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):
    if not isinstance(x, np.ndarray):
        x = np.array([x])
    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/np.math.factorial(n)

def lx(a,pc, dl, case):
    p1,p2 = pp(dl,case)
    me = m
    if case == 1:
        return m*((1-pc)*sing(xx,0,a)-p1*sing(xx,l0,a)-0.5*sing(xx,dl,a)-
p2*sing(xx,l1,a)+pc/2*(sing(xx,lw1,a)+sing(xx,lw2,a)))
    else:
        if case == 3:
            me = mb
        return me*((1-pc)*sing(xx,0,a)-p1*sing(xx,l0,a)-
p2*sing(xx,l1,a)+pc/2*(sing(xx,lw1,a)+sing(xx,lw2,a)))

def pp(l,cases=1):
    if cases == 1:
        j = 72
        k = 0.5
    else:
        k = 1
        j = 96
    e1 = k*(l-j)/(l1-120)
    return k-e1,e1

def trail(a,pc,l2, case=2):
    p1,p2 = pp(l2,case)
    me = m
    if case == 1:
        return m*(p1*sing(xx,l0,a)+p2*sing(xx,l1,a)-0.5*sing(xx,l2+wb,a))
    else:
        if case == 3:
            me = mb
        return me*(p1*sing(xx,l0,a)+p2*sing(xx,l1,a)-0.5*
(sing(xx,l2+wb,a)+sing(xx,l2,a)))
```

note case on full front, case on half front,

case on back

In [3]:

```
end_t = 300

# predefined arrays
xx = np.linspace(-1,end_t, 200)
lii = np.arange(60,end_t-50,10)
```

In [4]:

```


def run_f():
    max_p = [[0,0]]
    l_f = []

    max_p_t = [[0,0]]
    l_f_t = []
    # loop through locations

    for li in lii:
        p = (li+24)*2/(lw1+lw2)
        if li < st:
            case = 1
        elif li <end_t-50:
            case = 2
        else:
            case = 3

        # initialize constants for each


        #singularity

        load = lx(0,p,li,case)
        mom = lx(1,p,li,case)

        tip_l = trail(0,p,li,case)
        tip_m = trail(1,p, li,case)
        #, v: {}, m:{}')
        sig = mom/(2*S)  # stress
        sig_t = tip_m/(2*s2)

        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

        l_f_t.append([tip_l, tip_m, sig_t])
        max_sig_t = np.max(np.abs(sig_t))

        max_p_t.append([p*1, max_sig_t*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_n = np.argmax(max_p,0)
    m_a = max_p[m_n[1],:]

    # adding to list of all locs

    # tabulation of this location, and max of location
    max_p_t = np.array(max_p_t)
    m_n_t = np.argmax(max_p_t,0)
    m_a_t = max_p_t[m_n_t[1],:]
```

```
    # max for each percent, len
    for i in range(max_p.shape[0]-1):
        fis = max_p[i+1,1]
        fs2 = '||||||||||' if fis>= yield_s else ''
        print(f'Dis load loc {round(lii[i],1)}(in) at rear load:
{int(max_p[i+1,0]*100)}% = Max \u03C3: {round(fis,2)}(psi):::
{round(fis/1000,1)}(ksi){fs2}')


    print(f'\n--------------------\noverall max at len(in):
{round(lii[m_n[1]-1], 2)}, rear load: {int(m_a[0]*100)}%,  \u03C3 =
{round(m_a[1], 2)}(psi)')
    # max for each percent, len
    print(f'\n\n--------------------\ntrailer\n--------------------\n')

    for i in range(max_p_t.shape[0]-1):
        fis = max_p_t[i+1,1]
        fs2 = '||||||||||' if fis>= yield_s else ''
        print(f'Dis load loc {round(lii[i],1)}(in) at rear load:
{int(max_p_t[i+1,0]*100)}% = Max \u03C3: {round(fis,2)}(psi):::
{round(fis/1000,1)}(ksi){fs2}')


    print(f'\n--------------------\noverall max at len(in):
{round(lii[m_n_t[1]-1], 2)}, rear load: {int(m_a_t[0]*100)}%,  \u03C3 =
{round(m_a_t[1], 2)}(psi)')
    return l_f,l_f_t,max_p

def plot_x(l_f,l_f_t,max_p):
    # SFD BMD, \u03C3 vs distance for each condition of len,percent
    lft = [l_f,l_f_t]
    plt_n = ['main', 'tip']
    for ii in range(len(l_f)):
        fig, ax = plt.subplots(1,2)
        for i in range(2):
            ax[i].grid(True)
            m_half = lft[i][ii]

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

            ax[i].legend(['Shear (lb)', 'Moment(100*lb*in)', 'Sigma
(10*psi)'])
            ax[i].set_title(f'SFD BMD, \u03C3 allong trailer(in) for current
loading on {plt_n[i]}')
        fig.suptitle(f'Plots for len of load: {round(lii[ii],2)}(in) rear
Load:{int(max_p[ii,0]*100)}%')
```

In [5]:

```
#test 1
#constants
yield_s = 50000
l1 = 188
l0 =120
lw1 = 179-12
lw2 = 215-12
m = 16000
S = 5.61
s2=5.49

st = 104
```

```
wb = 48
mb=10000

l_f1,l_f_t1,mp = run_f()
plot_x(l_f1,l_f_t1,mp)
```

Out[5]:

```
Dis load loc 60(in) at rear load: 45% = Max σ: 50639.27(psi):::
50.6(ksi)||||||||||
Dis load loc 70(in) at rear load: 50% = Max σ: 49100.46(psi):::  49.1(ksi)
Dis load loc 80(in) at rear load: 56% = Max σ: 49889.28(psi):::  49.9(ksi)
Dis load loc 90(in) at rear load: 61% = Max σ: 49120.91(psi):::  49.1(ksi)
Dis load loc 100(in) at rear load: 67% = Max σ: 46937.31(psi):::  46.9(ksi)
Dis load loc 110(in) at rear load: 72% = Max σ: 47170.73(psi):::  47.2(ksi)
Dis load loc 120(in) at rear load: 77% = Max σ: 37921.51(psi):::  37.9(ksi)
Dis load loc 130(in) at rear load: 83% = Max σ: 28672.28(psi):::  28.7(ksi)
Dis load loc 140(in) at rear load: 88% = Max σ: 19423.06(psi):::  19.4(ksi)
Dis load loc 150(in) at rear load: 94% = Max σ: 10173.83(psi):::  10.2(ksi)
Dis load loc 160(in) at rear load: 99% = Max σ: 10587.48(psi):::  10.6(ksi)
Dis load loc 170(in) at rear load: 104% = Max σ: 11162.89(psi):::  11.2(ksi)
Dis load loc 180(in) at rear load: 110% = Max σ: 17573.84(psi):::  17.6(ksi)
Dis load loc 190(in) at rear load: 115% = Max σ: 26823.07(psi):::  26.8(ksi)
Dis load loc 200(in) at rear load: 121% = Max σ: 36072.29(psi):::  36.1(ksi)
Dis load loc 210(in) at rear load: 126% = Max σ: 45321.52(psi):::  45.3(ksi)
Dis load loc 220(in) at rear load: 131% = Max σ: 54570.74(psi):::
54.6(ksi)||||||||||
Dis load loc 230(in) at rear load: 137% = Max σ: 63819.97(psi):::
63.8(ksi)||||||||||
Dis load loc 240(in) at rear load: 142% = Max σ: 73069.19(psi):::
73.1(ksi)||||||||||

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overall max at len(in): 240, rear load: 142%,  σ = 73069.19(psi)


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trailer
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Dis load loc 60(in) at rear load: 45% = Max σ: 8742.52(psi):::  8.7(ksi)
Dis load loc 70(in) at rear load: 50% = Max σ: 1457.09(psi):::  1.5(ksi)
Dis load loc 80(in) at rear load: 56% = Max σ: 5050.43(psi):::  5.1(ksi)
Dis load loc 90(in) at rear load: 61% = Max σ: 9613.16(psi):::  9.6(ksi)
Dis load loc 100(in) at rear load: 67% = Max σ: 11777.31(psi):::  11.8(ksi)
Dis load loc 110(in) at rear load: 72% = Max σ: 8922.79(psi):::  8.9(ksi)
Dis load loc 120(in) at rear load: 77% = Max σ: 10076.74(psi):::  10.1(ksi)
Dis load loc 130(in) at rear load: 83% = Max σ: 7285.97(psi):::  7.3(ksi)
Dis load loc 140(in) at rear load: 88% = Max σ: 10115.51(psi):::  10.1(ksi)
Dis load loc 150(in) at rear load: 94% = Max σ: 8890.48(psi):::  8.9(ksi)
Dis load loc 160(in) at rear load: 99% = Max σ: 14520.69(psi):::  14.5(ksi)
Dis load loc 170(in) at rear load: 104% = Max σ: 21806.67(psi):::  21.8(ksi)
Dis load loc 180(in) at rear load: 110% = Max σ: 29092.64(psi):::  29.1(ksi)
Dis load loc 190(in) at rear load: 115% = Max σ: 37784.55(psi):::  37.8(ksi)
Dis load loc 200(in) at rear load: 121% = Max σ: 52356.5(psi):::
52.4(ksi)||||||||||
Dis load loc 210(in) at rear load: 126% = Max σ: 66928.45(psi):::
66.9(ksi)||||||||||
Dis load loc 220(in) at rear load: 131% = Max σ: 81500.4(psi):::
81.5(ksi)||||||||||
Dis load loc 230(in) at rear load: 137% = Max σ: 96072.35(psi):::
96.1(ksi)||||||||||
Dis load loc 240(in) at rear load: 142% = Max σ: 110644.3(psi):::
110.6(ksi)||||||||||
```

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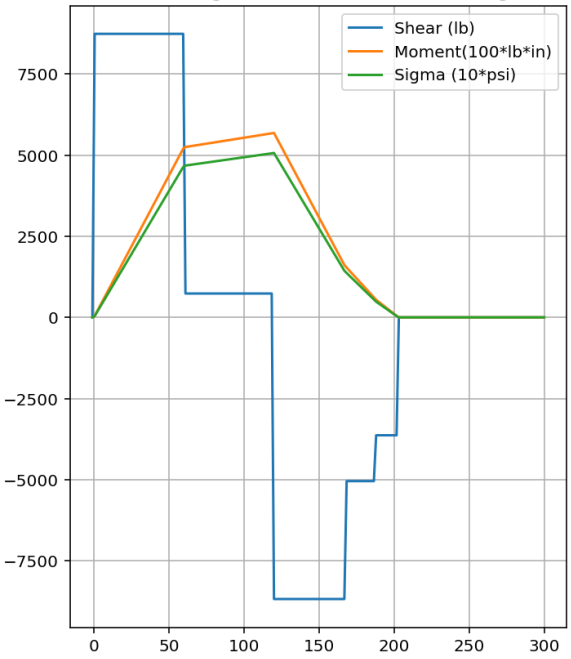
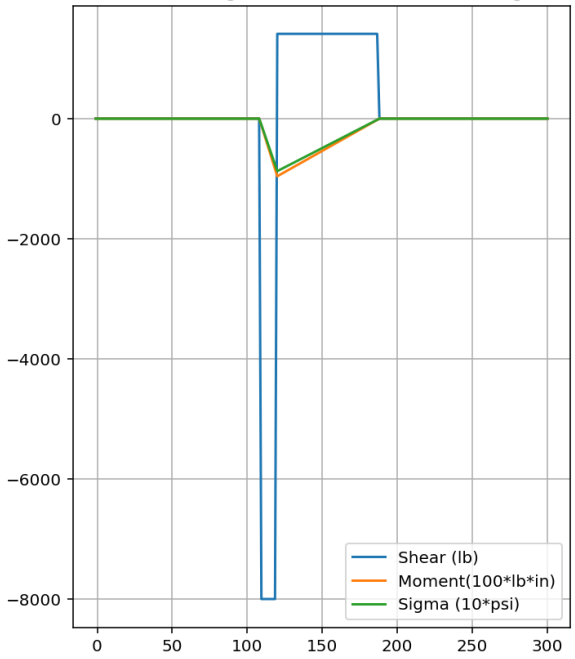
overall max at len(in): 240, rear load: 142%,  σ = 110644.3(psi)
```

Plots for len of load: 60(in) rear Load:0%

SFD BMD, σ allong trailer(in) for current loading on main

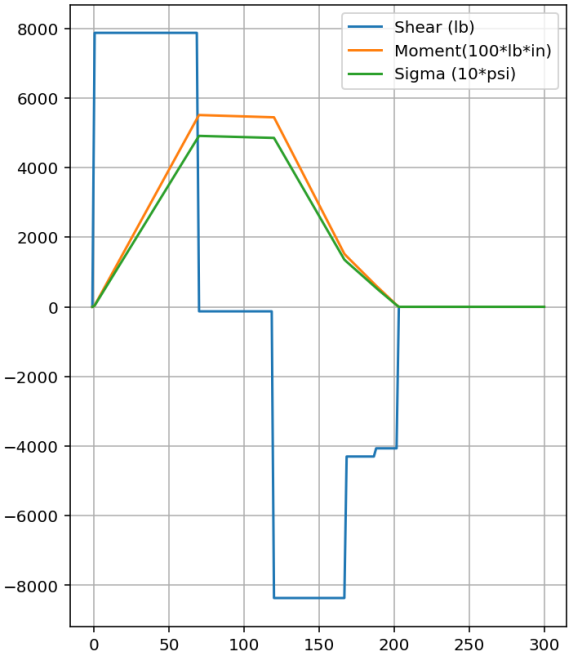


SFD BMD, σ allong trailer(in) for current loading on tip

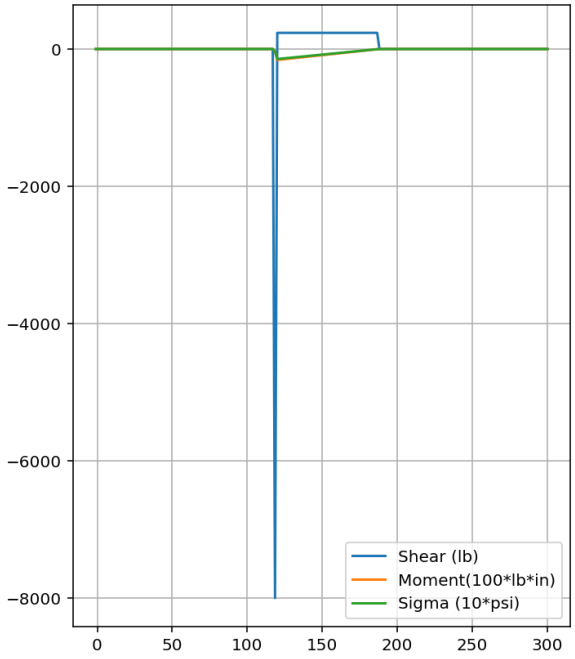


Plots for len of load: 70(in) rear Load:45%

SFD BMD, σ allong trailer(in) for current loading on main

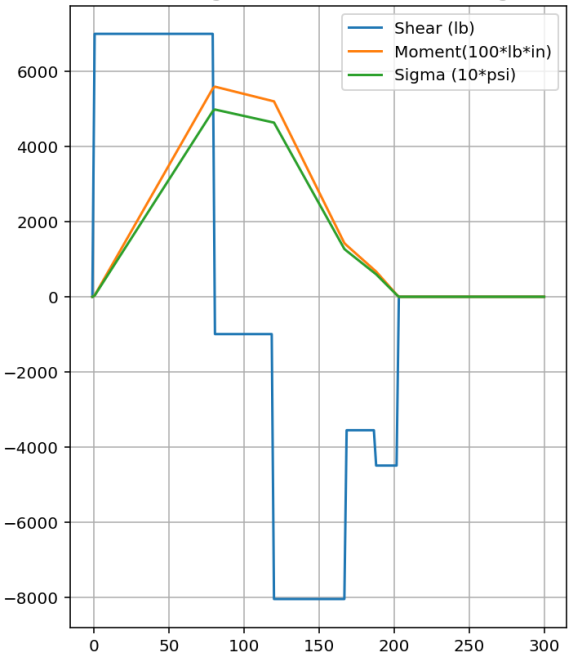


SFD BMD, σ allong trailer(in) for current loading on tip

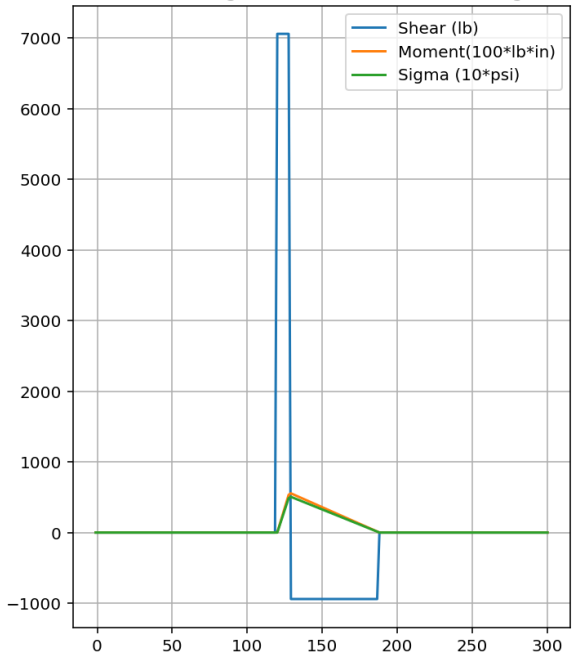


Plots for len of load: 80(in) rear Load:50%

SFD BMD, σ allong trailer(in) for current loading on main

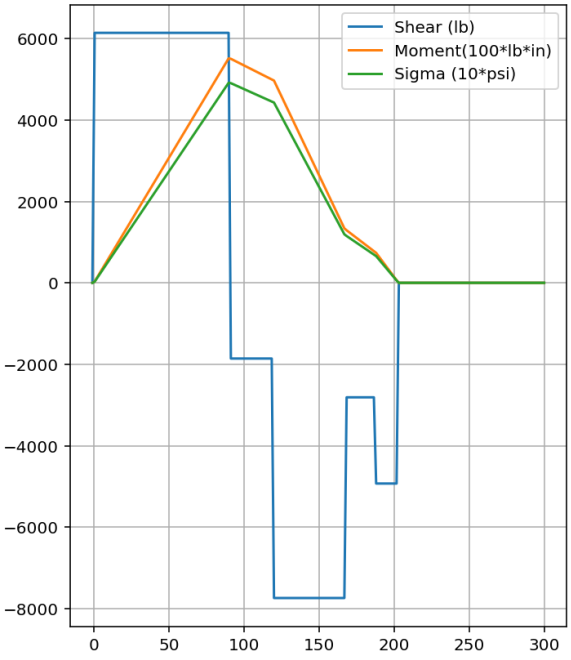


SFD BMD, σ allong trailer(in) for current loading on tip

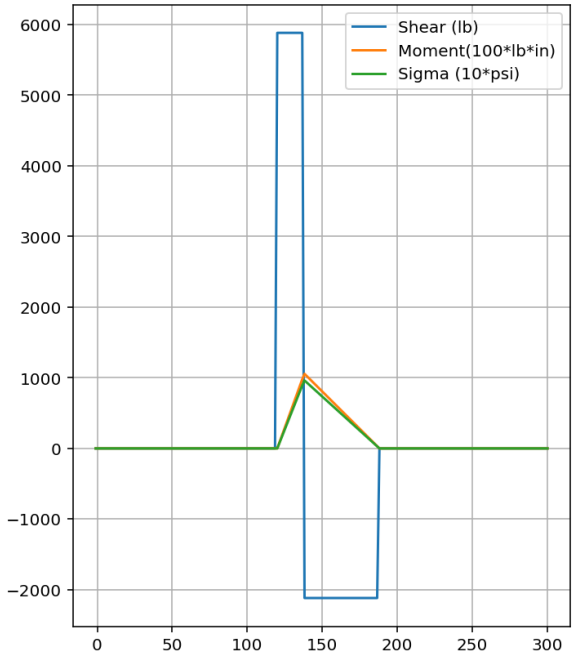


Plots for len of load: 90(in) rear Load:56%

SFD BMD, σ allong trailer(in) for current loading on main

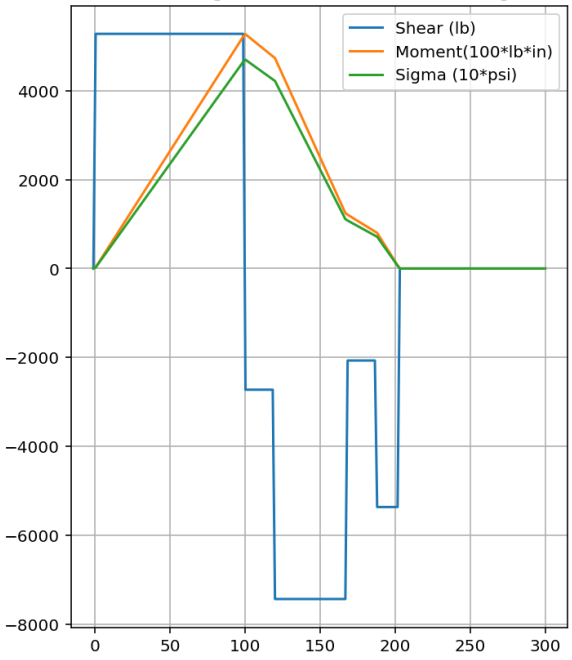


SFD BMD, σ allong trailer(in) for current loading on tip

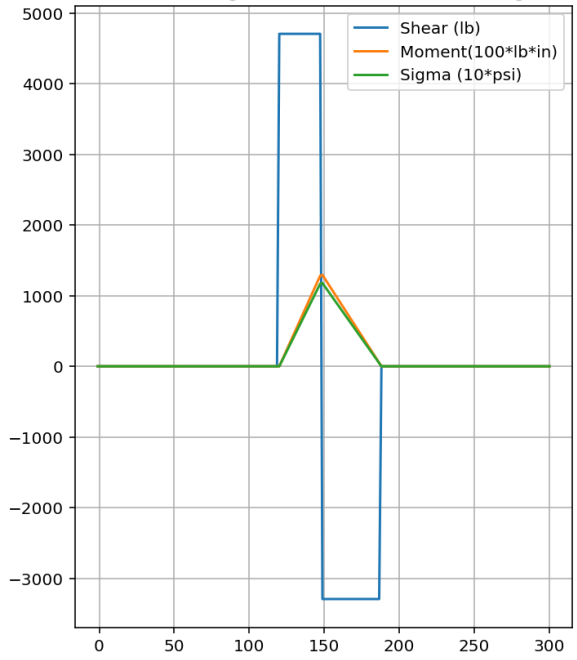


Plots for len of load: 100(in) rear Load:61%

SFD BMD, σ allong trailer(in) for current loading on main

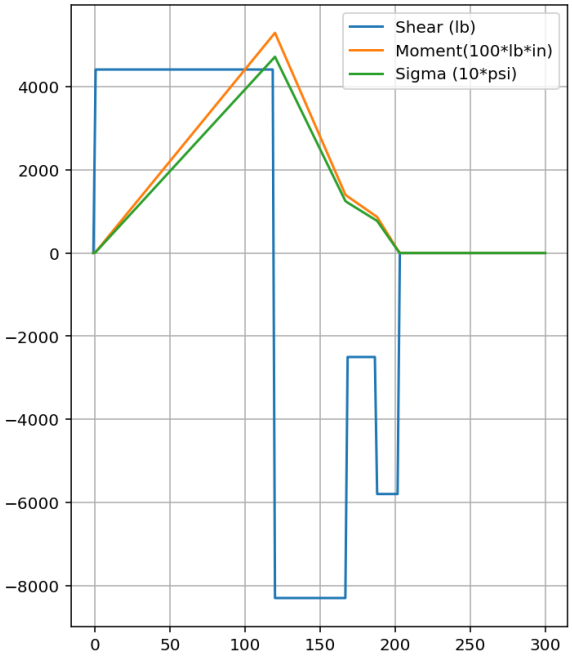


SFD BMD, σ allong trailer(in) for current loading on tip

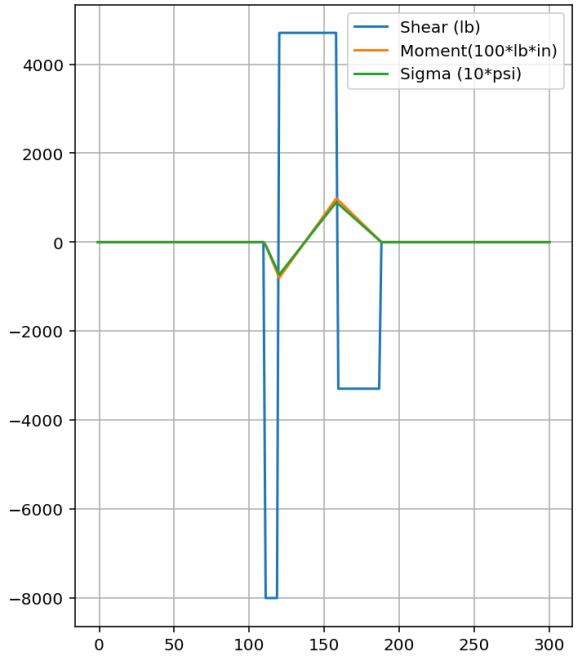


Plots for len of load: 110(in) rear Load:67%

SFD BMD, σ allong trailer(in) for current loading on main

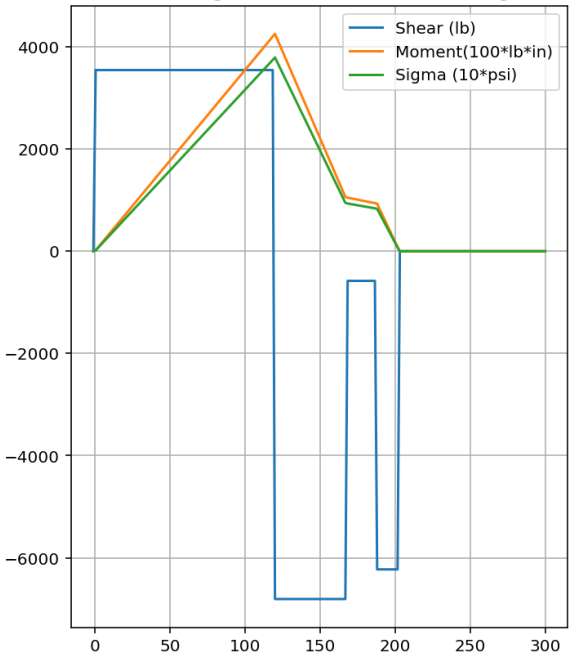


SFD BMD, σ allong trailer(in) for current loading on tip

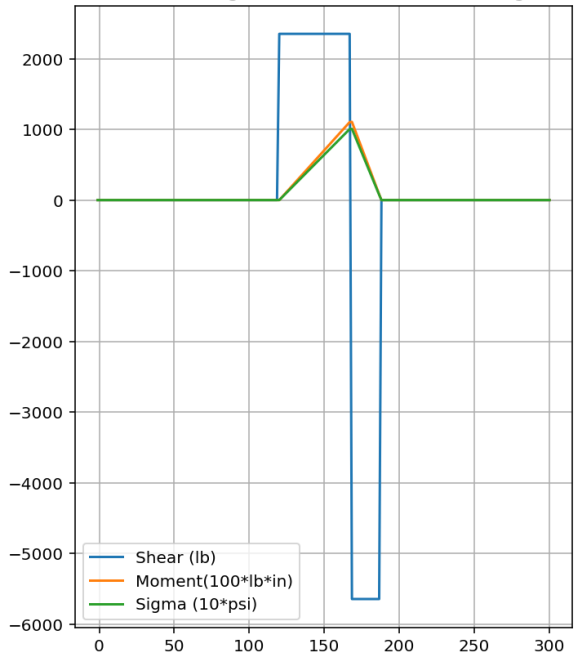


Plots for len of load: 120(in) rear Load:72%

SFD BMD, σ allong trailer(in) for current loading on main

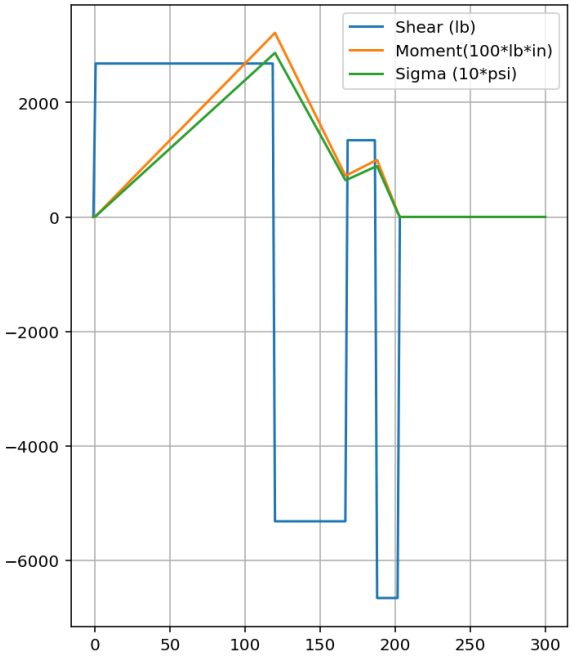


SFD BMD, σ allong trailer(in) for current loading on tip

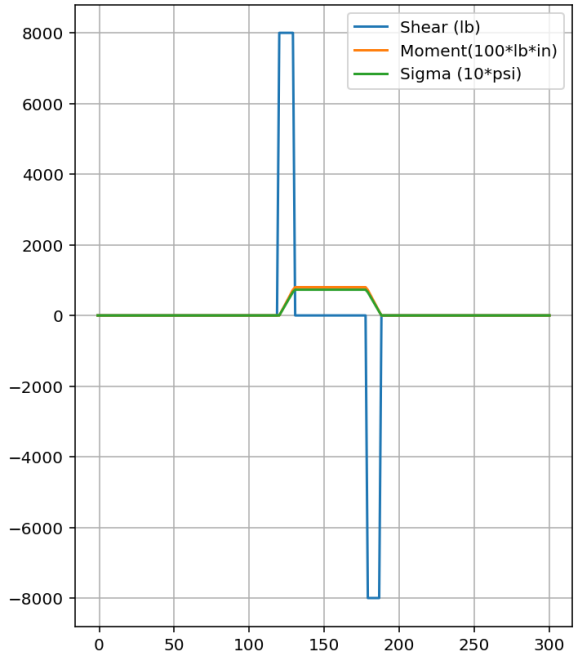


Plots for len of load: 130(in) rear Load:77%

SFD BMD, σ allong trailer(in) for current loading on main

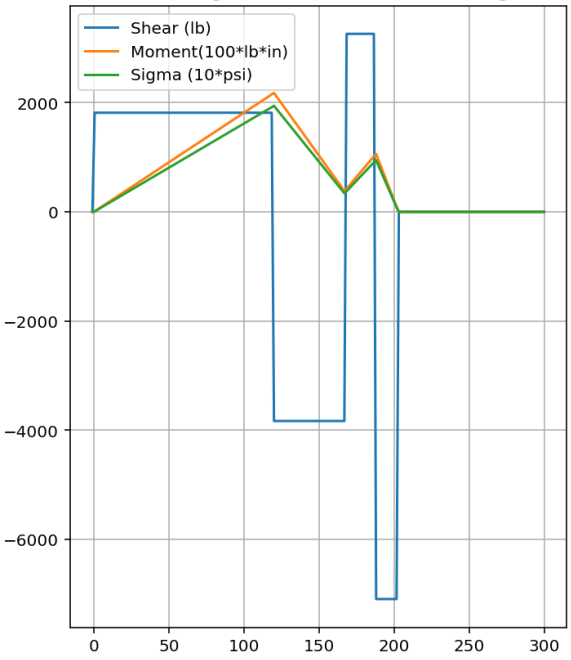


SFD BMD, σ allong trailer(in) for current loading on tip

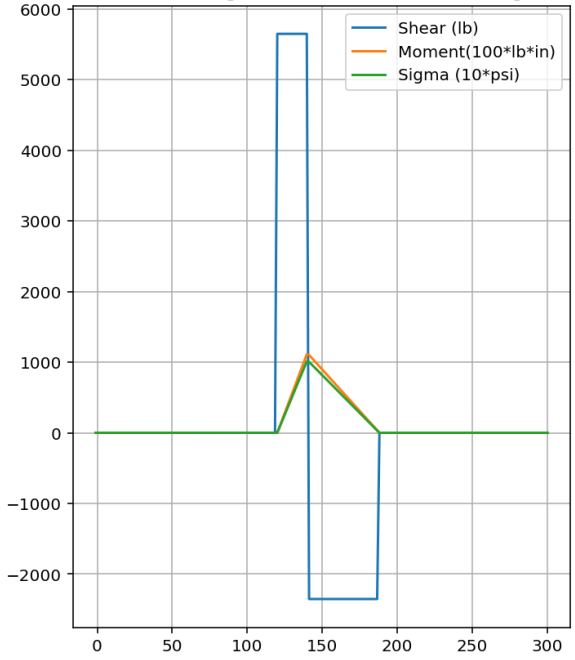


Plots for len of load: 140(in) rear Load:83%

SFD BMD, σ allong trailer(in) for current loading on main

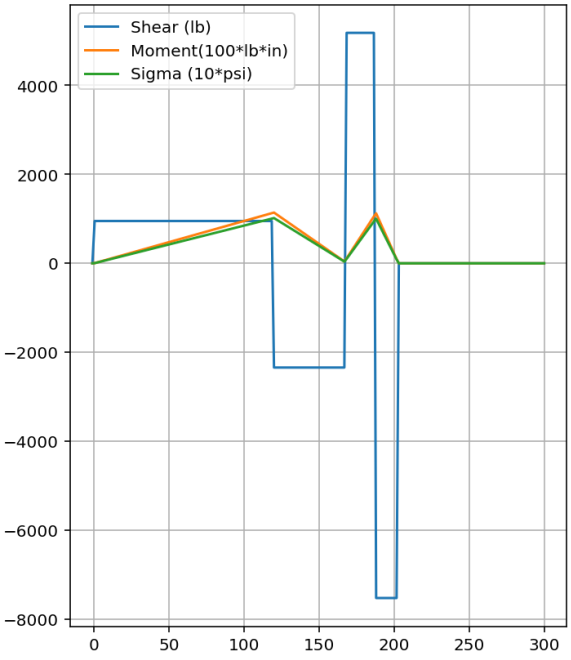


SFD BMD, σ allong trailer(in) for current loading on tip

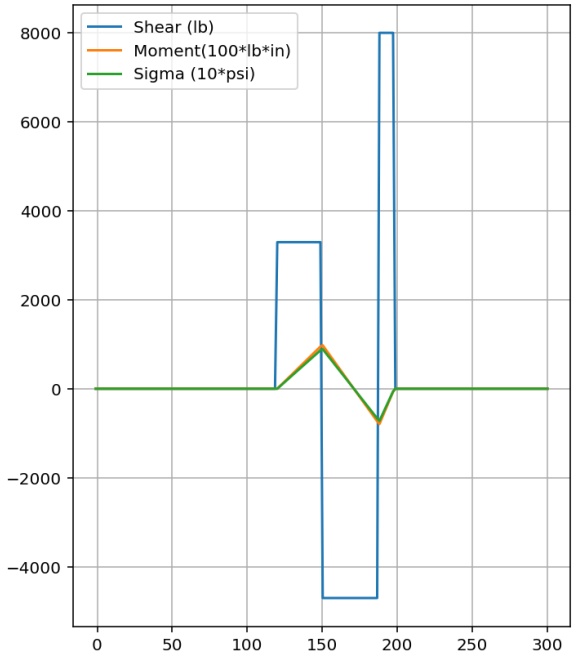


Plots for len of load: 150(in) rear Load:88%

SFD BMD, σ allong trailer(in) for current loading on main

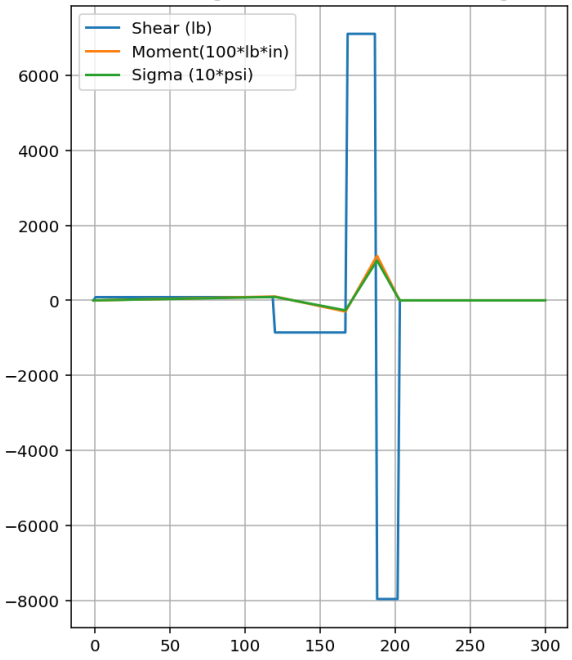


SFD BMD, σ allong trailer(in) for current loading on tip

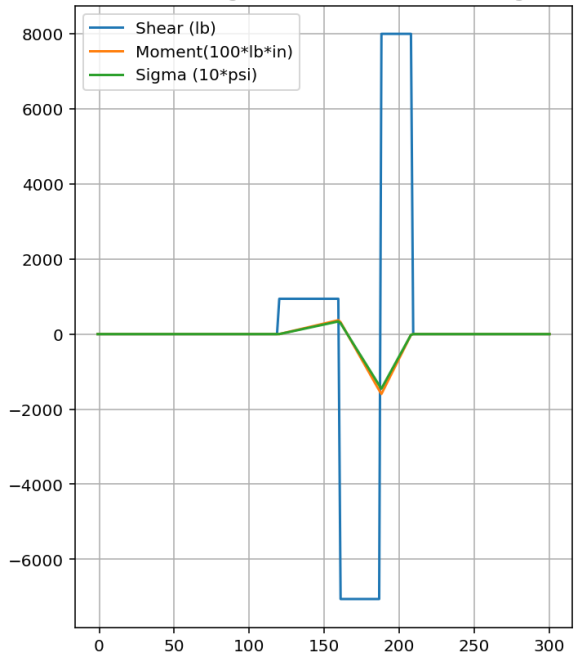


Plots for len of load: 160(in) rear Load:94%

SFD BMD, σ allong trailer(in) for current loading on main

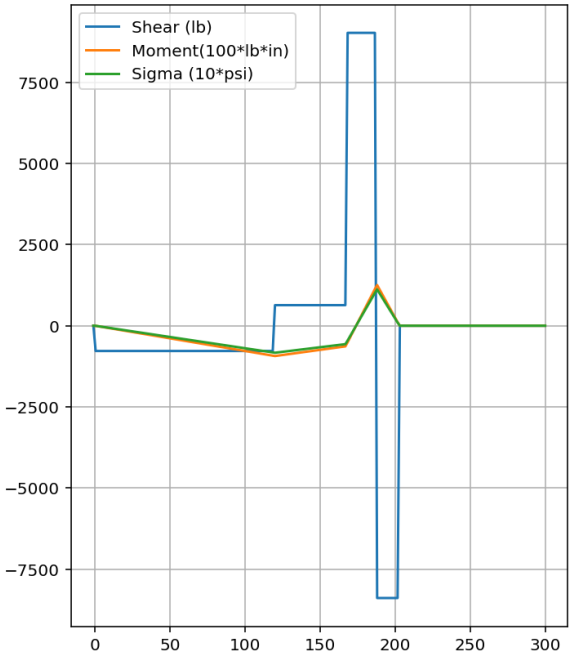


SFD BMD, σ allong trailer(in) for current loading on tip

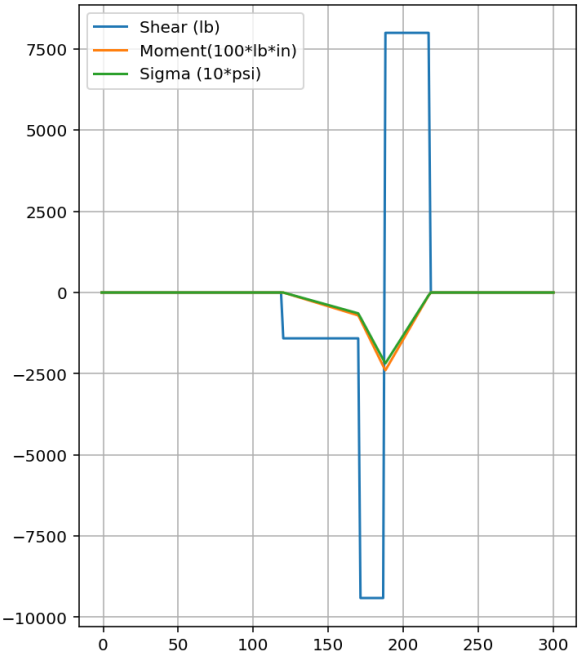


Plots for len of load: 170(in) rear Load:99%

SFD BMD, σ allong trailer(in) for current loading on main

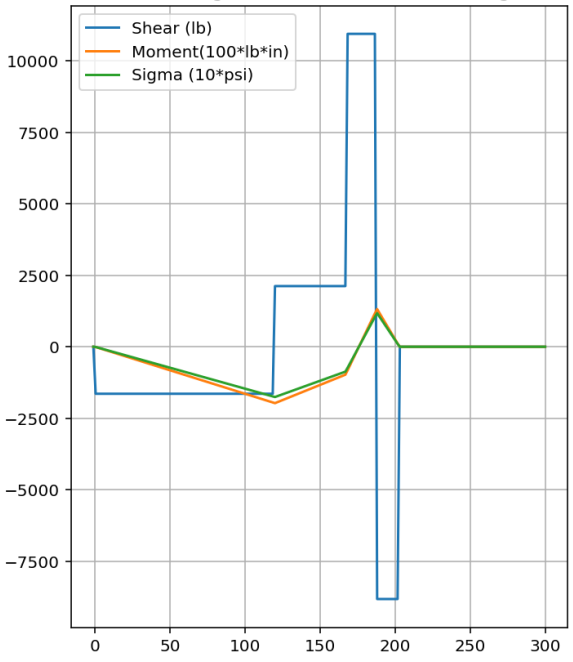


SFD BMD, σ allong trailer(in) for current loading on tip

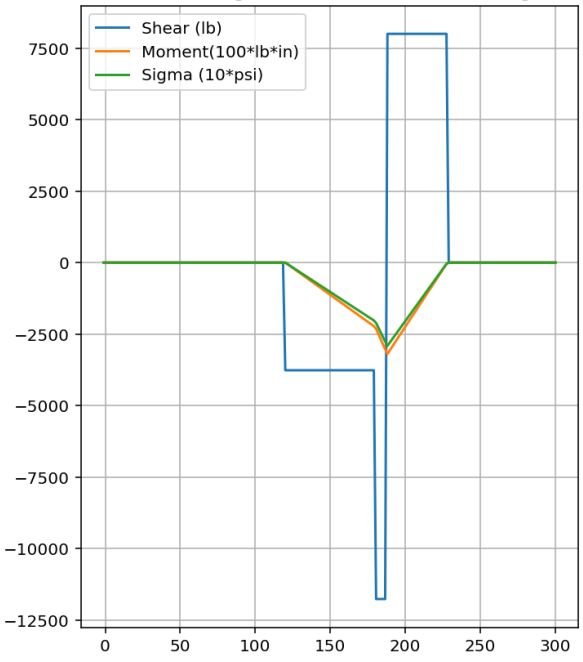


Plots for len of load: 180(in) rear Load:104%

SFD BMD, σ allong trailer(in) for current loading on main

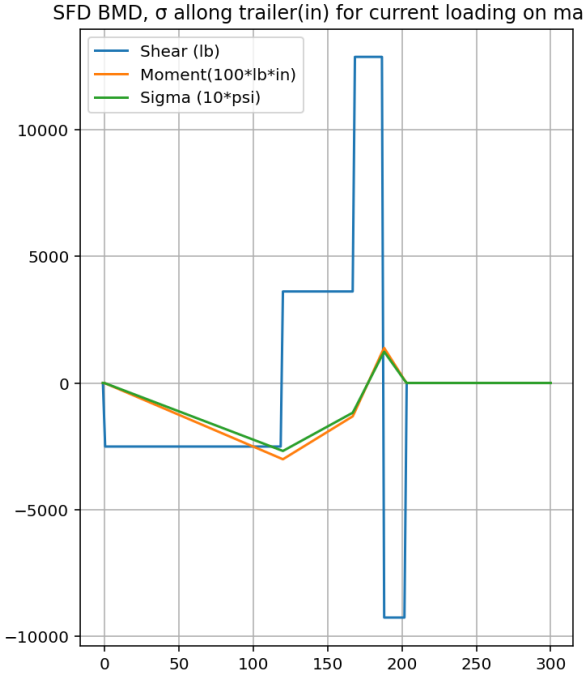


SFD BMD, σ allong trailer(in) for current loading on tip

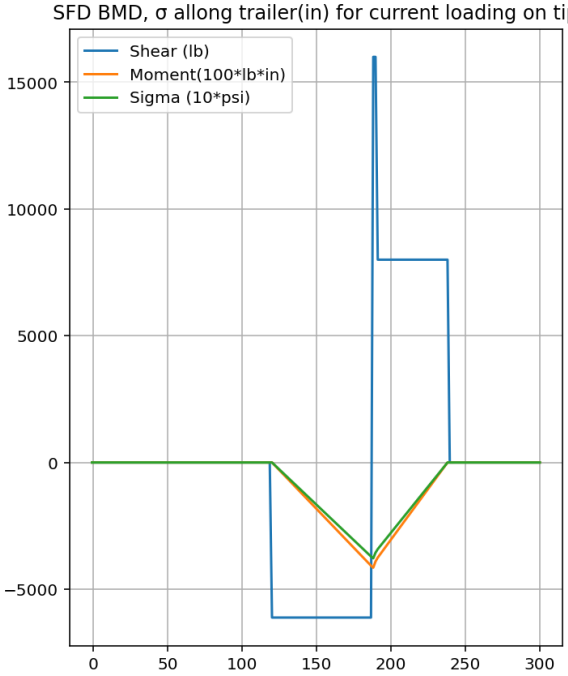


Plots for len of load: 190(in) rear Load:110%

SFD BMD, σ allong trailer(in) for current loading on main

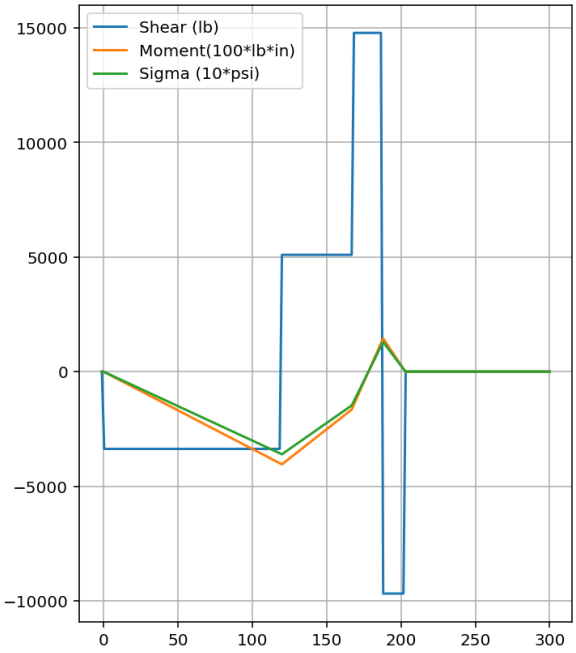


SFD BMD, σ allong trailer(in) for current loading on tip

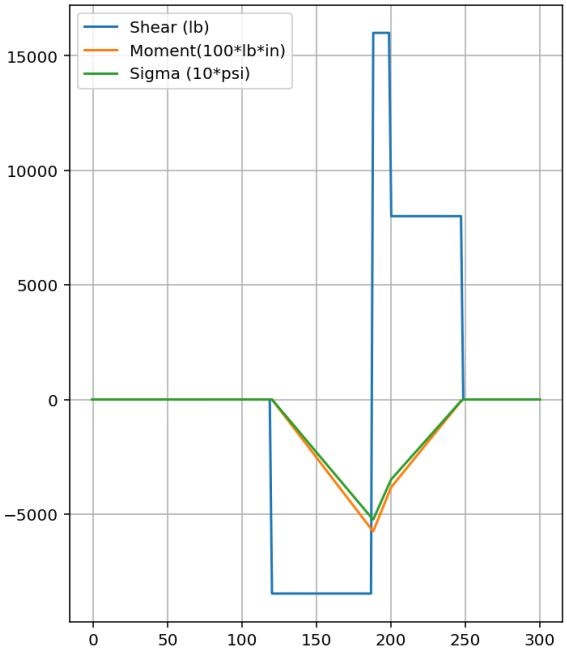


Plots for len of load: 200(in) rear Load:115%

SFD BMD, σ allong trailer(in) for current loading on main

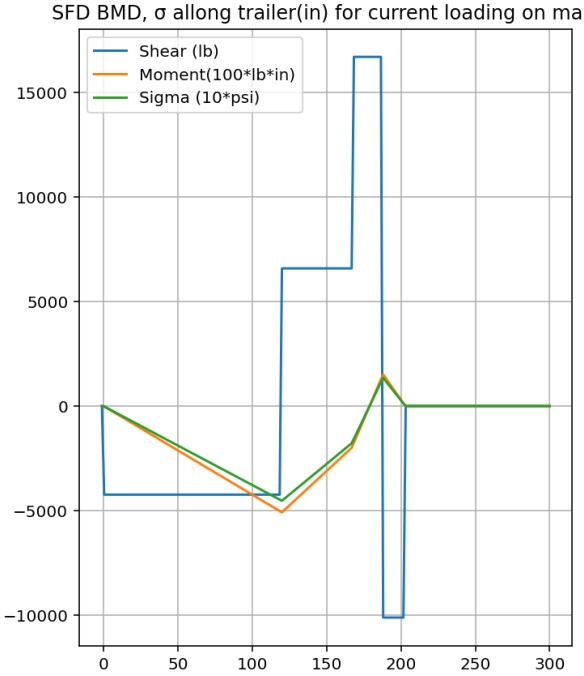


SFD BMD, σ allong trailer(in) for current loading on tip

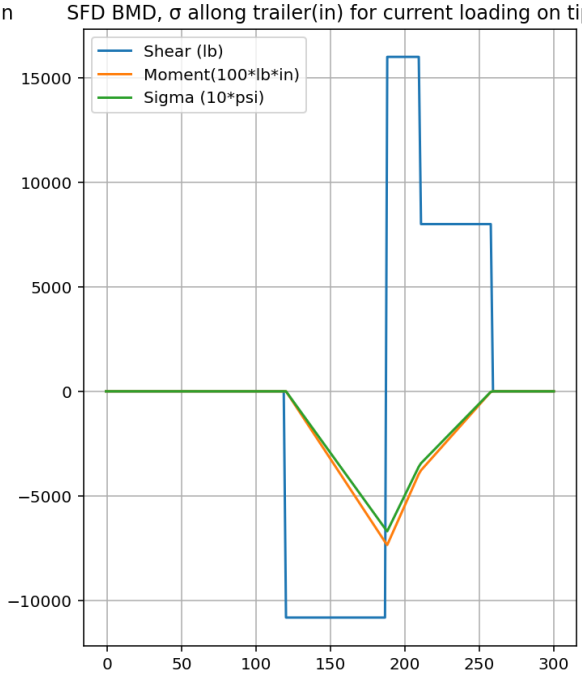


Plots for len of load: 210(in) rear Load:121%

SFD BMD, σ allong trailer(in) for current loading on main

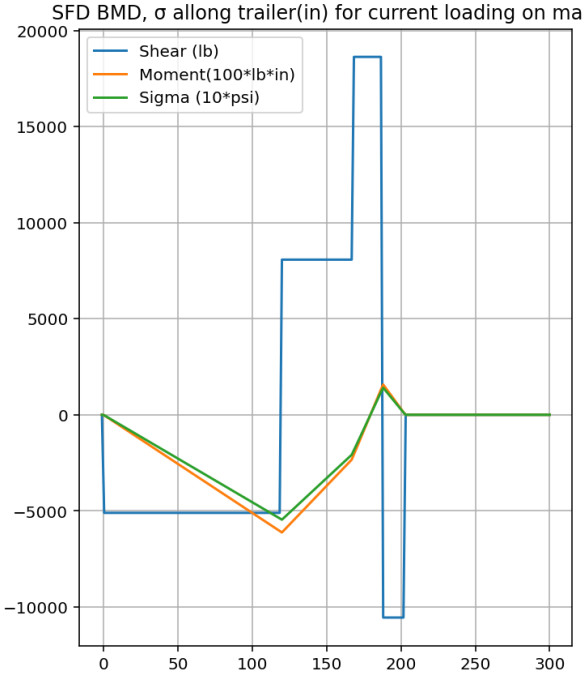


SFD BMD, σ allong trailer(in) for current loading on tip

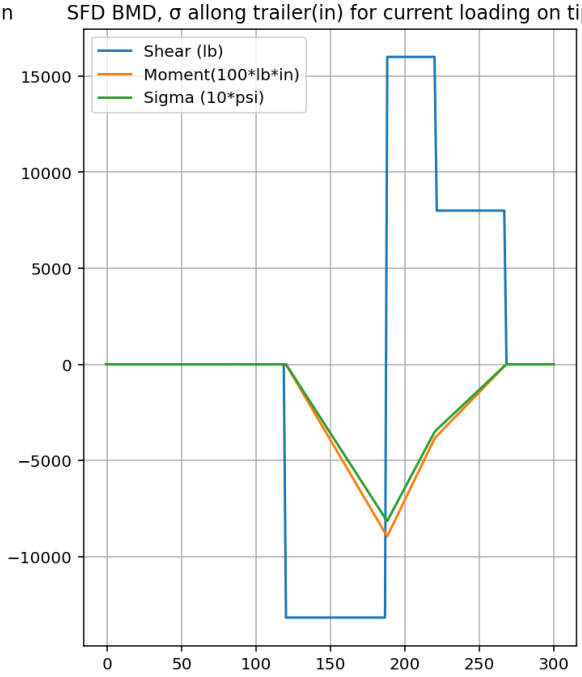


Plots for len of load: 220(in) rear Load:126%

SFD BMD, σ allong trailer(in) for current loading on main

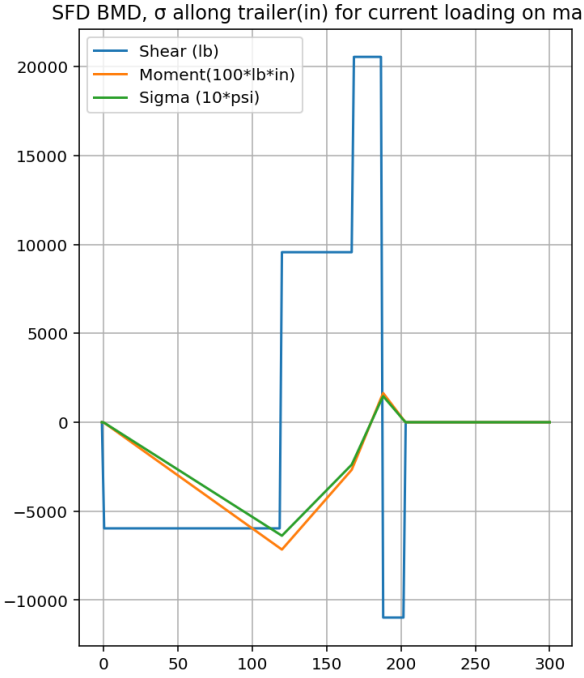


SFD BMD, σ allong trailer(in) for current loading on tip

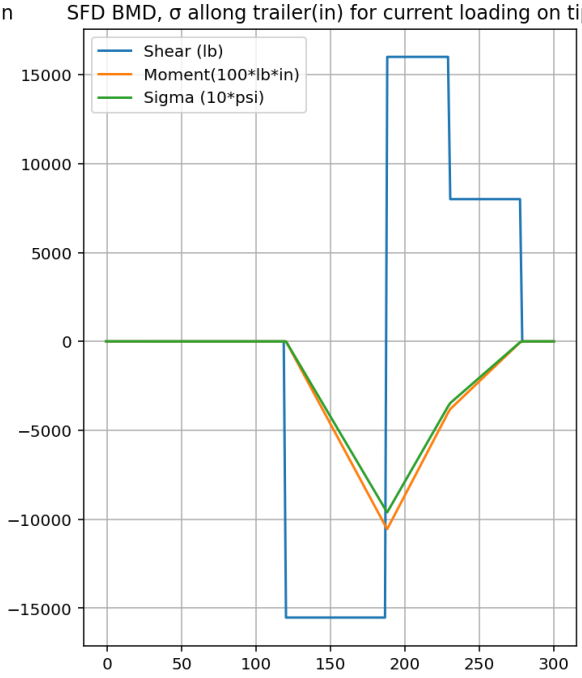


Plots for len of load: 230(in) rear Load:131%

SFD BMD, σ allong trailer(in) for current loading on main

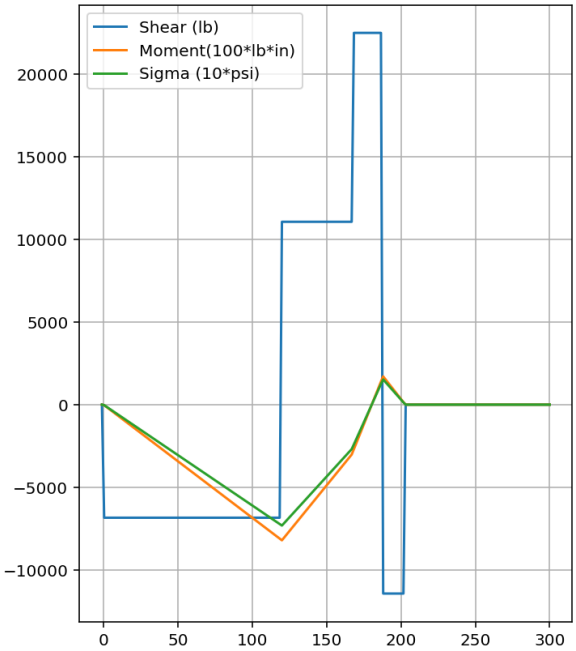


SFD BMD, σ allong trailer(in) for current loading on tip



Plots for len of load: 240(in) rear Load:137%

SFD BMD, σ allong trailer(in) for current loading on main



SFD BMD, σ allong trailer(in) for current loading on tip