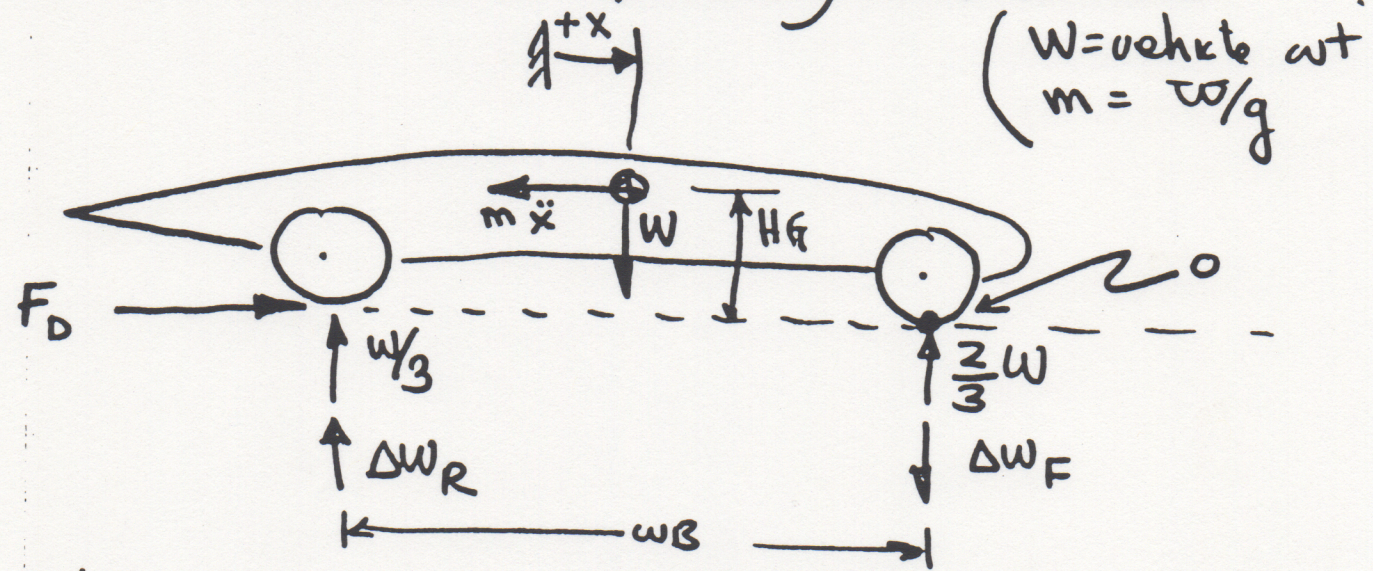


HANDOUT 9. SWING ARM REAR SUSPENSION AND ANTI-SQUAT GEOMETRY

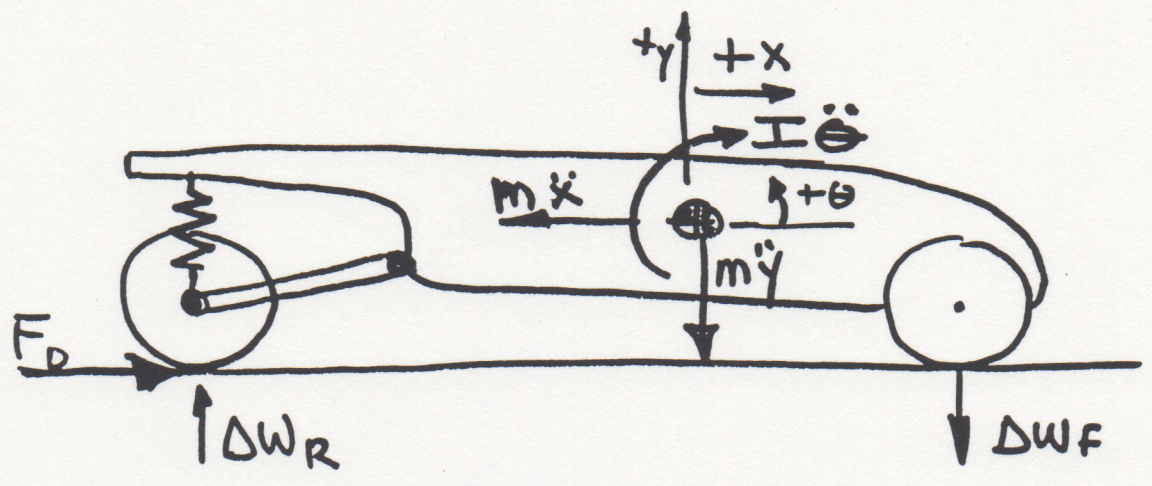
THIS PRESENTS ANOTHER VIEW AND DRAWS THE SAME "ANTI-SQUAT LINE" AS IN HANDOUT 3.

CONSIDER A 3 wheeled vehicle, 2 at front, one at rear with equal weight on each corner statically. Suppose drive force F_D is applied at the rear wheel by the ground causing acceleration, \ddot{x} . First consider NO suspension. Also, ignore the aerodynamic & rolling resistance.



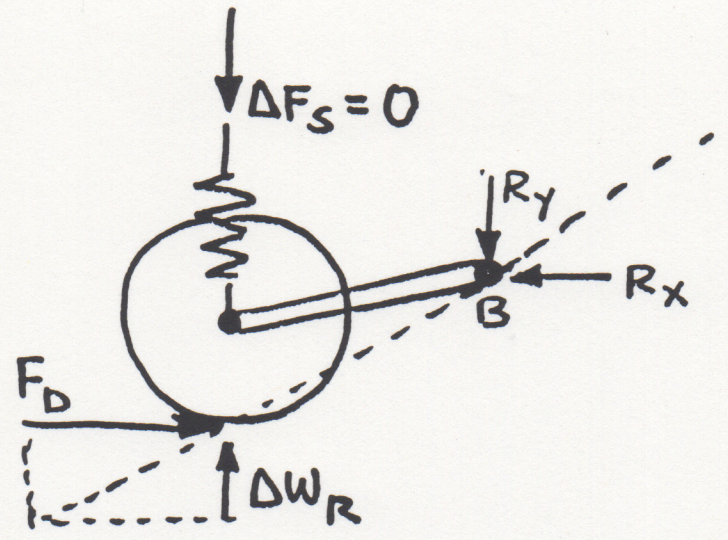
- Static weight W cancels static wheel loads $W/3$ and $2/3 W$
- weight ΔW_R is transferred to the rear and ΔW_F is removed from the front
- inertia force $m \ddot{x}$ acts at the CG
- $\sum F_y$ direction shows $\Delta W_R = \Delta W_F$

NOW ADD SUSPENSION AT THE REAR -
USE A SWING ARM -



- As before, ignore the static weight and reactions as they cancel.
- Now the vehicle has more degrees of freedom - x, y, θ , when F_D is applied - so we must show inertial reactions in all opposite directions.

• CAN we find conditions when there is NO y or θ movement? This would occur if there were NO change in the spring force from its static value. So explore the rear arm FBD:



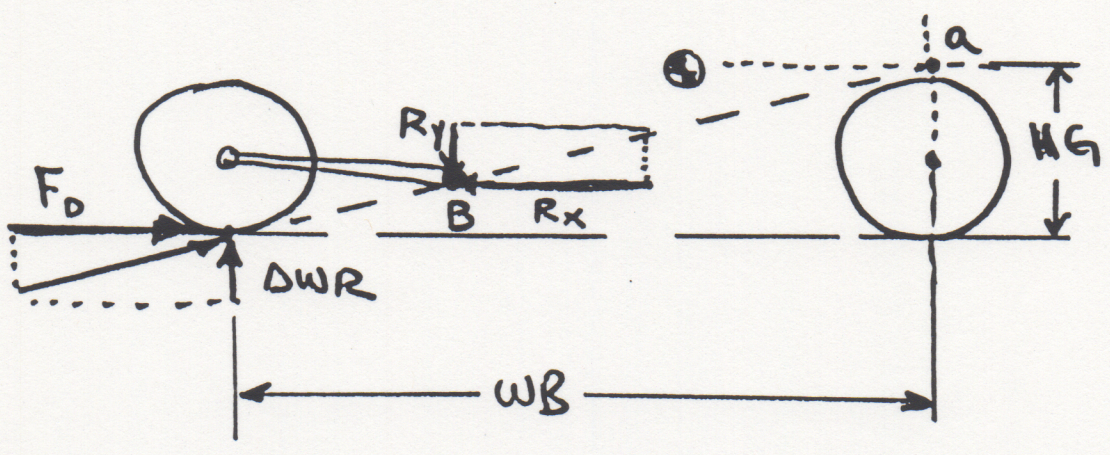
R_y, R_x are reactions at arm pivot B on the chassis due to accel.

ΔF_s = change in spring force from static (the static spring force would balance the static load at the bottom of the tire, and any static components in the y dir. at B)

When can $\Delta F_s = 0$? (I) obviously, when $R_y = \Delta W_R$ and also $F_D = R_x$
 (II) more subtly, when we sum torques about B, the resultant of F_D and ΔW_R must pass through B. But we know how F_D and ΔW_R are related if there is no $\ddot{\theta}$ and \ddot{y} terms. = that is, no "squatting" or "lift" at the rear. Then it would behave as if there were no suspension and equation (1) would apply. (Also note that $F_D = m\ddot{x}$)

FROM EQU 1: $\Delta WR = F_D \left(\frac{HG}{WB} \right)$

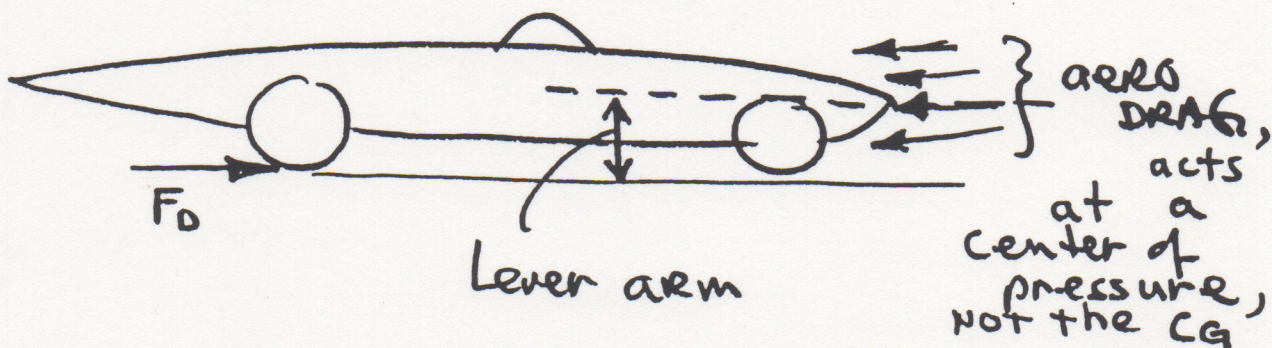
OR $\frac{\Delta WR}{F_D} = \frac{HG}{WB}$ (4)



This condition, eqn (4), will occur if swing arm pivot B is on the line running from the rear tire contact up to point a. If point B is on this line, the rear end should not squat, since ΔF_s would be zero. If point B is above this line Force F_D will cause a combination of ΔF_s and R_y to lift slightly and if its below the line, the rear end will squat.

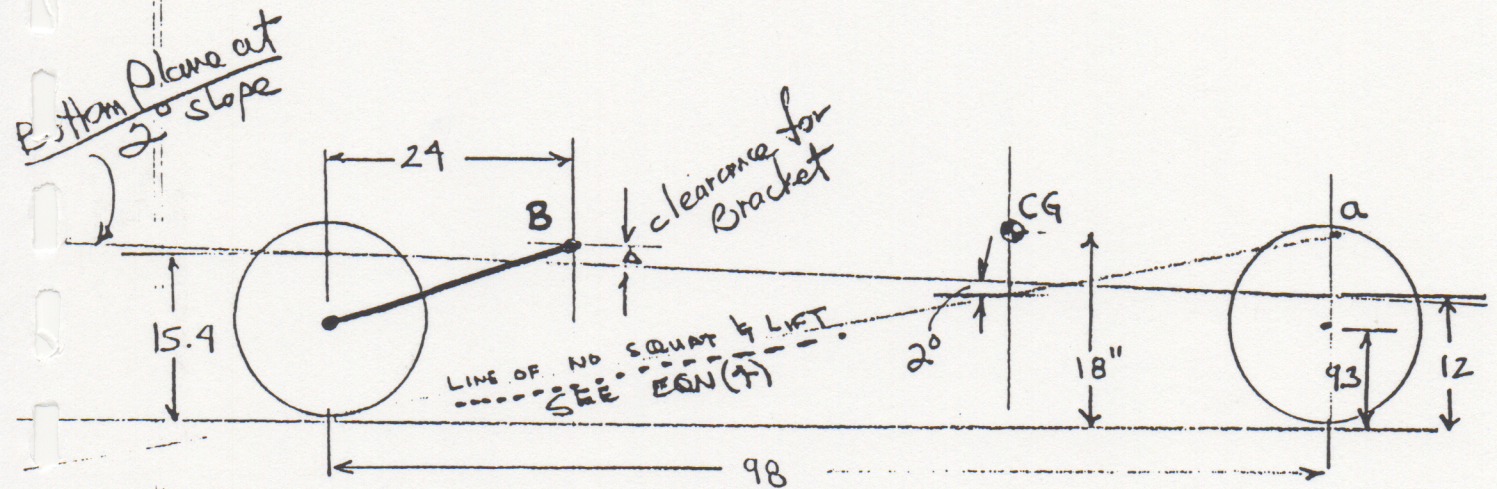
We've seen some solar car suspensions where the swing arm rises over 30° in a forward direction causing much lifting at the rear under acceleration.

If squat or lift occur, its NOT "BAD". ONE could argue that some lift may be useful to counteract the moment on the vehicle caused by the drag force being applied above the ground - LIKE:



However, if much lift occurs, then we are putting energy into raising the car, rather than propelling it forward - that's bad

So what about Aurora III? Since we are proposing raising the body and angling the bottom of the chassis, then there won't be a low point to mount a swing arm.

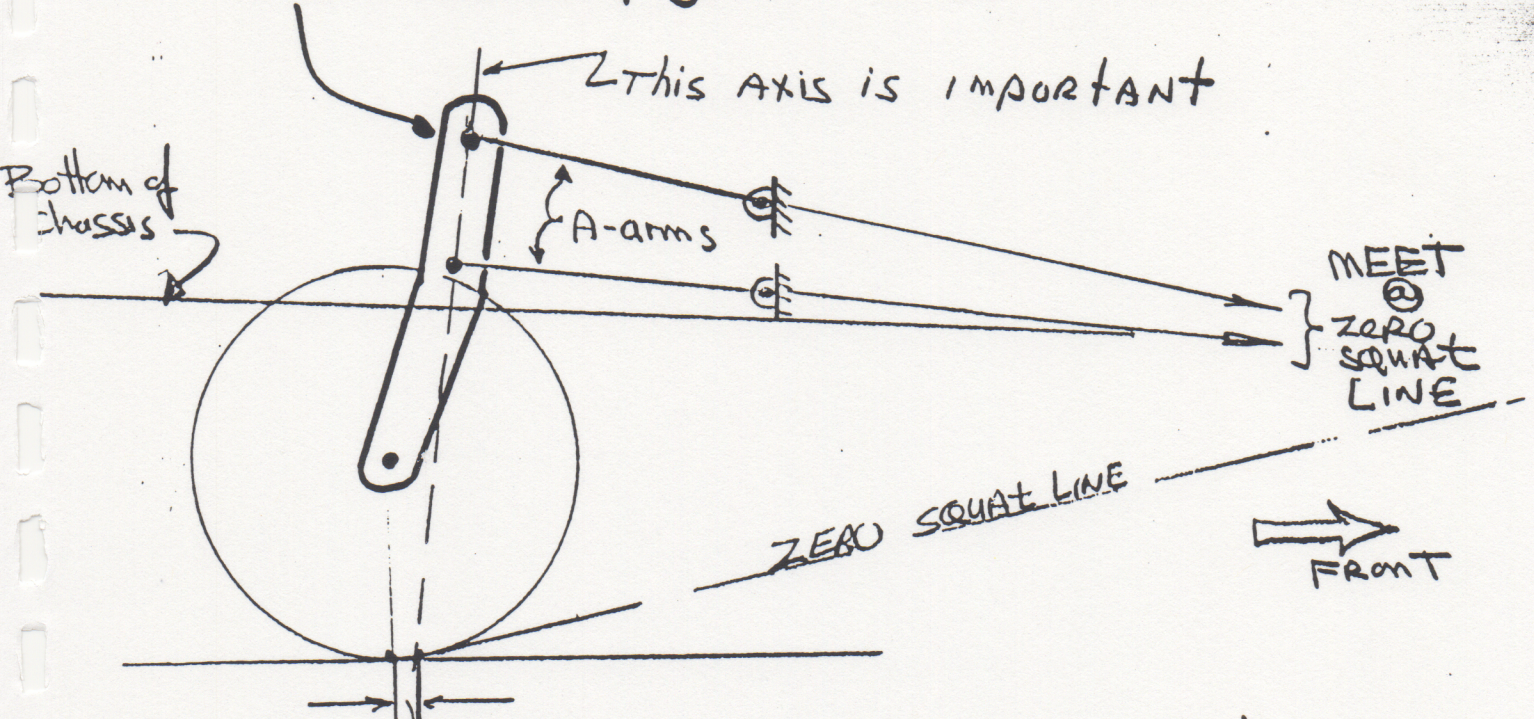


All DIMENSIONS are NOMINAL GUESSES

NOTE the arm pivot is way above the NO SQUAT line - This will cause lift - Severe? we'd have to model it - (we could make estimates)

So? WE CAN consider a 4 bar link arrangement that would kinematically give a zero squat/lift property.

REAR "KINGPIN" upright



Question: choice do we want this ahead, at or behind the center of tire contact? (CONSIDER SIDE LOADS WHEN CORNERING)

NOTE 1: The upright and upper A-arm cannot go thru the body at full bump.

2. The lower A-arm should not go thru the bottom of the chassis at full droop, though its outer end could drop through, since a hole is needed for the wheel and in-wheel motor and lower part of the upright

3. As in the front, the farther apart the A-arms, the smaller the loads.

Next Tasks - Rear Susp Group -

Create nominal dimensions for figures ⑦ & ⑧ - use current chassis options and body dimensions -

• Estimate the CG height & find the zero squat line

• Try different A-arm lengths AND chassis lengths -

• NOTE since the array is to be the 5 meters long (now it was supposed to be 4.4m but I don't think it was), try to estimate the vehicle length (see Aeron in Aero). Then perhaps we need to lengthen the WB ~ maybe in the same proportion as the increase in vehicle length - If so, it will affect the thickness of the body at the rear upright and the ackerman steering angles.