pitch. Positioned over the top deck, the bar keeps the underside of the chassis completely clear of cross-axles, maintaining maximum ground clearance.
3. **Direct Chassis Mount Considerations:** Heavy impact forces from the suspension flow directly into the chassis side plates through the primary pivot mounts. Placing high-capacity bearings at these specific mounting points prevents binding under side-loading (e.g., when turning on a steep slope) while preserving smooth pitch rotation during obstacle negotiation.

# Future Work

While th main part of the suspension system works quite well, there are a few areas where it can be improved upon.

1. The bearing housing unit currently being used it not that good. The bearing suffers from improper embedding. This means it wobbels when a slight load is applied to it. This wobble is then amplified throughout the whole suspension system which cuases a slight camber or "squatting" to occur. A simple fix would be drilling a hole in the side of chassis and letting the main tube go in there with a buishing in the hole, limiting the wobble. Other fixes can include embedding a bearing straight in the side of the chassis.
2. Currently differential bar only connects using one rod end. While this is fine at the moment, what it connects to is a custom plastic part. This part can wear over time and possibly fail. A fix would be adding another rod end inplace of the plastic part which would result in a more reliable connection.
3. The differential bar consits of two laser cut plates. During testing these plates would twist and lift, hence why at the moment they are constrained using a bushing above and a spacer between them. Ideally this would be replaced with something more solid like a tube or a bar.

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