Norfolk Southern

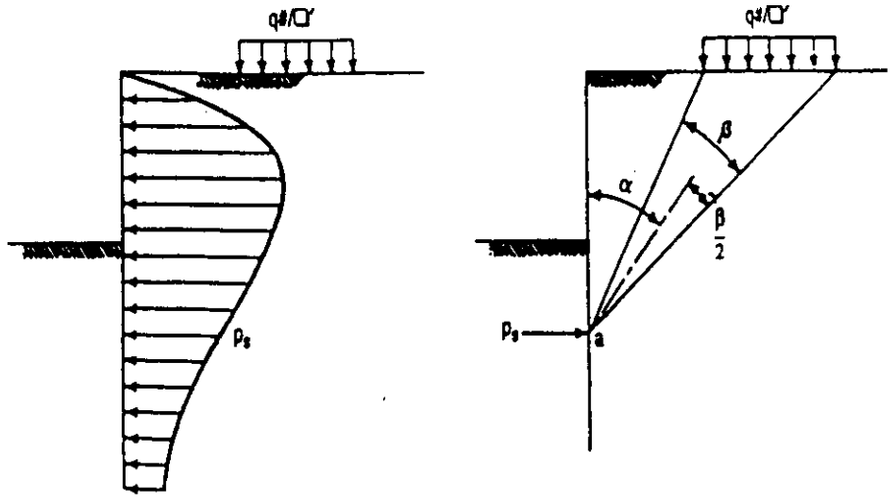
Lateral Pressures from Coopers E-80 Train Loads

The Boussinesq Equation for strip loads is shown in the AREMA Manual for Railway Engineering, Chapter 8, Section 20.3.2.2

Boussinesq Equation:

$$Ps = (2q/\pi)\{\beta+(\sin\beta)(\sin^2\alpha) - (\sin\beta)(\cos^2\alpha)\}$$

Where:
Ps = Active Pressure from Surcharge Loading
β = {atan(CLT+TL/2)/Hs - atan(CLT-TL/2)/Hs} IN RADIANS
α = β/2+ atan(CLT-TL/2)/Hs IN RADIANS
q = uniform surcharge load from trains = 80 kips/(5)(TL)
CLT = Distance from face of retaining wall to centerline of track
TL = Tie Length = 8.5′ standard
Hs = Depth below applied surcharge loading



The attached Table 1 provides the resultant lateral pressures for various depths and distances from centerline of track. Three representative pressure curves are also shown on the attached graph.

For a simplified engineering analysis, the railroad loading surcharge pressure may be assumed rectangular with width (P) equal to 0.8 of the maximum pressure ordinate as given by the appropriate railroad curve.

Table 1 - Lateral Pressure from E-80 Train Loads

(From Boussinesq Equation)

"CLT" (Distance From Centerline of Track in Feet)	Depth (Feet) 0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20
8	0	0.700	0.846	0.732	0.576	0.439	0.333	0.253	0.195	0.152	0.120
9	0	0.550	0.746	0.703	0.585	0.464	0.363	0.283	0.221	0.175	0.139
10	0	0.441	0.650	0.659	0.579	0.478	0.385	0.307	0.245	0.196	0.158
11	0	0.361	0.565	0.608	0.561	0.482	0.399	0.326	0.265	0.215	0.176
12	0	0.301	0.492	0.556	0.536	0.477	0.406	0.339	0.281	0.232	0.192
14	0	0.218	0.378	0.460	0.475	0.450	0.404	0.352	0.302	0.257	0.218
16	0	0.165	0.297	0.380	0.413	0.411	0.386	0.350	0.311	0.272	0.236
18	0	0.130	0.239	0.315	0.357	0.369	0.360	0.338	0.309	0.278	0.247
20	0	0.104	0.196	0.265	0.309	0.329	0.331	0.319	0.300	0.276	0.251
23	0	0.078	0.150	0.208	0.250	0.276	0.287	0.287	0.279	0.265	0.247
26	0	0.061	0.118	0.166	0.205	0.232	0.248	0.255	0.254	0.247	0.237
29	0	0.049	0.095	0.136	0.170	0.196	0.214	0.224	0.228	0.227	0.222
32	0	0.040	0.078	0.113	0.143	0.167	0.185	0.197	0.205	0.207	0.206
35	0	0.034	0.066	0.095	0.122	0.144	0.161	0.174	0.183	0.188	0.189
39	0	0.027	0.053	0.078	0.100	0.119	0.135	0.148	0.158	0.164	0.168
43	0	0.022	0.044	0.064	0.083	0.100	0.115	0.127	0.137	0.144	0.149
47	0	0.019	0.037	0.054	0.070	0.085	0.098	0.110	0.119	0.127	0.133
51	0	0.016	0.031	0.046	0.060	0.073	0.085	0.095	0.104	0.112	0.118
55	0	0.014	0.027	0.040	0.052	0.063	0.074	0.084	0.092	0.099	0.105

All pressures shown are in kips per sq. ft.

Boxed values represent the maximum pressure ordinate for each value of "CLT".

Lateral Pressure From E-80 Train Load

Sample Curves from Boussinesq Equation