Kernel: Python 3 (system-wide)

In [1]:
```
import numpy as np
from matplotlib import pyplot as plt
```

In [2]:
```
# sigularities
def sing(x,a,n):
    ni = np.zeros(x.size)
    for i in range(x.size):
        if x[i] >=a and n>=0:
            ni[i] = (x[i]-a)**n
    return ni

def lx(a,b,pc, l2,l3):

    a_p = np.math.factorial(a)
    b_p = np.math.factorial(b)
    return (1-pc)*m*sing(xx,0,a)/a_p-
m/l2*sing(xx,l3,b)/b_p+m/l2*sing(xx,l3+l2,b)/b_p+pc*m*sing(xx,l1,a)/a_p
```

In [3]:
```
#constants
l1 = 200
m = 18400
S = 5.61
```

In [4]:
```
# predefined arrays
xx = np.linspace(0,200)
lii = np.linspace(10, 120, 15)
```

In [0]:
```
```

In [5]:
```
o_m_l = []
max_loc = []
m_full = []
# loop through locations
for lis in lii:

    # initialize constants for each
    max_p = [[0,0]]
    l_f = []
    min_x_x = lis/40
    min_x = np.ceil((min_x_x, 10-min_x_x))/10
    # print('-minx: ', min_x)
    for p in np.arange(min_x[0],min_x[1],0.1):
        l4 = 200*p-lis/2  # calculates resulting length

        #singularity
```

```
        load = lx(0,1,p,lis,l4)
        mom = lx(1,2,p,lis,l4)

        sig = mom/(2*S)  # stress

        l_f.append([load, mom, sig])
        max_sig = np.max(np.abs(sig))

        max_p.append([p*1, max_sig*1])  # max stress for this loading
condition and this location

    # tabulation of this location, and max of location
    max_p = np.array(max_p)
    m_full.append(l_f)
    m_n = np.argmax(max_p,0)
    m_a = max_p[m_n[1],:]

    # adding to list of all locs
    max_loc.append(max_p)
    o_m_l.append(m_a)

# max of all
o_m_l = np.array(o_m_l)
m_aa = np.argmax(o_m_l,0)

m_aaa = o_m_l[m_aa[1],:]

# max for each percent, len
for i in range(len(max_loc)):
    print(f'\n------------loading for Dis load len: {round(lii[i],1)}(in)')
    for ii in max_loc[i]:
        print(f'at rear load: {int(ii[0]*100)}% = Max \u03C3:
{round(ii[1],2)}(psi)')
print(f'\n--------------------\n')

ni = 0
# max for each len
for i in o_m_l:
    print(f'max at len: {round(lii[ni],1)}(in), rear load: {int(i[0]*100)}%,
\u03C3 = {round(i[1], 2)}(psi)')
    ni +=1
print(f'\n--------------------\noverall max at len(in): {round(lii[m_aa[1]],
2)}, rear load: {int(m_aaa[0]*100)}%,  \u03C3 = {round(m_aaa[1], 2)}(psi)')
```

Out[5]:

```
------------loading for Dis load len: 10.0(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 10% = Max σ: 28761.08(psi)
at rear load: 20% = Max σ: 50870.4(psi)
at rear load: 30% = Max σ: 67105.77(psi)
at rear load: 40% = Max σ: 76715.84(psi)
at rear load: 50% = Max σ: 79605.01(psi)
at rear load: 60% = Max σ: 76715.84(psi)
at rear load: 70% = Max σ: 67105.77(psi)
at rear load: 80% = Max σ: 50870.4(psi)
at rear load: 90% = Max σ: 28761.08(psi)

------------loading for Dis load len: 17.9(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 10% = Max σ: 28107.21(psi)
at rear load: 20% = Max σ: 50125.28(psi)
at rear load: 30% = Max σ: 65663.96(psi)
at rear load: 40% = Max σ: 75201.37(psi)
```

at rear load: 50% = Max σ: 78144.63(psi)
at rear load: 60% = Max σ: 75201.37(psi)
at rear load: 70% = Max σ: 65663.96(psi)
at rear load: 80% = Max σ: 50125.28(psi)
at rear load: 90% = Max σ: 28107.21(psi)

------------loading for Dis load len: 25.7(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 10% = Max σ: 27527.37(psi)
at rear load: 20% = Max σ: 49053.1(psi)
at rear load: 30% = Max σ: 64448.35(psi)
at rear load: 40% = Max σ: 73628.12(psi)
at rear load: 50% = Max σ: 76592.43(psi)
at rear load: 60% = Max σ: 73628.12(psi)
at rear load: 70% = Max σ: 64448.35(psi)
at rear load: 80% = Max σ: 49053.1(psi)
at rear load: 90% = Max σ: 27527.37(psi)

------------loading for Dis load len: 33.6(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 10% = Max σ: 27026.56(psi)
at rear load: 20% = Max σ: 48044.22(psi)
at rear load: 30% = Max σ: 63047.82(psi)
at rear load: 40% = Max σ: 72037.37(psi)
at rear load: 50% = Max σ: 75012.87(psi)
at rear load: 60% = Max σ: 72037.37(psi)
at rear load: 70% = Max σ: 63047.82(psi)
at rear load: 80% = Max σ: 48044.22(psi)
at rear load: 90% = Max σ: 27026.56(psi)

------------loading for Dis load len: 41.4(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 20% = Max σ: 47034.6(psi)
at rear load: 30% = Max σ: 61719.28(psi)
at rear load: 40% = Max σ: 70514.91(psi)
at rear load: 50% = Max σ: 73421.51(psi)
at rear load: 60% = Max σ: 70514.91(psi)
at rear load: 70% = Max σ: 61719.28(psi)
at rear load: 80% = Max σ: 47034.6(psi)

------------loading for Dis load len: 49.3(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 20% = Max σ: 45962.24(psi)
at rear load: 30% = Max σ: 60386.71(psi)
at rear load: 40% = Max σ: 69007.3(psi)
at rear load: 50% = Max σ: 71824.01(psi)
at rear load: 60% = Max σ: 69007.3(psi)
at rear load: 70% = Max σ: 60386.71(psi)
at rear load: 80% = Max σ: 45962.24(psi)

------------loading for Dis load len: 57.1(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 20% = Max σ: 44980.9(psi)
at rear load: 30% = Max σ: 58977.67(psi)
at rear load: 40% = Max σ: 67471.35(psi)
at rear load: 50% = Max σ: 70222.89(psi)
at rear load: 60% = Max σ: 67471.35(psi)
at rear load: 70% = Max σ: 58977.67(psi)
at rear load: 80% = Max σ: 44980.9(psi)

------------loading for Dis load len: 65.0(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 20% = Max σ: 43912.57(psi)
at rear load: 30% = Max σ: 57681.71(psi)
at rear load: 40% = Max σ: 65917.35(psi)

at rear load: 50% = Max σ: 68619.47(psi)
at rear load: 60% = Max σ: 65917.35(psi)
at rear load: 70% = Max σ: 57681.71(psi)
at rear load: 80% = Max σ: 43912.57(psi)

------------loading for Dis load len: 72.9(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 20% = Max σ: 42914.77(psi)
at rear load: 30% = Max σ: 56317.88(psi)
at rear load: 40% = Max σ: 64351.12(psi)
at rear load: 50% = Max σ: 67014.5(psi)
at rear load: 60% = Max σ: 64351.12(psi)
at rear load: 70% = Max σ: 56317.88(psi)
at rear load: 80% = Max σ: 42914.77(psi)

------------loading for Dis load len: 80.7(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 54958.47(psi)
at rear load: 40% = Max σ: 62802.49(psi)
at rear load: 50% = Max σ: 65408.41(psi)
at rear load: 60% = Max σ: 62802.49(psi)
at rear load: 70% = Max σ: 54958.47(psi)

------------loading for Dis load len: 88.6(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 53625.42(psi)
at rear load: 40% = Max σ: 61278.32(psi)
at rear load: 50% = Max σ: 63801.52(psi)
at rear load: 60% = Max σ: 61278.32(psi)
at rear load: 70% = Max σ: 53625.42(psi)

------------loading for Dis load len: 96.4(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 52247.14(psi)
at rear load: 40% = Max σ: 59740.06(psi)
at rear load: 50% = Max σ: 62194.02(psi)
at rear load: 60% = Max σ: 59740.06(psi)
at rear load: 70% = Max σ: 52247.14(psi)

------------loading for Dis load len: 104.3(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 50915.06(psi)
at rear load: 40% = Max σ: 58190.89(psi)
at rear load: 50% = Max σ: 60586.05(psi)
at rear load: 60% = Max σ: 58190.89(psi)
at rear load: 70% = Max σ: 50915.06(psi)

------------loading for Dis load len: 112.1(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 49562.21(psi)
at rear load: 40% = Max σ: 56633.11(psi)
at rear load: 50% = Max σ: 58977.7(psi)
at rear load: 60% = Max σ: 56633.11(psi)
at rear load: 70% = Max σ: 49562.21(psi)

------------loading for Dis load len: 120.0(in)
at rear load: 0% = Max σ: 0.0(psi)
at rear load: 30% = Max σ: 48193.82(psi)
at rear load: 40% = Max σ: 55077.52(psi)
at rear load: 50% = Max σ: 57369.05(psi)
at rear load: 60% = Max σ: 55077.52(psi)

----

max at len: 10.0(in), rear load: 50%, σ = 79605.01(psi)

```
max at len: 17.9(in), rear load: 50%, σ = 78144.63(psi)
max at len: 25.7(in), rear load: 50%, σ = 76592.43(psi)
max at len: 33.6(in), rear load: 50%, σ = 75012.87(psi)
max at len: 41.4(in), rear load: 50%, σ = 73421.51(psi)
max at len: 49.3(in), rear load: 50%, σ = 71824.01(psi)
max at len: 57.1(in), rear load: 50%, σ = 70222.89(psi)
max at len: 65.0(in), rear load: 50%, σ = 68619.47(psi)
max at len: 72.9(in), rear load: 50%, σ = 67014.5(psi)
max at len: 80.7(in), rear load: 50%, σ = 65408.41(psi)
max at len: 88.6(in), rear load: 50%, σ = 63801.52(psi)
max at len: 96.4(in), rear load: 50%, σ = 62194.02(psi)
max at len: 104.3(in), rear load: 50%, σ = 60586.05(psi)
max at len: 112.1(in), rear load: 50%, σ = 58977.7(psi)
max at len: 120.0(in), rear load: 50%, σ = 57369.05(psi)

--------------------
overall max at len(in): 10.0, rear load: 50%,  σ = 79605.01(psi)
```

In [6]:

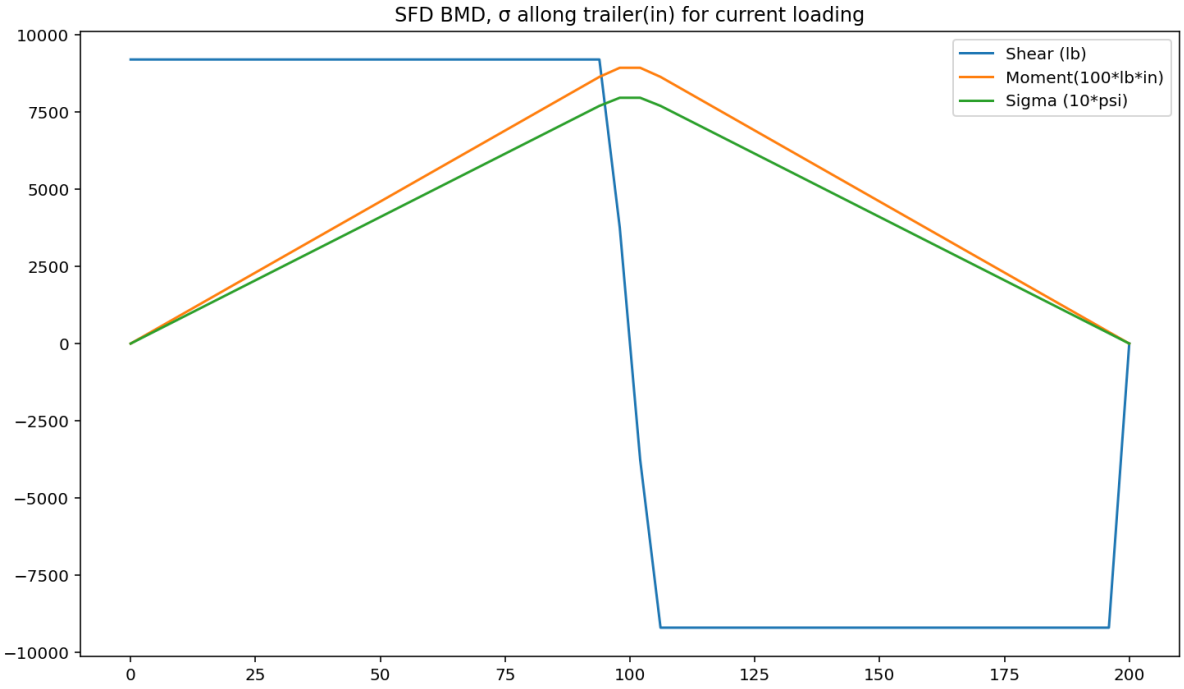
```
# SFD BMD, \u03C3 vs distance for each condition of len,percent

for ii in range(len(m_full)):
    fig, ax = plt.subplots(1,1)
    m_half_2 = m_full[ii]
    m_half = m_half_2[len(m_half_2)//2]

    ax.plot(xx,m_half[0])
    ax.plot(xx,m_half[1]*1e-2)
    ax.plot(xx,m_half[2]*1e-1)

    ax.legend(['Shear (lb)', 'Moment(100*lb*in)', 'Sigma (10*psi)'])
    fig.suptitle(f'Plots for len of load: {round(lii[ii],2)}(in)')
    ax.set_title('SFD BMD, \u03C3 allong trailer(in) for current loading')
    fig.show()

# init plots
title = ['\u03C3(psi) vs percentage rear load at max condition: for meadian
length load', '\u03C3(psi) vs length load(in): for  median percent rear
load']

fig, ax = plt.subplots(1,2)
#for same loc
ax[0].plot(max_loc[7][:,0], max_loc[7][:,1])

# for same per
ax[1].plot(lii,[i[i.shape[0]//2,1] for i in max_loc])

# for readbility
fig.suptitle('overall plots')
for iii in range(2):
    ax[iii].grid(True)
    ax[iii].set_title(title[iii])
fig.show()
```

Out[6]:

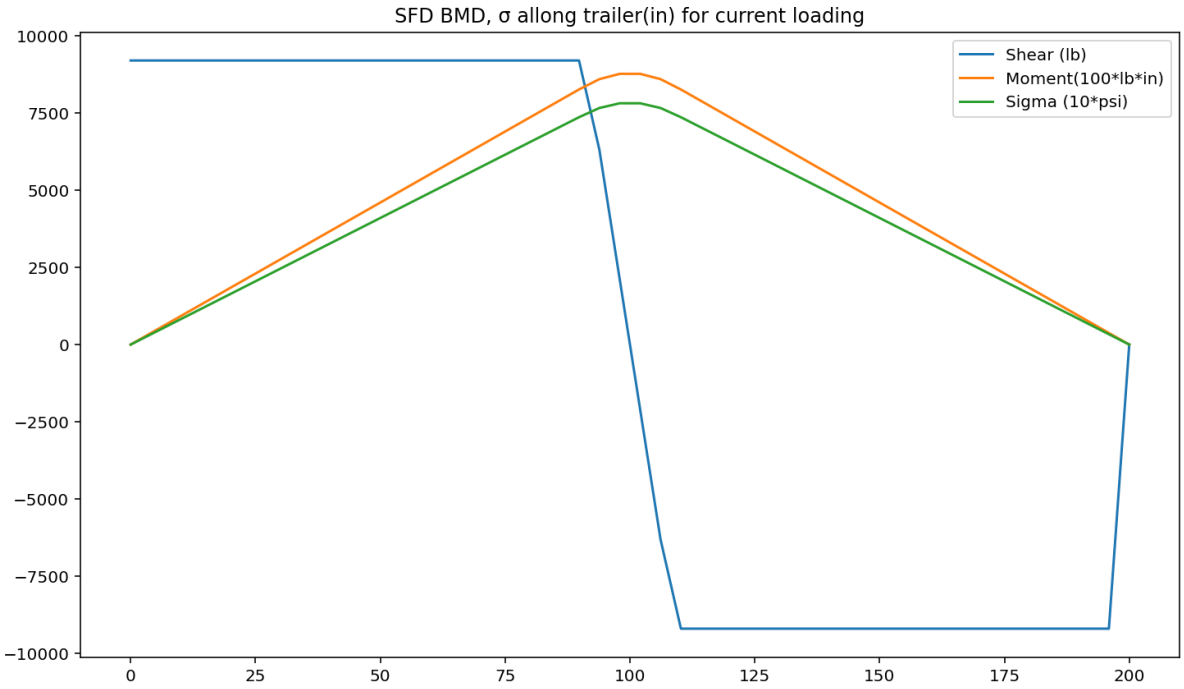
```
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently
using module://matplotlib_inline.backend_inline, which is a non-GUI backend,
so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently
using module://matplotlib_inline.backend_inline, which is a non-GUI backend,
so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently
```

```
using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:15: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
/tmp/ipykernel_2374/4095886525.py:32: UserWarning: Matplotlib is currently using module://matplotlib_inline.backend_inline, which is a non-GUI backend, so cannot show the figure.
  fig.show()
```

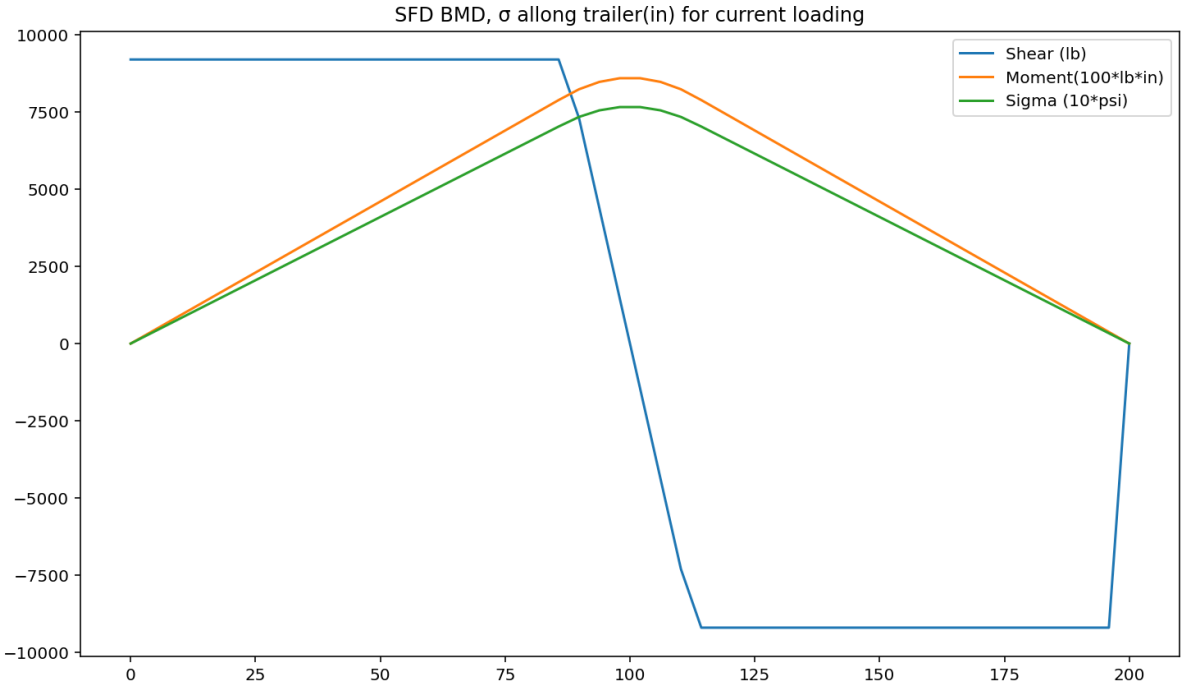
Plots for len of load: 10.0(in)



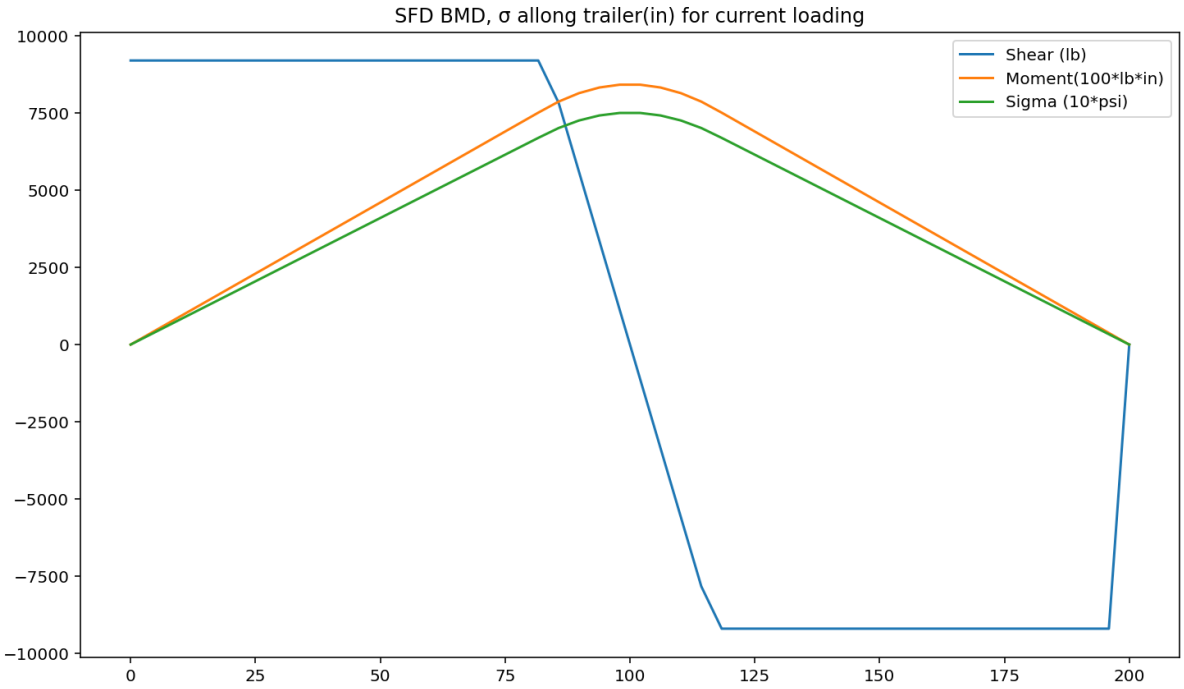
Plots for len of load: 17.86(in)



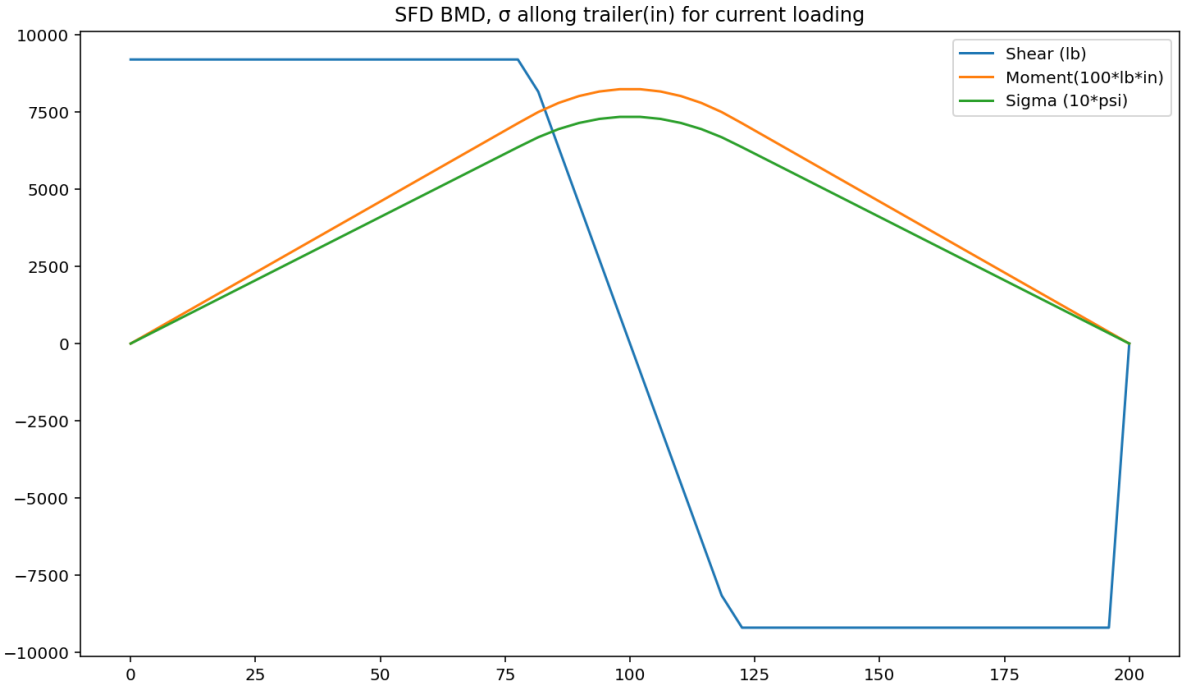
Plots for len of load: 25.71(in)



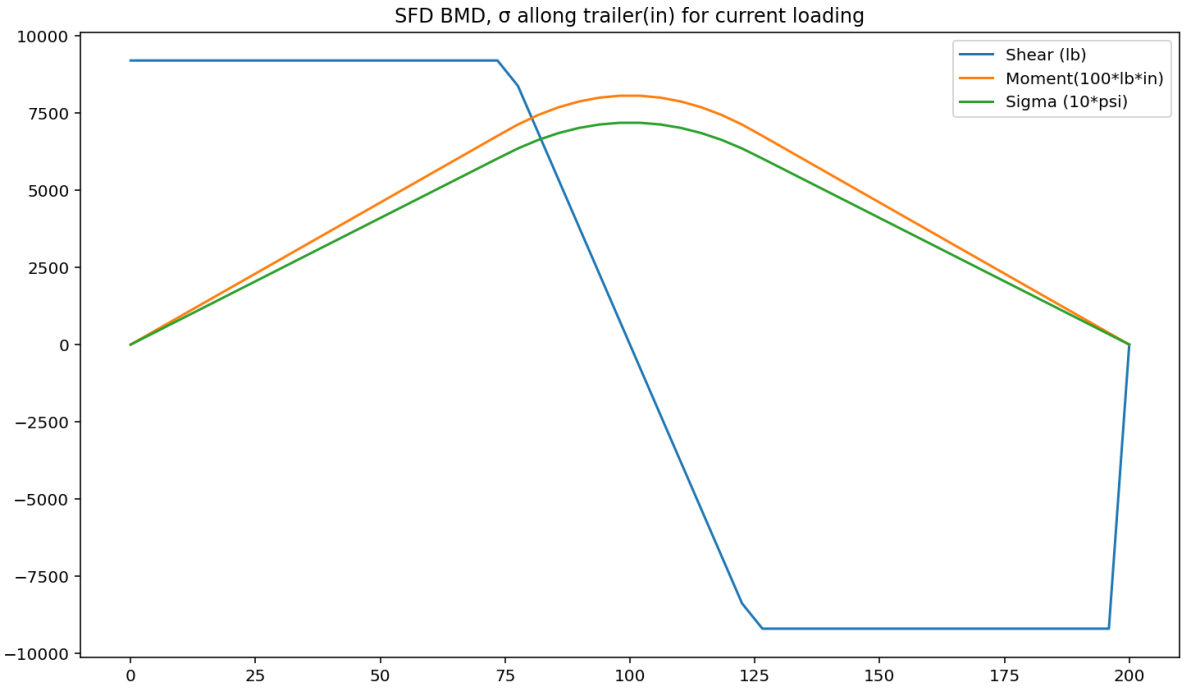
Plots for len of load: 33.57(in)



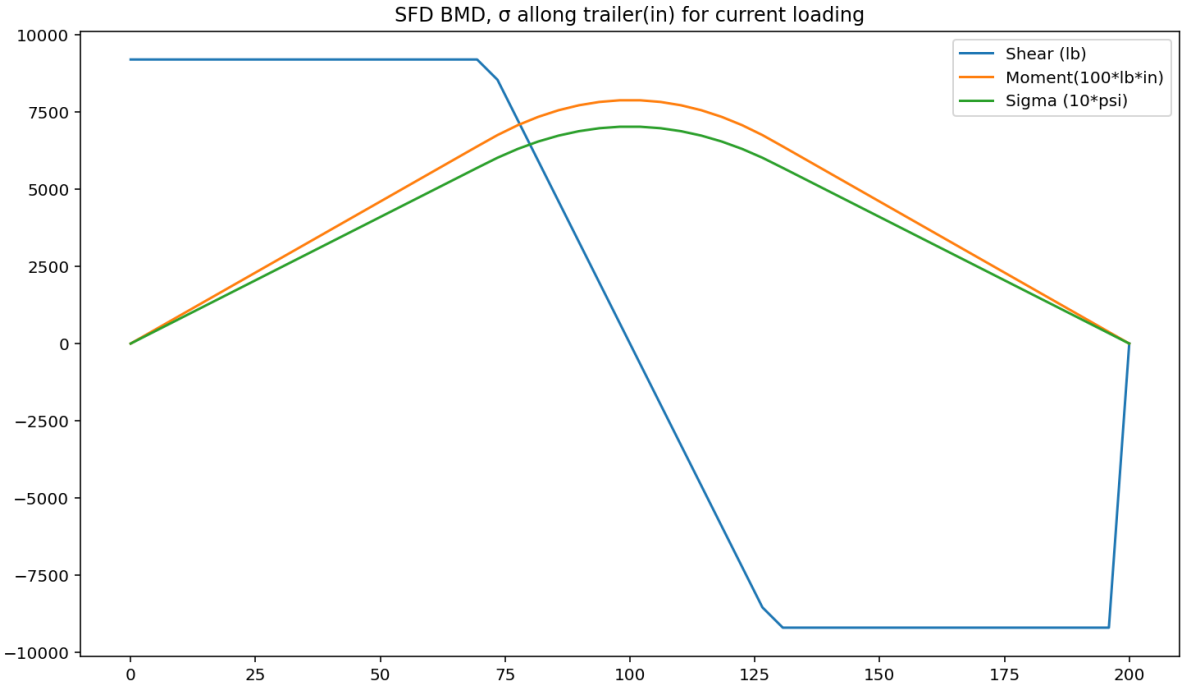
Plots for len of load: 41.43(in)



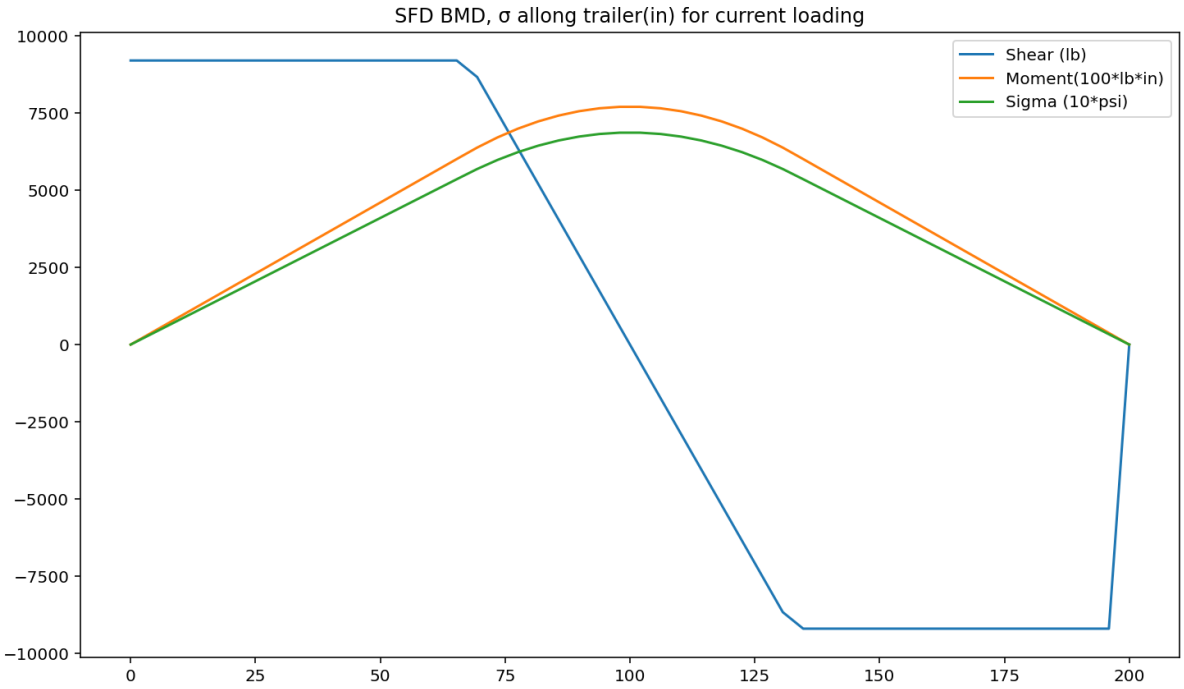
Plots for len of load: 49.29(in)



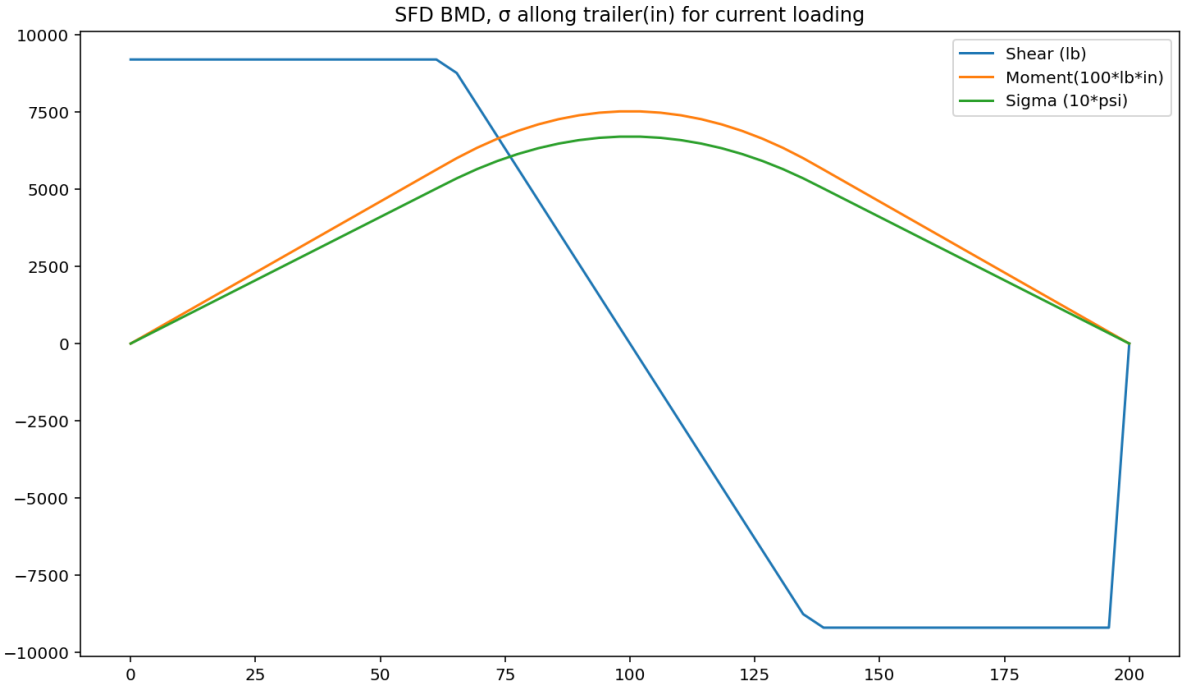
Plots for len of load: 57.14(in)



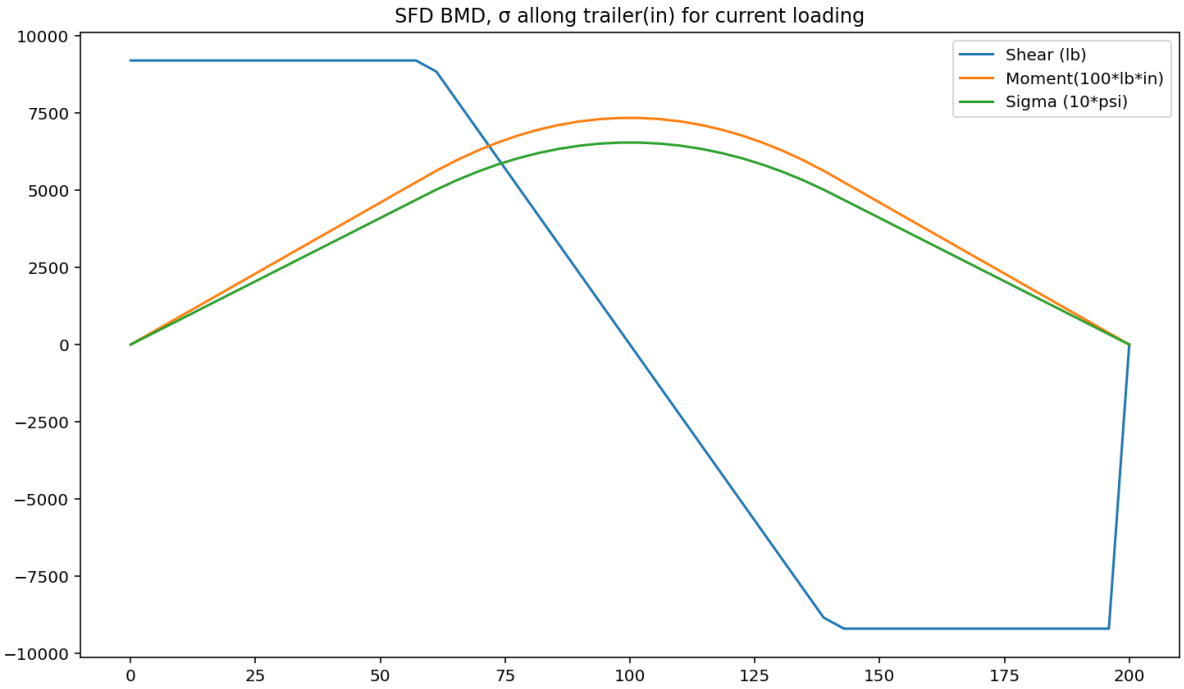
Plots for len of load: 65.0(in)



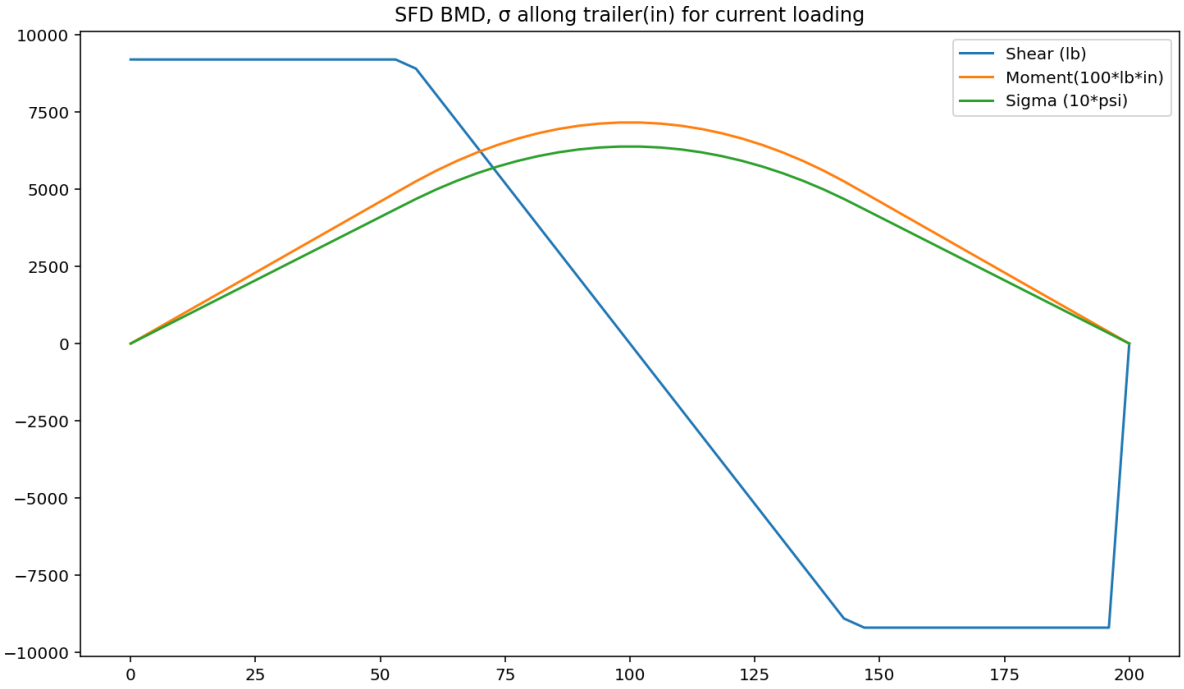
Plots for len of load: 72.86(in)



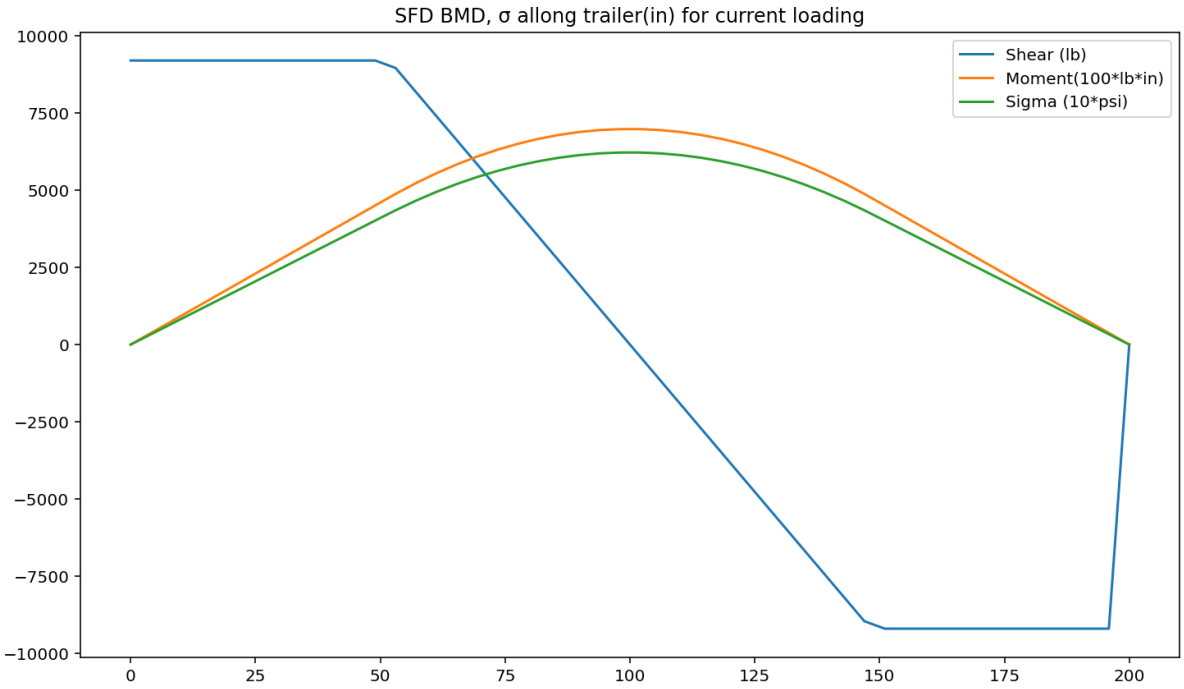
Plots for len of load: 80.71(in)



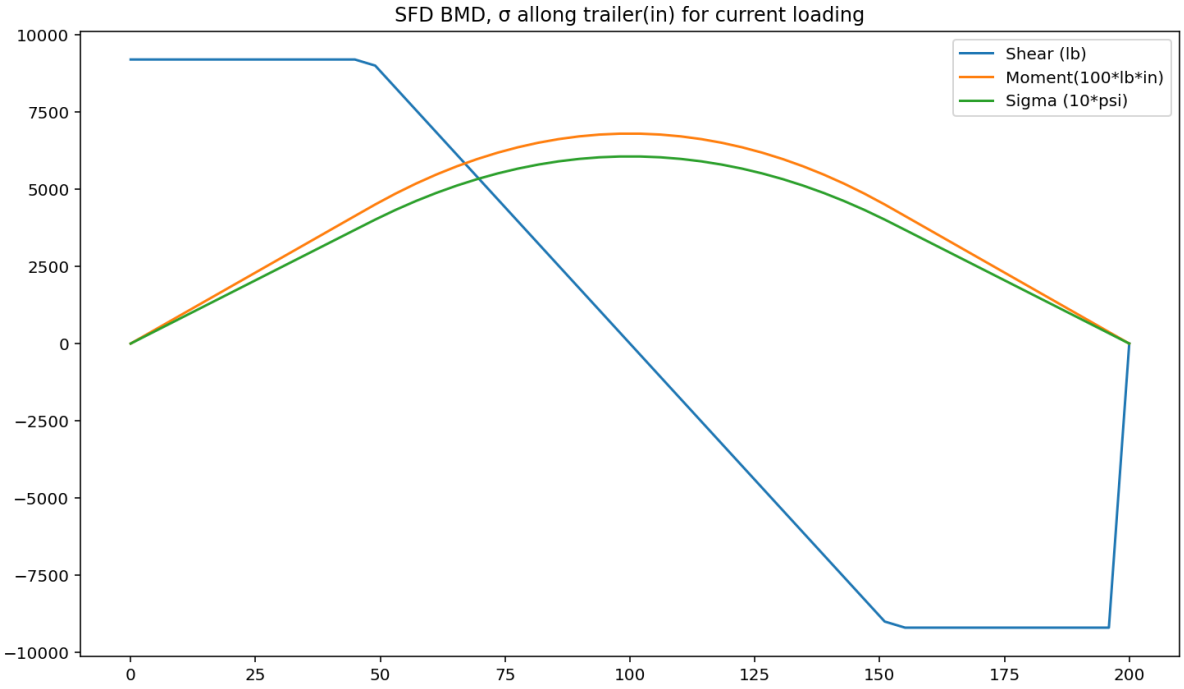
Plots for len of load: 88.57(in)



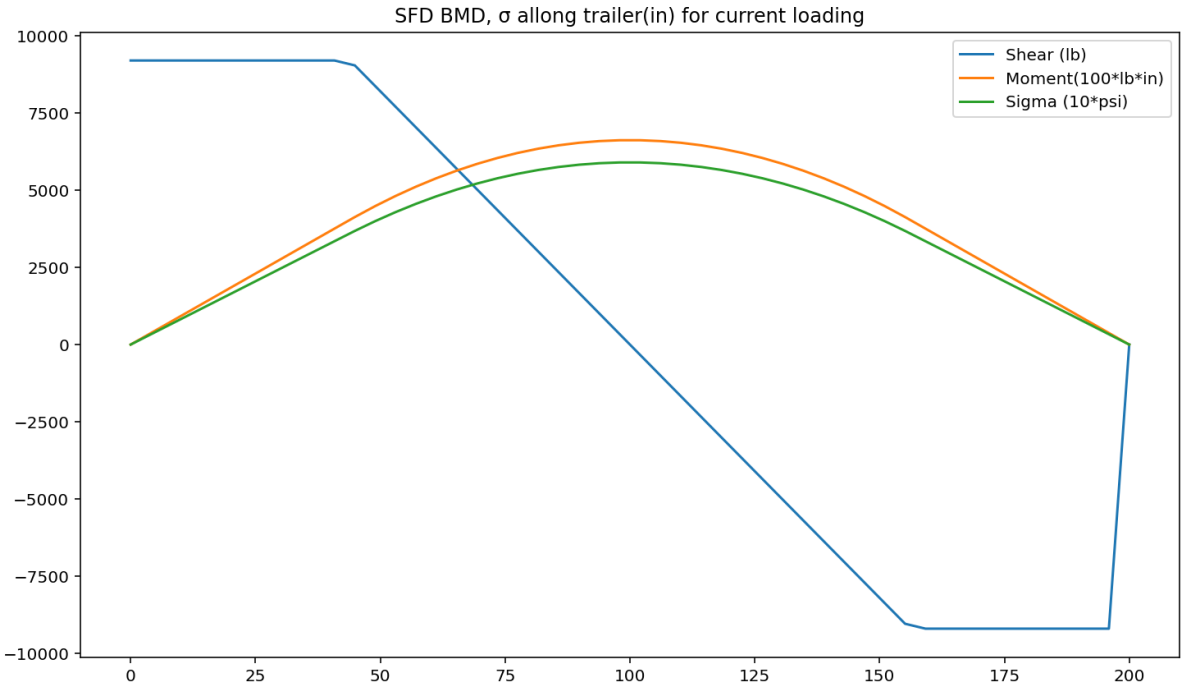
Plots for len of load: 96.43(in)



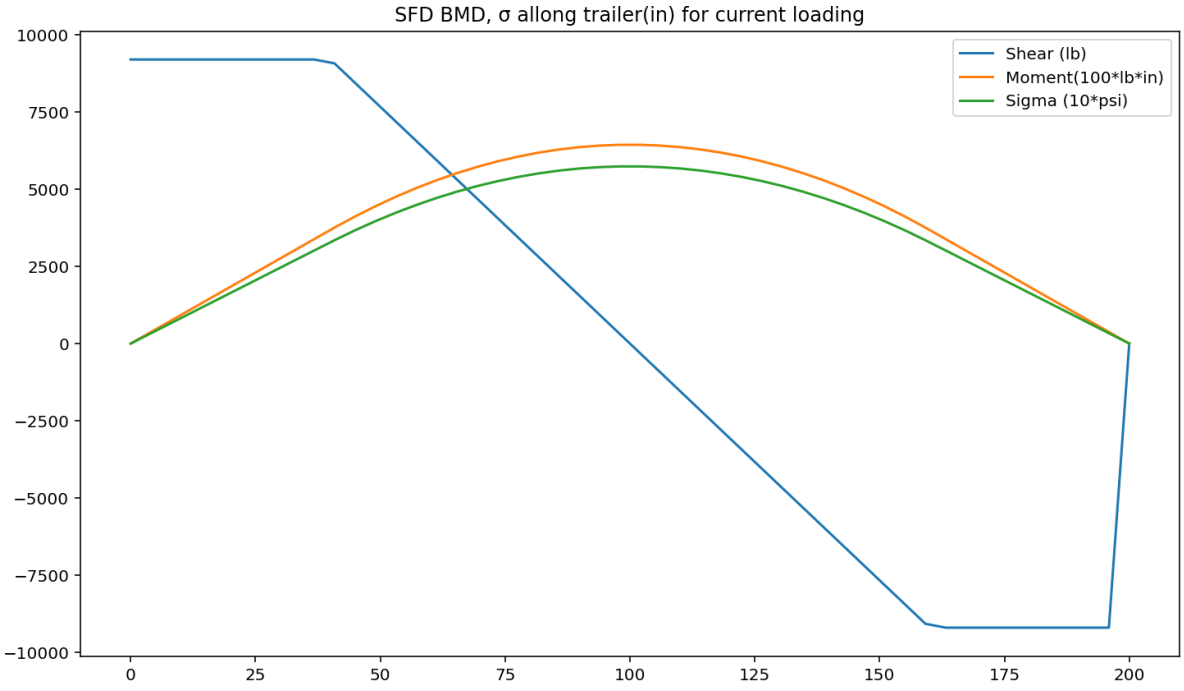
Plots for len of load: 104.29(in)



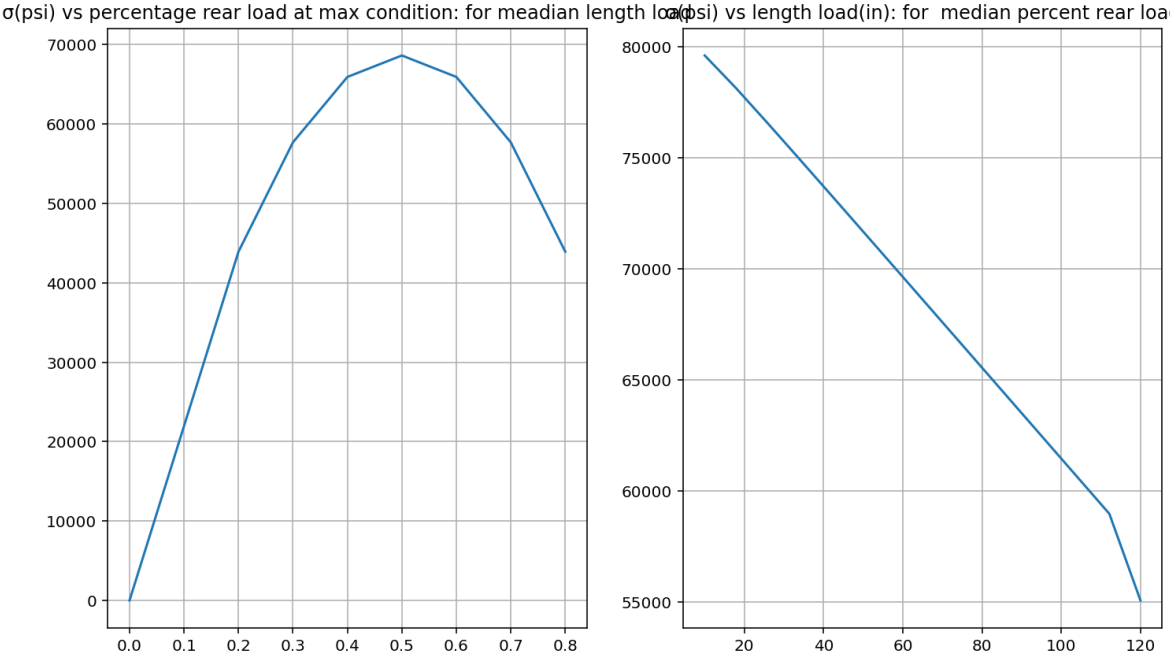
Plots for len of load: 112.14(in)



Plots for len of load: 120.0(in)



overall plots



In [7]:
```
for i in lii:
    print(i/400)
```

Out[7]:
```
0.025
0.044642857142857144
0.0642857142857143
0.08392857142857142
0.10357142857142858
0.1232142857142857
0.14285714285714285
0.1625
0.18214285714285716
0.20178571428571426
```

```
0.22142857142857142
0.24107142857142858
0.2607142857142857
0.28035714285714286
0.3
```

In [0]: