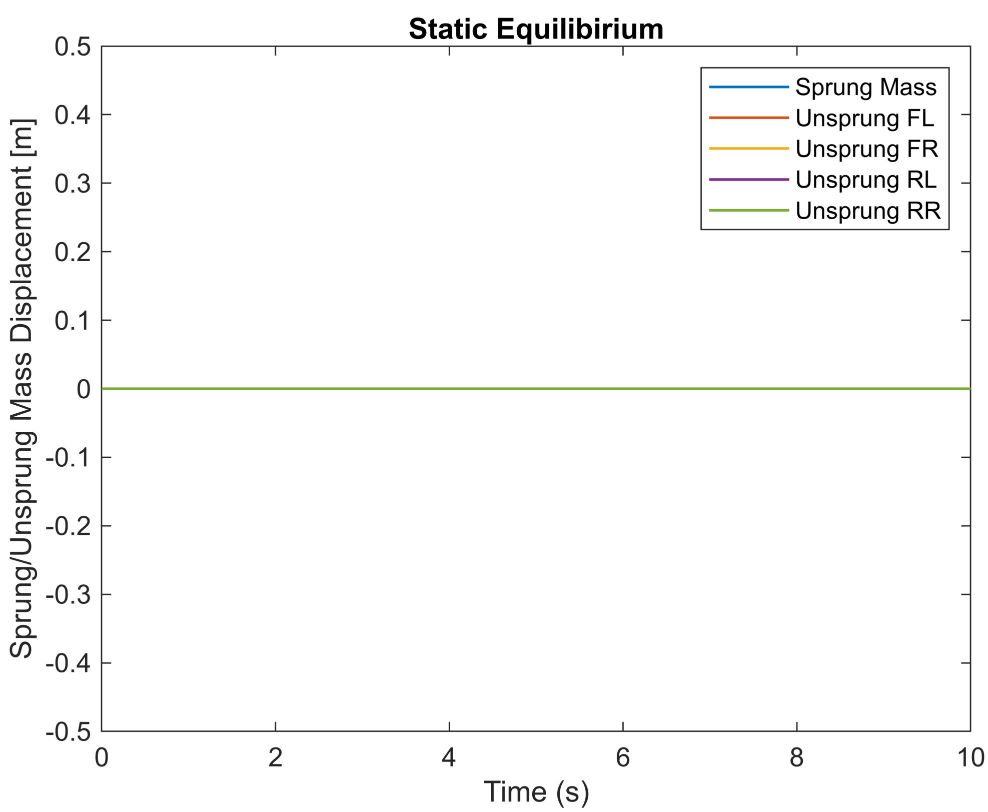
Model Verification

Static Equilibrium - Mass displacement should be 0 for no velocity, lateral acceleration and road roughness inputs.

```
load("Static_Equilibrium.mat")

plot(Static_Equilibrium.zs.time,Static_Equilibrium.zs.data, "LineWidth",1)
hold on
plot(Static_Equilibrium.zusfl.time, Static_Equilibrium.zusfl.data, "LineWidth",1)
plot(Static_Equilibrium.zusfr.time, Static_Equilibrium.zusfr.data, "LineWidth",1)
plot(Static_Equilibrium.zusrl.time, Static_Equilibrium.zusrl.data, "LineWidth",1)
plot(Static_Equilibrium.zusrr.time, Static_Equilibrium.zusrr.data, "LineWidth",1)
ylim([-0.5 0.5])
xlabel('Time (s)')
ylabel('Sprung/Unsprung Mass Displacement [m]')
title('Static Equilibirium')
legend(['Sprung Mass'; 'Unsprung FL'; 'Unsprung FR'; 'Unsprung RL'; 'Unsprung RR'])
hold off
```

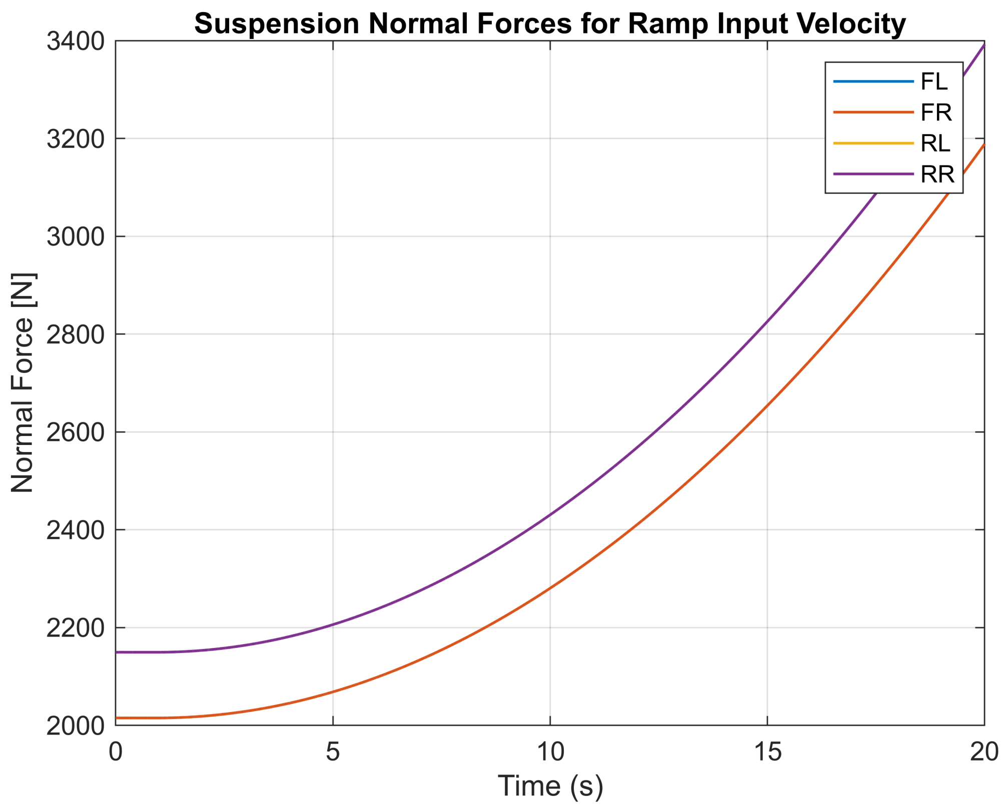


Aero Forces - Ramp velocity input form 0 to 300kmph in 20s.

```
load("Aero_Forces.mat")

plot(Aero_Forces.Ftfl.time, Aero_Forces.Ftfl.data, "LineWidth",1)
hold on
```

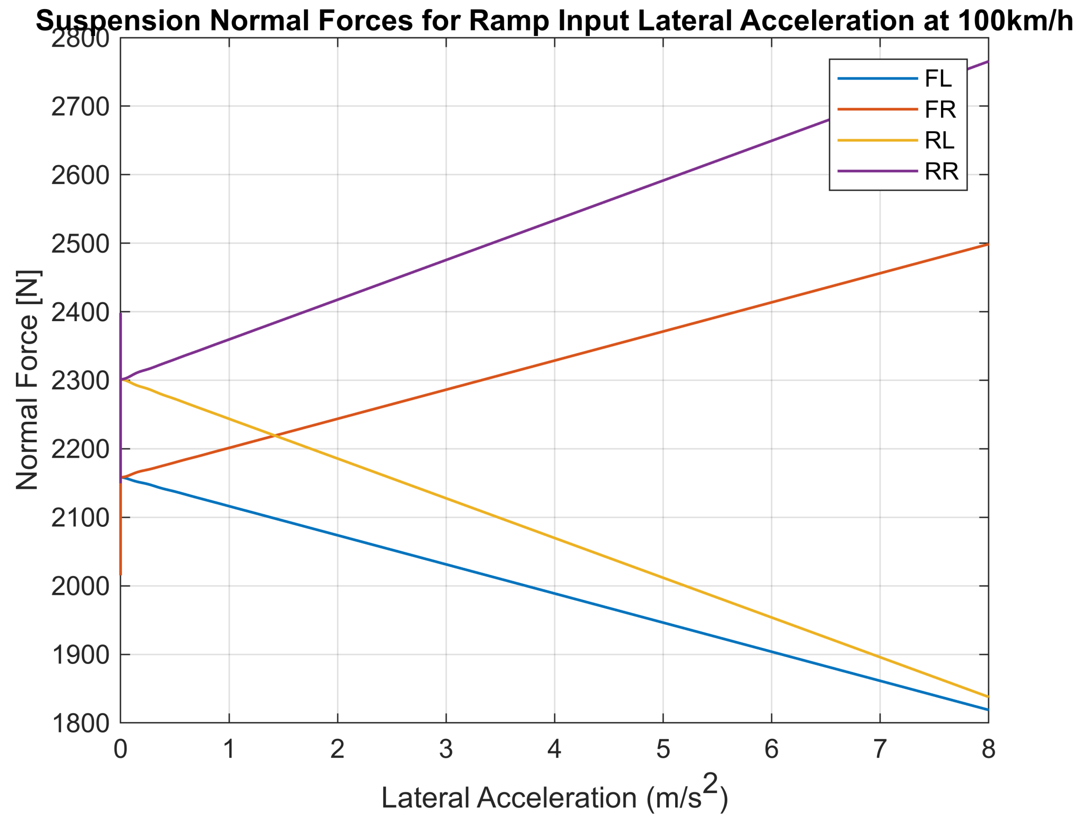
```
plot(Aero_Forces.Ftfr.time, Aero_Forces.Ftfr.data, "LineWidth",1)
plot(Aero_Forces.Ftrl.time, Aero_Forces.Ftrl.data, "LineWidth",1)
plot(Aero_Forces.Ftrr.time, Aero_Forces.Ftrr.data, "LineWidth",1)
xlabel('Time (s)')
ylabel('Normal Force [N]')
title('Suspension Normal Forces for Ramp Input Velocity')
legend(['FL'; 'FR'; 'RL'; 'RR'])
hold off
grid on
```



Load Transfer - Ramp lateral acceleration input from 0 to 8m/s^2 with constant 100km/h velocity.

```
load("Load_Transfer.mat")

plot(Load_Transfer.latacc.data, Load_Transfer.Ftfl.data, "LineWidth",1)
hold on
plot(Load_Transfer.latacc.data, Load_Transfer.Ftfr.data, "LineWidth",1)
plot(Load_Transfer.latacc.data, Load_Transfer.Ftrl.data, "LineWidth",1)
plot(Load_Transfer.latacc.data, Load_Transfer.Ftrr.data, "LineWidth",1)
xlabel('Lateral Acceleration (m/s^2)')
ylabel('Normal Force [N]')
title('Suspension Normal Forces for Ramp Input Lateral Acceleration at 100km/h')
legend(['FL'; 'FR'; 'RL'; 'RR'])
hold off
grid on
```




```
deltaFz_FR = 2328.74 - 2150.2
```

```
deltaFz_FR = 178.5400
```

```
deltaFz_RR = 2533.48 - 2302.63
```

```
deltaFz_RR = 230.8500
```

Suspension Natural Frequencies - Heave and wheel hop frequency calculations vs model outputs.

```
ms_front = ms*(b/L);
ms_rear = ms*(a/L);

f_frontcorner = sqrt(ksf/(0.5*ms_front))/(2*pi)
```

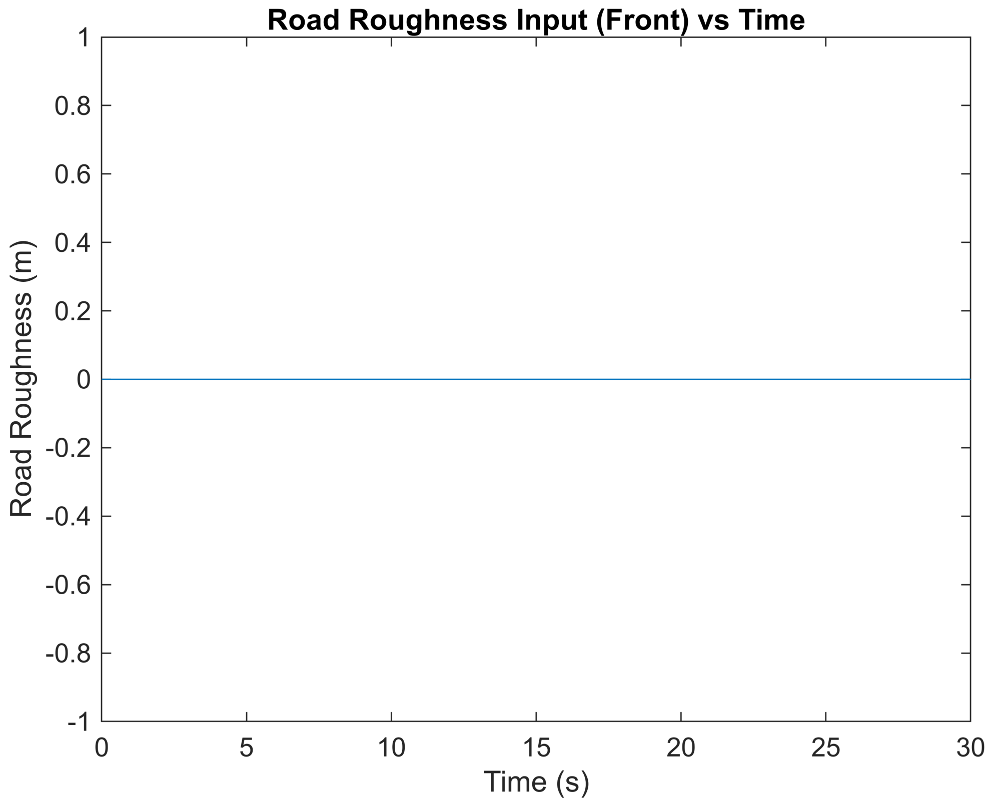
```
f_frontcorner = 2.9948
```

```
f_rearcorner = sqrt(ksr/(0.5*ms_rear))/(2*pi)
```

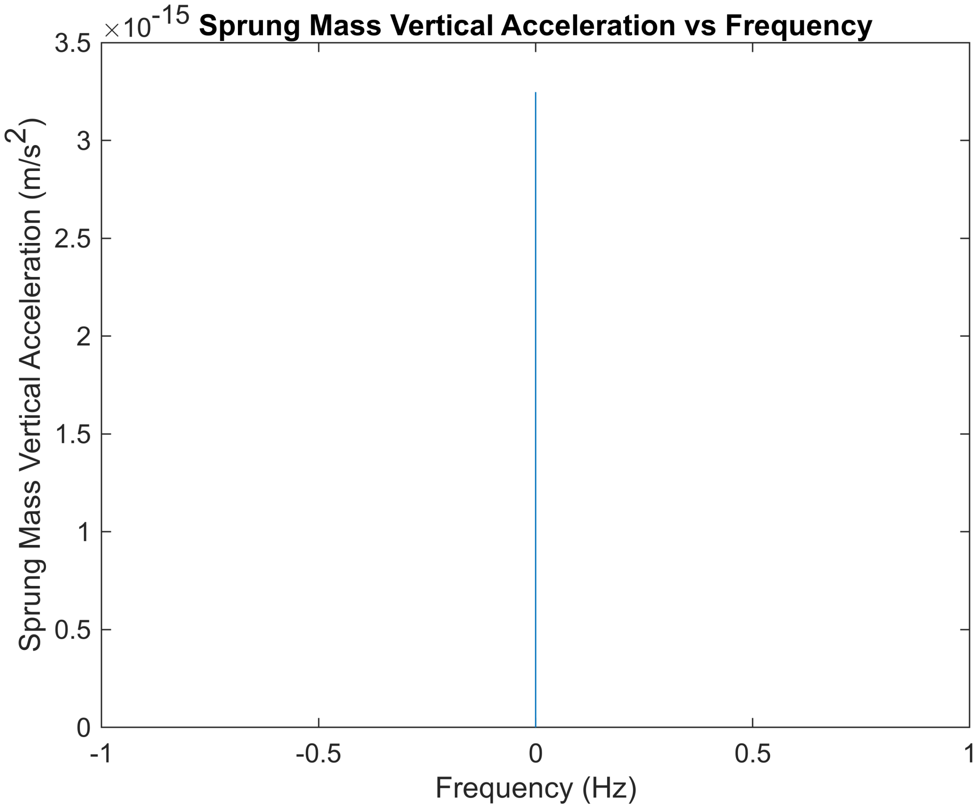
```
f_rearcorner = 3.5424
```

```
plot(out.zf_road.time, out.zf_road.data)
title('Road Roughness Input (Front) vs Time')
xlabel('Time (s)')
ylabel('Road Roughness (m)')
```

```
xlim([0 30])
```




```
dt = 0.005;
[amps, freqs, phases] = fft_VD(out.zsdotdot.data,dt);
plot(freqs,amps)
title('Sprung Mass Vertical Acceleration vs Frequency')
xlabel('Frequency (Hz)')
ylabel('Sprung Mass Vertical Acceleration (m/s^2)')
```




```
%xlim([0 30])

f_wheelhopfront = (1/(2*pi))*sqrt((ktyre+ksf)/musf)
```

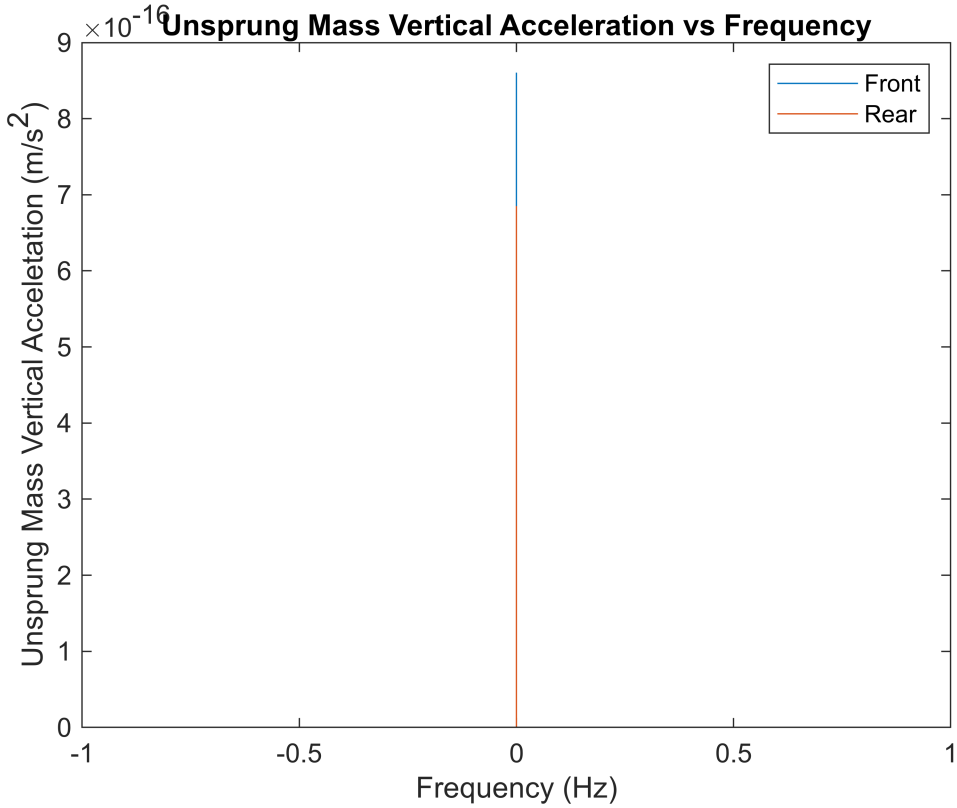
```
f_wheelhopfront = 28.0973
```

```
f_wheelhoprear = (1/(2*pi))*sqrt((ktyre+ksr)/musr)
```

```
f_wheelhoprear = 26.9021
```

```

[ampfWH, freqfWH, phasefWH] = fft_VD(out.zusfldotdot.data,dt);
[amprWH, freqrWH, phaserWH] = fft_VD(out.zusrldotdot.data,dt);
plot(freqfWH,ampfWH)
hold on
plot(freqrWH,amprWH)
title('Unsprung Mass Vertical Acceleration vs Frequency')
xlabel('Frequency (Hz)')
ylabel('Unsprung Mass Vertical Acceletation (m/s^2)')
legend('Front', 'Rear')
%xlim([0 30])
hold off
```



How can we generate a road roughness input if the velocity is a constant 0km/h?

Please can you clarify how I should construct my model inputs for this final stage of the verification?