

Report of Mechanical Model

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1 Global Definitions

1.1 Variables

1.1.1 Variables 9

Selection

Geometric entity level	Entire model
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Name	Expression	Description
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Name	Expression	Description
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Name	Expression	Description
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m128	0[N]	
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m1246	0[N]	
m1247	0[N]	
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m218	0[N]	
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m2112	0[N]	
m2113	0[N]	
m2114	0[N]	

Name	Expression	Description
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m225	0[N]	
m226	0[N]	
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m228	0[N]	
m229	0[N]	
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m2220	0[N]	
m2221	0[N]	
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Name	Expression	Description
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m2318	0[N]	
m2319	0[N]	
m2320	0[N]	
m2321	0[N]	
m2322	0[N]	
m2323	0[N]	
m2324	0[N]	
m2325	0[N]	
m2326	0[N]	
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m2333	0[N]	
m2334	0[N]	
m2335	0[N]	
m2336	0[N]	
m2337	0[N]	
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Name	Expression	Description
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m2341	0[N]	
m2342	0[N]	
m2343	0[N]	
m2344	0[N]	
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m2346	0[N]	
m2347	0[N]	
m2348	0[N]	
m2349	0[N]	
m2350	0[N]	
m311	0[N]	
m312	0[N]	
m313	0[N]	
m314	0[N]	
m315	0[N]	
m316	0[N]	
m317	0[N]	
m318	0[N]	
m319	0[N]	
m3110	0[N]	
m3111	0[N]	
m3112	0[N]	
m3113	0[N]	
m3114	0[N]	
m3115	0[N]	
m3116	0[N]	
m3117	0[N]	
m3118	0[N]	
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m3122	0[N]	
m3123	0[N]	
m3124	0[N]	
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m3134	0[N]	
m3135	0[N]	
m3136	0[N]	
m3137	0[N]	
m3138	0[N]	
m3139	0[N]	
m3140	0[N]	
m3141	0[N]	
m3142	0[N]	
m3143	0[N]	
m3144	0[N]	
m3145	0[N]	
m3146	0[N]	
m3147	0[N]	
m3148	0[N]	
m3149	0[N]	
m3150	0[N]	

Name	Expression	Description
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m324	0[N]	
m325	0[N]	
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m329	0[N]	
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m3211	0[N]	
m3212	0[N]	
m3213	0[N]	
m3214	0[N]	
m3215	0[N]	
m3216	0[N]	
m3217	0[N]	
m3218	0[N]	
m3219	0[N]	
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m3221	0[N]	
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m3225	0[N]	
m3226	0[N]	
m3227	0[N]	
m3228	0[N]	
m3229	0[N]	
m3230	0[N]	
m3231	0[N]	

Name	Expression	Description
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m3234	0[N]	
m3235	0[N]	
m3236	0[N]	
m3237	0[N]	
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m3246	0[N]	
m3247	0[N]	
m3248	0[N]	
m3249	0[N]	
m3250	0[N]	
m331	0[N]	
m332	0[N]	
m333	0[N]	
m334	0[N]	
m335	0[N]	
m336	0[N]	
m337	0[N]	
m338	0[N]	
m339	0[N]	
m3310	0[N]	
m3311	0[N]	
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Name	Expression	Description
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m3317	0[N]	
m3318	0[N]	
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m3323	0[N]	
m3324	0[N]	
m3325	0[N]	
m3326	0[N]	
m3327	0[N]	
m3328	0[N]	
m3329	0[N]	
m3330	0[N]	
m3331	0[N]	
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m3337	0[N]	
m3338	0[N]	
m3339	0[N]	
m3340	0[N]	
m3341	0[N]	
m3342	0[N]	
m3343	0[N]	

Name	Expression	Description
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m3346	0[N]	
m3347	0[N]	
m3348	0[N]	
m3349	0[N]	
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n113	-12305.4[N]	
n114	-12582.8[N]	
n115	-12957.2[N]	
n116	-13196.8[N]	
n117	-13416.4[N]	
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n119	-12957.2[N]	
n1110	-12582.8[N]	
n1111	-12305.4[N]	
n1112	-12582.8[N]	
n1113	-12957.2[N]	
n1114	-13196.8[N]	
n1115	-13416.4[N]	
n1116	-13196.8[N]	
n1117	-12957.2[N]	
n1118	-11292.8[N]	
n1119	-12305.4[N]	
n1120	-12582.8[N]	
n1121	-12957.2[N]	
n1122	-13196.8[N]	
n1123	-13416.4[N]	
n1124	-13681.2[N]	

Name	Expression	Description
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n1126	-14529.8[N]	
n1127	-15928.8[N]	
n1128	-22038.2[N]	
n1129	-611.4[N]	
n1130	0[N]	
n1131	0[N]	
n1132	0[N]	
n1133	0[N]	
n1134	0[N]	
n1135	0[N]	
n1136	0[N]	
n1137	0[N]	
n1138	0[N]	
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n1142	0[N]	
n1143	0[N]	
n1144	0[N]	
n1145	0[N]	
n1146	0[N]	
n1147	0[N]	
n1148	0[N]	
n1149	0[N]	
n1150	0[N]	
n121	-1673.6[N]	
n122	-1711.8[N]	
n123	-1466.4[N]	
n124	-1547.8[N]	
n125	-1673.6[N]	

Name	Expression	Description
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n127	-1745.6[N]	
n128	-1720.6[N]	
n129	-1673.6[N]	
n1210	-1547.8[N]	
n1211	-1466.4[N]	
n1212	-1547.8[N]	
n1213	-1673.6[N]	
n1214	-1720.6[N]	
n1215	-1745.6[N]	
n1216	-1720.6[N]	
n1217	-1673.6[N]	
n1218	-1711.8[N]	
n1219	-1466.4[N]	
n1220	-1547.8[N]	
n1221	-1673.6[N]	
n1222	-1720.6[N]	
n1223	-1745.6[N]	
n1224	-1767.4[N]	
n1225	-1778.4[N]	
n1226	-1745.4[N]	
n1227	-1874.4[N]	
n1228	-2150.2[N]	
n1229	-27.4[N]	
n1230	0[N]	
n1231	0[N]	
n1232	0[N]	
n1233	0[N]	
n1234	0[N]	
n1235	0[N]	
n1236	0[N]	

Name	Expression	Description
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n1238	0[N]	
n1239	0[N]	
n1240	0[N]	
n1241	0[N]	
n1242	0[N]	
n1243	0[N]	
n1244	0[N]	
n1245	0[N]	
n1246	0[N]	
n1247	0[N]	
n1248	0[N]	
n1249	0[N]	
n1250	0[N]	
n131	83.4[N]	
n132	-133.4[N]	
n133	135.8[N]	
n134	113[N]	
n135	83.4[N]	
n136	81[N]	
n137	83.2[N]	
n138	81[N]	
n139	83.4[N]	
n1310	113[N]	
n1311	135.8[N]	
n1312	113[N]	
n1313	83.4[N]	
n1314	81[N]	
n1315	83.2[N]	
n1316	81[N]	
n1317	83.4[N]	

Name	Expression	Description
n1318	-133.4[N]	
n1319	135.8[N]	
n1320	113[N]	
n1321	83.4[N]	
n1322	81[N]	
n1323	83.2[N]	
n1324	85[N]	
n1325	93.4[N]	
n1326	134.4[N]	
n1327	149.2[N]	
n1328	87.2[N]	
n1329	14.2[N]	
n1330	0[N]	
n1331	0[N]	
n1332	0[N]	
n1333	0[N]	
n1334	0[N]	
n1335	0[N]	
n1336	0[N]	
n1337	0[N]	
n1338	0[N]	
n1339	0[N]	
n1340	0[N]	
n1341	0[N]	
n1342	0[N]	
n1343	0[N]	
n1344	0[N]	
n1345	0[N]	
n1346	0[N]	
n1347	0[N]	
n1348	0[N]	

Name	Expression	Description
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n1350	0[N]	
n211	-7280.8[N]	
n212	-7090.6[N]	
n213	-6964[N]	
n214	-7075.8[N]	
n215	-7280.8[N]	
n216	-7450.8[N]	
n217	-7606.8[N]	
n218	-7450.8[N]	
n219	-7280.8[N]	
n2110	-7075.8[N]	
n2111	-6964[N]	
n2112	-7075.8[N]	
n2113	-7280.8[N]	
n2114	-7450.8[N]	
n2115	-7606.8[N]	
n2116	-7450.8[N]	
n2117	-7280.8[N]	
n2118	-7090.6[N]	
n2119	-6964[N]	
n2120	-7075.8[N]	
n2121	-7280.8[N]	
n2122	-7450.8[N]	
n2123	-7606.8[N]	
n2124	-7796.8[N]	
n2125	-8070.4[N]	
n2126	-8596.2[N]	
n2127	-9940.2[N]	
n2128	-13440.2[N]	
n2129	-231.4[N]	

Name	Expression	Description
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n2132	0[N]	
n2133	0[N]	
n2134	0[N]	
n2135	0[N]	
n2136	0[N]	
n2137	0[N]	
n2138	0[N]	
n2139	0[N]	
n2140	0[N]	
n2141	0[N]	
n2142	0[N]	
n2143	0[N]	
n2144	0[N]	
n2145	0[N]	
n2146	0[N]	
n2147	0[N]	
n2148	0[N]	
n2149	0[N]	
n2150	0[N]	
n221	-394.6[N]	
n222	-518.8[N]	
n223	-349.6[N]	
n224	-362.4[N]	
n225	-394.6[N]	
n226	-414.4[N]	
n227	-425.4[N]	
n228	-414.4[N]	
n229	-394.6[N]	
n2210	-362.4[N]	

Name	Expression	Description
n2211	-349.6[N]	
n2212	-362.4[N]	
n2213	-394.6[N]	
n2214	-414.4[N]	
n2215	-425.4[N]	
n2216	-414.4[N]	
n2217	-394.6[N]	
n2218	-518.8[N]	
n2219	-349.6[N]	
n2220	-362.4[N]	
n2221	-394.6[N]	
n2222	-414.4[N]	
n2223	-425.4[N]	
n2224	-432.6[N]	
n2225	-435.4[N]	
n2226	-448.4[N]	
n2227	-522[N]	
n2228	-614.6[N]	
n2229	-1.4[N]	
n2230	0[N]	
n2231	0[N]	
n2232	0[N]	
n2233	0[N]	
n2234	0[N]	
n2235	0[N]	
n2236	0[N]	
n2237	0[N]	
n2238	0[N]	
n2239	0[N]	
n2240	0[N]	
n2241	0[N]	

Name	Expression	Description
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n2243	0[N]	
n2244	0[N]	
n2245	0[N]	
n2246	0[N]	
n2247	0[N]	
n2248	0[N]	
n2249	0[N]	
n2250	0[N]	
n231	-37[N]	
n232	-71.8[N]	
n233	-37.8[N]	
n234	-38[N]	
n235	-37[N]	
n236	-36.4[N]	
n237	-36.8[N]	
n238	-36.4[N]	
n239	-37[N]	
n2310	-38[N]	
n2311	-37.8[N]	
n2312	-38[N]	
n2313	-37[N]	
n2314	-36.4[N]	
n2315	-36.8[N]	
n2316	-36.4[N]	
n2317	-37[N]	
n2318	-71.8[N]	
n2319	-37.8[N]	
n2320	-38[N]	
n2321	-37[N]	
n2322	-36.4[N]	

Name	Expression	Description
n2323	-36.8[N]	
n2324	-37.8[N]	
n2325	-39.8[N]	
n2326	-42.8[N]	
n2327	-45.6[N]	
n2328	-40.4[N]	
n2329	-10.4[N]	
n2330	0[N]	
n2331	0[N]	
n2332	0[N]	
n2333	0[N]	
n2334	0[N]	
n2335	0[N]	
n2336	0[N]	
n2337	0[N]	
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n2339	0[N]	
n2340	0[N]	
n2341	0[N]	
n2342	0[N]	
n2343	0[N]	
n2344	0[N]	
n2345	0[N]	
n2346	0[N]	
n2347	0[N]	
n2348	0[N]	
n2349	0[N]	
n2350	0[N]	
n311	-3313[N]	
n312	-3302.6[N]	
n313	-3181.3[N]	

Name	Expression	Description
n314	-3224.9[N]	
n315	-3313[N]	
n316	-3394[N]	
n317	-3470.2[N]	
n318	-3394[N]	
n319	-3313[N]	
n3110	-3224.9[N]	
n3111	-3181.3[N]	
n3112	-3224.9[N]	
n3113	-3313[N]	
n3114	-3394[N]	
n3115	-3470.2[N]	
n3116	-3394[N]	
n3117	-3313[N]	
n3118	-3302.6[N]	
n3119	-3181.3[N]	
n3120	-3224.9[N]	
n3121	-3313[N]	
n3122	-3394[N]	
n3123	-3470.2[N]	
n3124	-3561.7[N]	
n3125	-3698.3[N]	
n3126	-3974[N]	
n3127	-4643.5[N]	
n3128	-6078.3[N]	
n3129	-88.8[N]	
n3130	0[N]	
n3131	0[N]	
n3132	0[N]	
n3133	0[N]	
n3134	0[N]	

Name	Expression	Description
n3135	0[N]	
n3136	0[N]	
n3137	0[N]	
n3138	0[N]	
n3139	0[N]	
n3140	0[N]	
n3141	0[N]	
n3142	0[N]	
n3143	0[N]	
n3144	0[N]	
n3145	0[N]	
n3146	0[N]	
n3147	0[N]	
n3148	0[N]	
n3149	0[N]	
n3150	0[N]	
n321	-181.9[N]	
n322	-236.8[N]	
n323	-162.6[N]	
n324	-168.6[N]	
n325	-181.9[N]	
n326	-192.3[N]	
n327	-198.1[N]	
n328	-192.3[N]	
n329	-181.9[N]	
n3210	-168.6[N]	
n3211	-162.6[N]	
n3212	-168.6[N]	
n3213	-181.9[N]	
n3214	-192.3[N]	
n3215	-198.1[N]	

Name	Expression	Description
n3216	-192.3[N]	
n3217	-181.9[N]	
n3218	-236.8[N]	
n3219	-162.6[N]	
n3220	-168.6[N]	
n3221	-181.9[N]	
n3222	-192.3[N]	
n3223	-198.1[N]	
n3224	-201.3[N]	
n3225	-203[N]	
n3226	-210.9[N]	
n3227	-248.3[N]	
n3228	-277.9[N]	
n3229	0.6[N]	
n3230	0[N]	
n3231	0[N]	
n3232	0[N]	
n3233	0[N]	
n3234	0[N]	
n3235	0[N]	
n3236	0[N]	
n3237	0[N]	
n3238	0[N]	
n3239	0[N]	
n3240	0[N]	
n3241	0[N]	
n3242	0[N]	
n3243	0[N]	
n3244	0[N]	
n3245	0[N]	
n3246	0[N]	

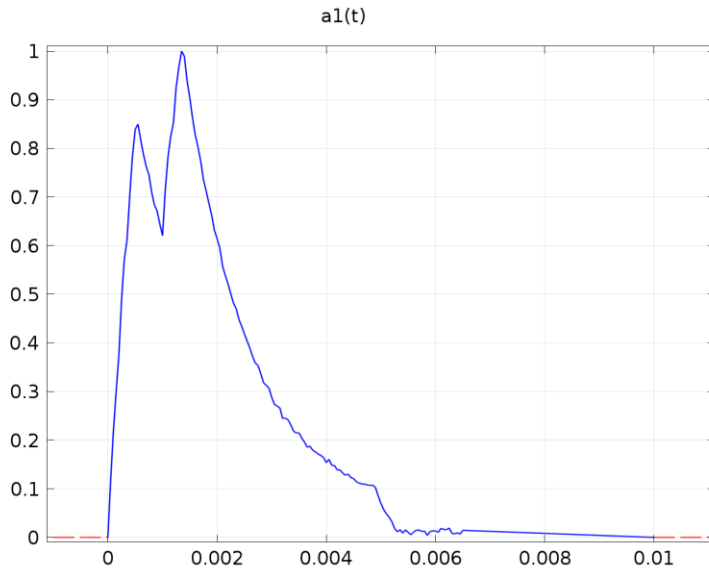
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n3249	0[N]	
n3250	0[N]	
n331	-5[N]	
n332	-25.7[N]	
n333	-5.8[N]	
n334	-5.7[N]	
n335	-5[N]	
n336	-4.7[N]	
n337	-4.7[N]	
n338	-4.7[N]	
n339	-5[N]	
n3310	-5.7[N]	
n3311	-5.8[N]	
n3312	-5.7[N]	
n3313	-5[N]	
n3314	-4.7[N]	
n3315	-4.7[N]	
n3316	-4.7[N]	
n3317	-5[N]	
n3318	-25.7[N]	
n3319	-5.8[N]	
n3320	-5.7[N]	
n3321	-5[N]	
n3322	-4.7[N]	
n3323	-4.7[N]	
n3324	-5.1[N]	
n3325	-5.6[N]	
n3326	-6.6[N]	
n3327	-7.7[N]	

Name	Expression	Description
n3328	-7.2[N]	
n3329	-3.1[N]	
n3330	0[N]	
n3331	0[N]	
n3332	0[N]	
n3333	0[N]	
n3334	0[N]	
n3335	0[N]	
n3336	0[N]	
n3337	0[N]	
n3338	0[N]	
n3339	0[N]	
n3340	0[N]	
n3341	0[N]	
n3342	0[N]	
n3343	0[N]	
n3344	0[N]	
n3345	0[N]	
n3346	0[N]	
n3347	0[N]	
n3348	0[N]	
n3349	0[N]	
n3350	0[N]	

1.2 Functions

1.2.1 Interpolation 1

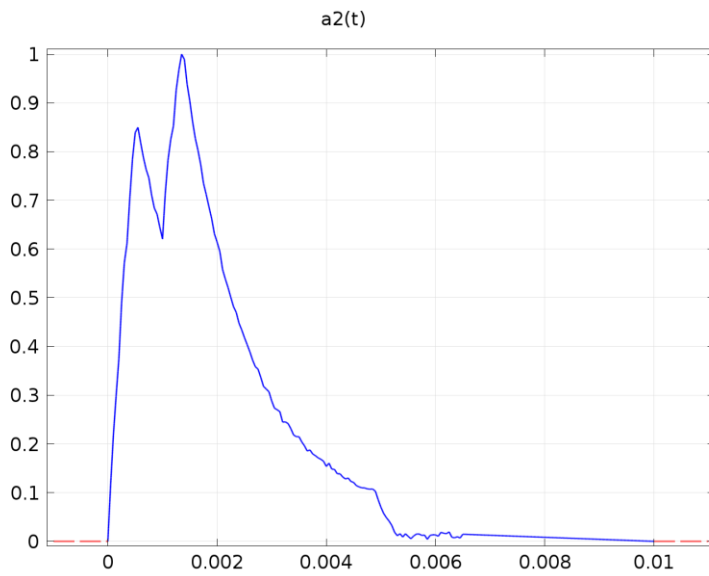
Function name	a1
Function type	Interpolation



Interpolation 1

1.2.2 Interpolation 2

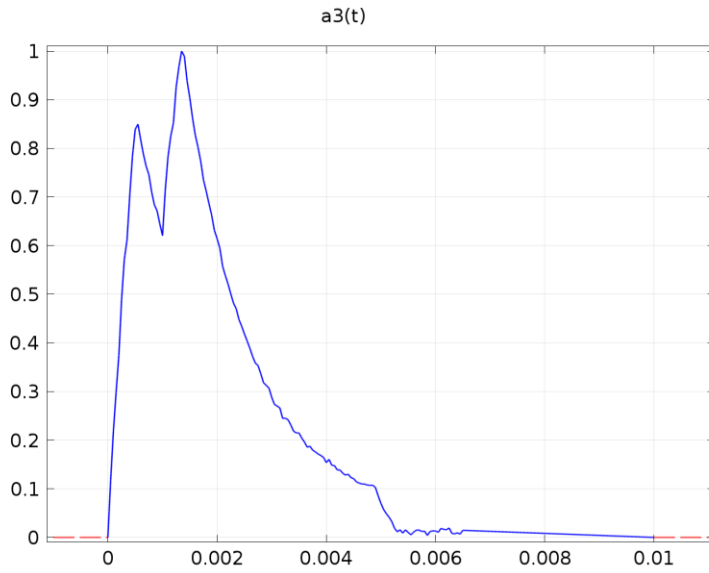
Function name	a2
Function type	Interpolation



Interpolation 2

1.2.3 Interpolation 3

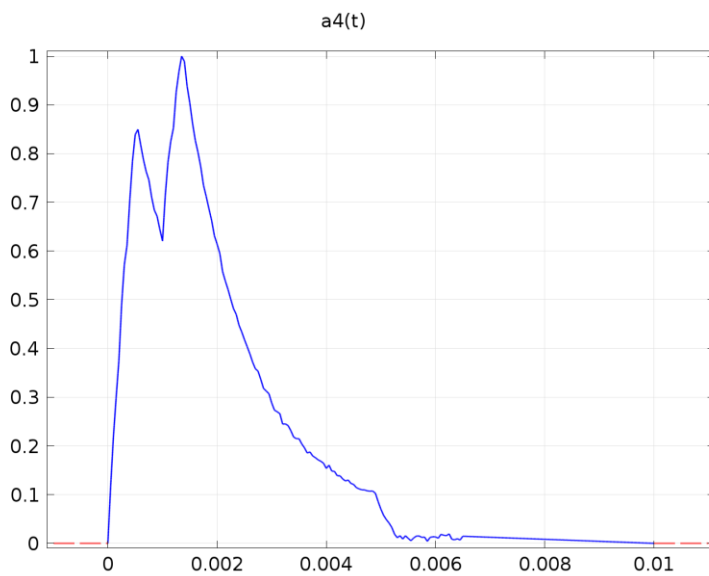
Function name	a3
Function type	Interpolation



Interpolation 3

1.2.4 Interpolation 4

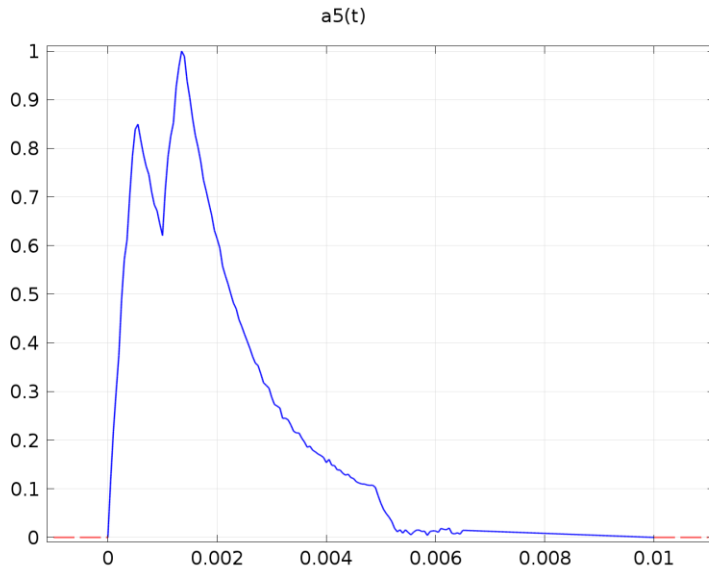
Function name	a4
Function type	Interpolation



Interpolation 4

1.2.5 Interpolation 5

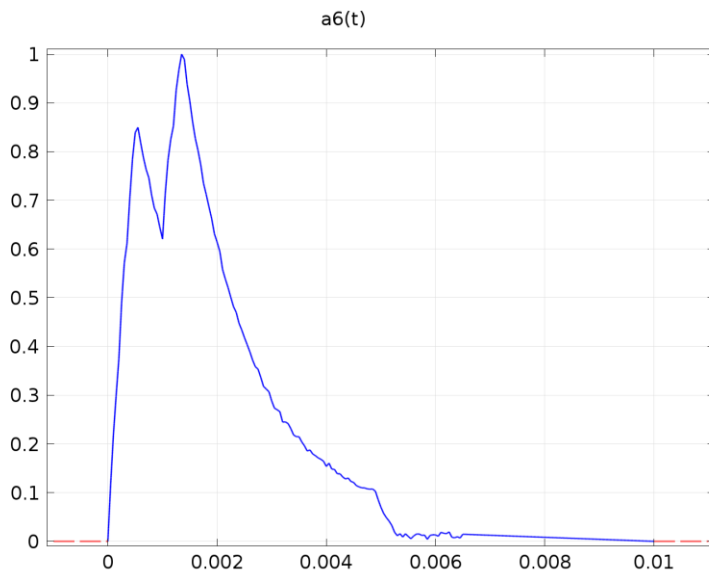
Function name	a5
Function type	Interpolation



Interpolation 5

1.2.6 Interpolation 6

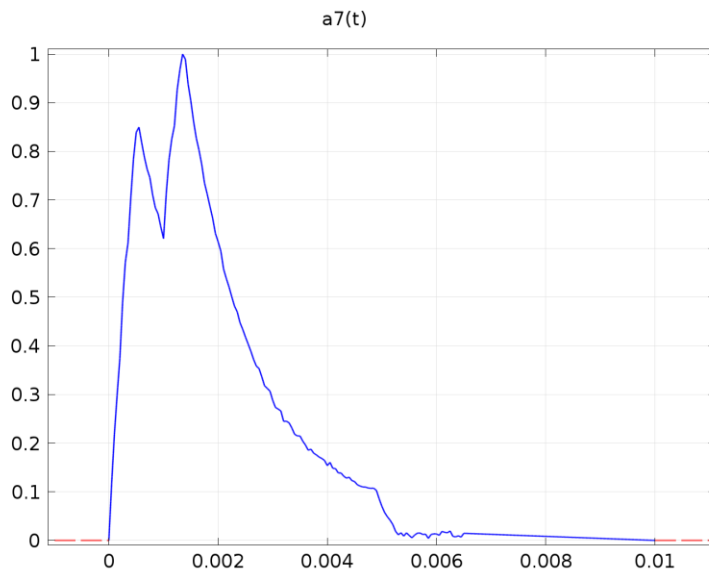
Function name	a6
Function type	Interpolation



Interpolation 6

1.2.7 Interpolation 7

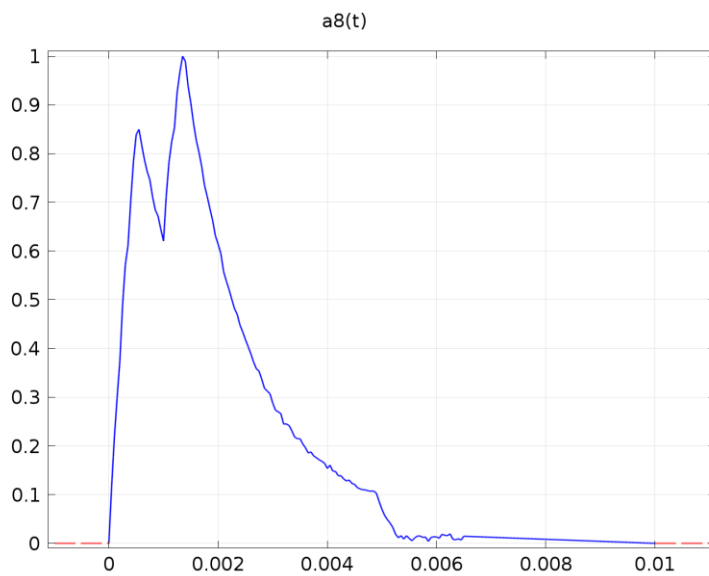
Function name	a7
Function type	Interpolation



Interpolation 7

1.2.8 Interpolation 8

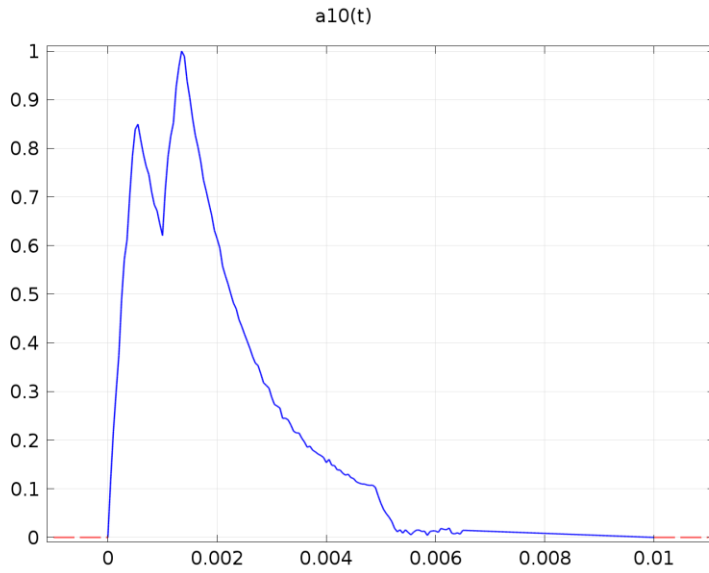
Function name	a8
Function type	Interpolation



Interpolation 8

1.2.9 Interpolation 9

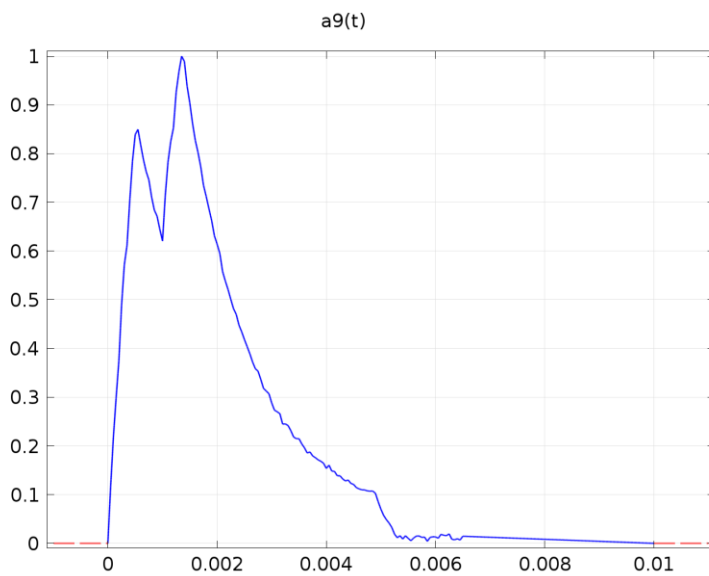
Function name	a10
Function type	Interpolation



Interpolation 9

1.2.10 Interpolation 10

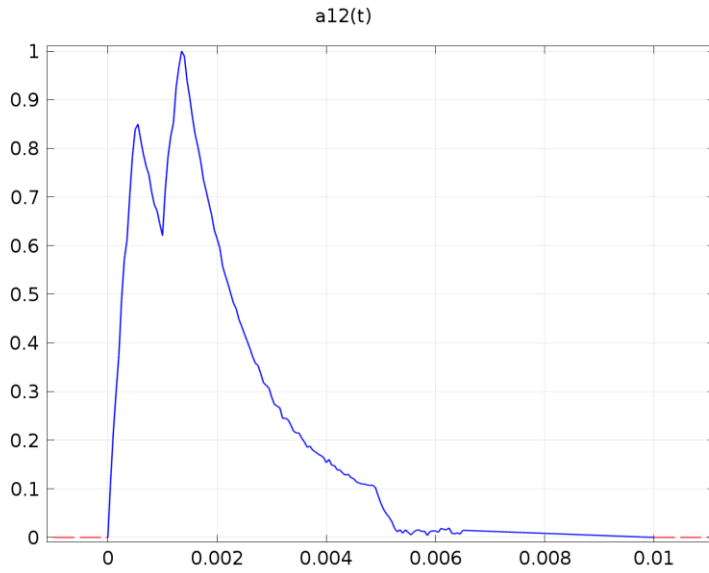
Function name	a9
Function type	Interpolation



Interpolation 10

1.2.11 Interpolation 12

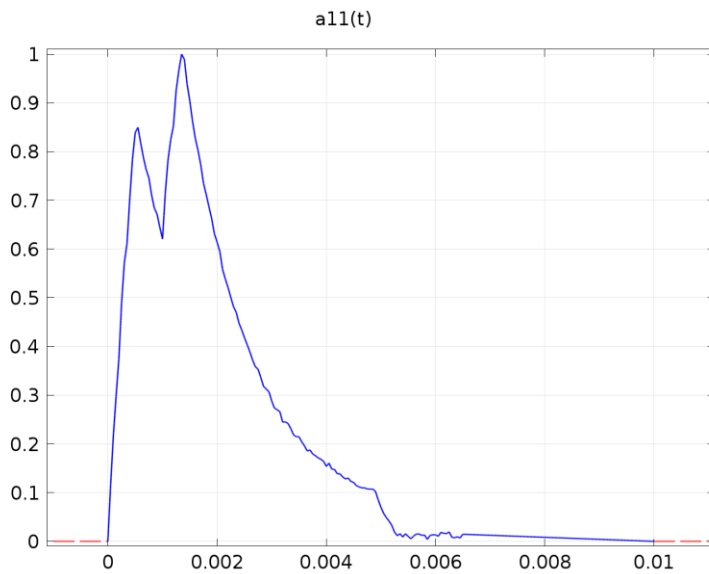
Function name	a12
Function type	Interpolation



Interpolation 12

1.2.12 Interpolation 11

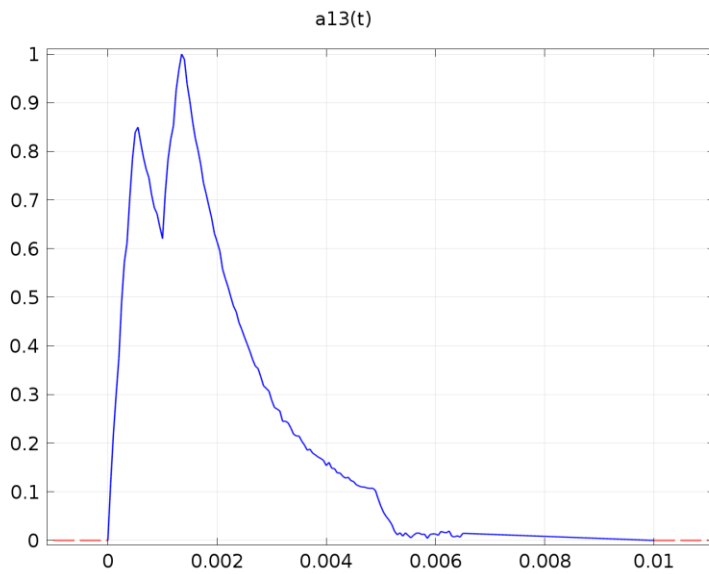
Function name	a11
Function type	Interpolation



Interpolation 11

1.2.13 Interpolation 13

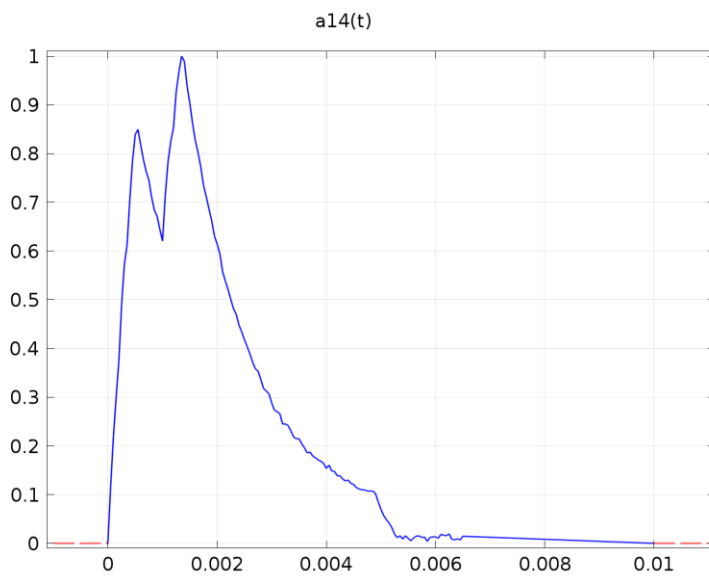
Function name	a13
Function type	Interpolation



Interpolation 13

1.2.14 Interpolation 14

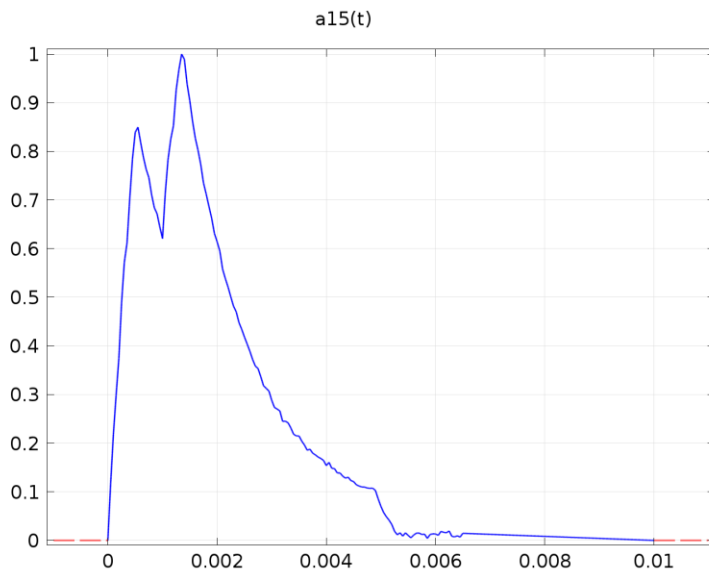
Function name	a14
Function type	Interpolation



Interpolation 14

1.2.15 Interpolation 15

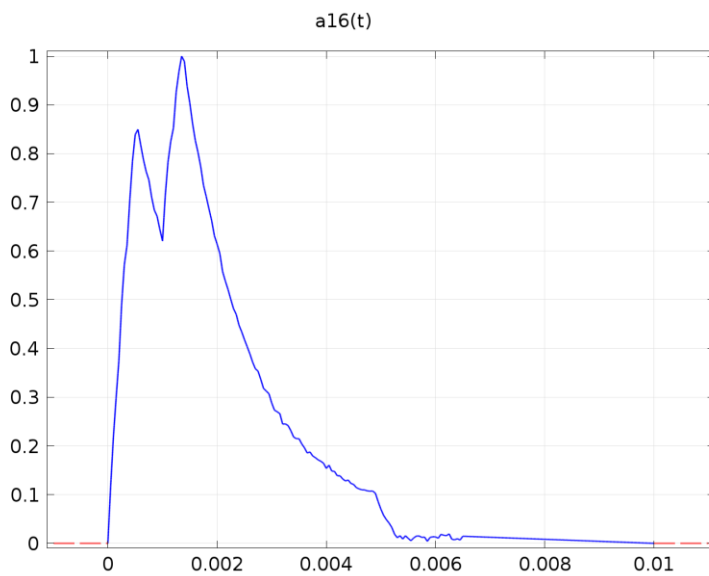
Function name	a15
Function type	Interpolation



Interpolation 15

1.2.16 Interpolation 16

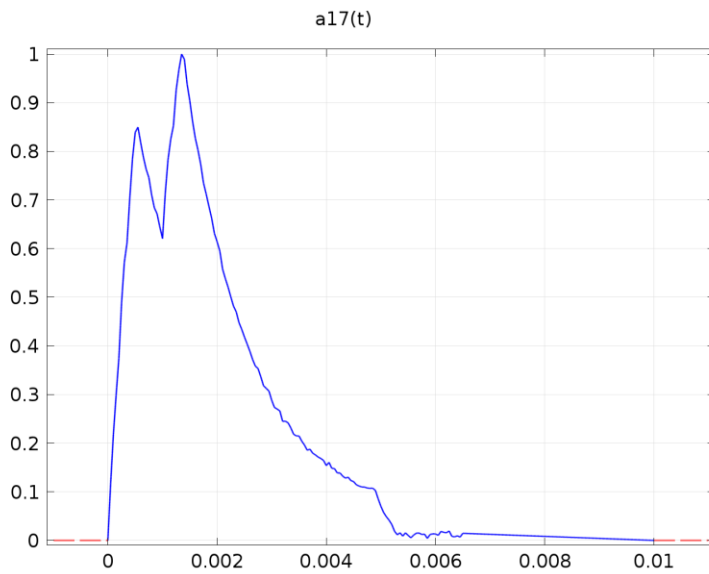
Function name	a16
Function type	Interpolation



Interpolation 16

1.2.17 Interpolation 17

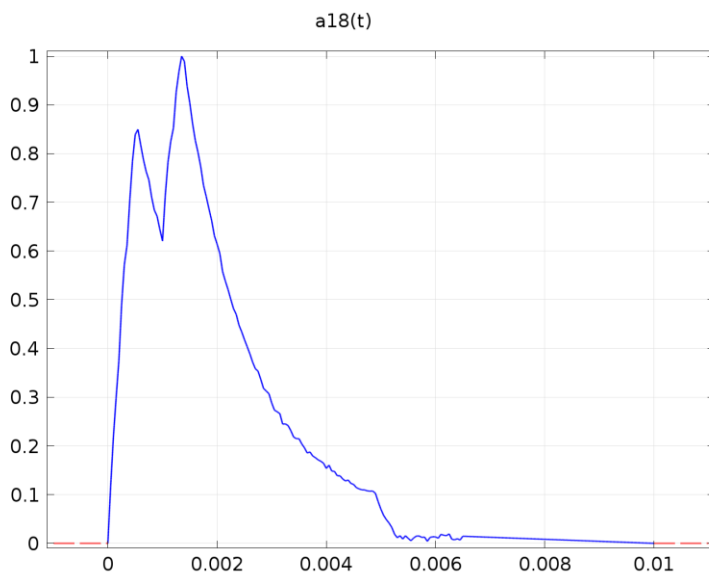
Function name	a17
Function type	Interpolation



Interpolation 17

1.2.18 Interpolation 18

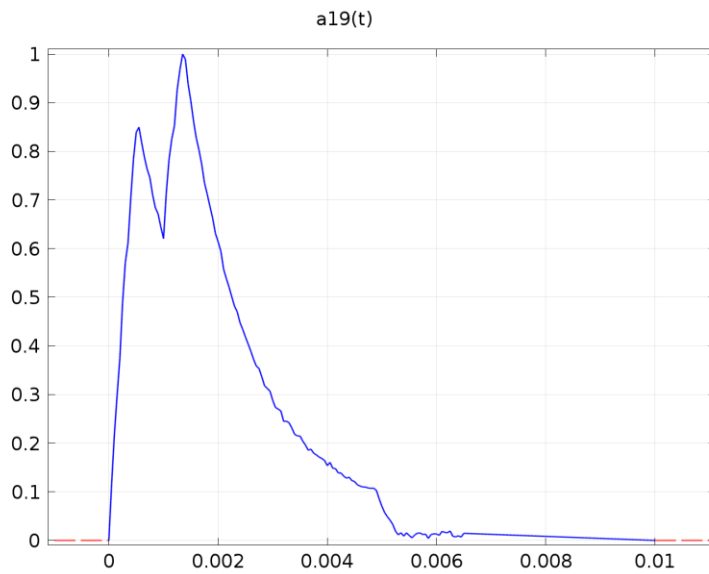
Function name	a18
Function type	Interpolation



Interpolation 18

1.2.19 Interpolation 19

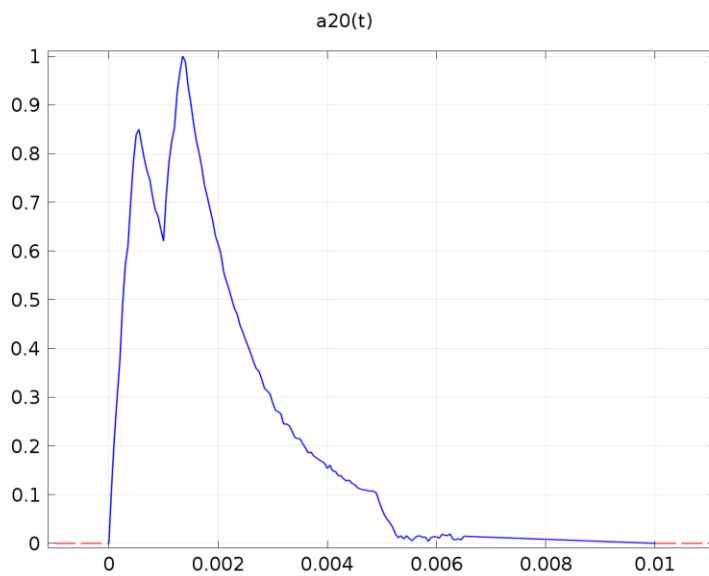
Function name	a19
Function type	Interpolation



Interpolation 19

1.2.20 Interpolation 20

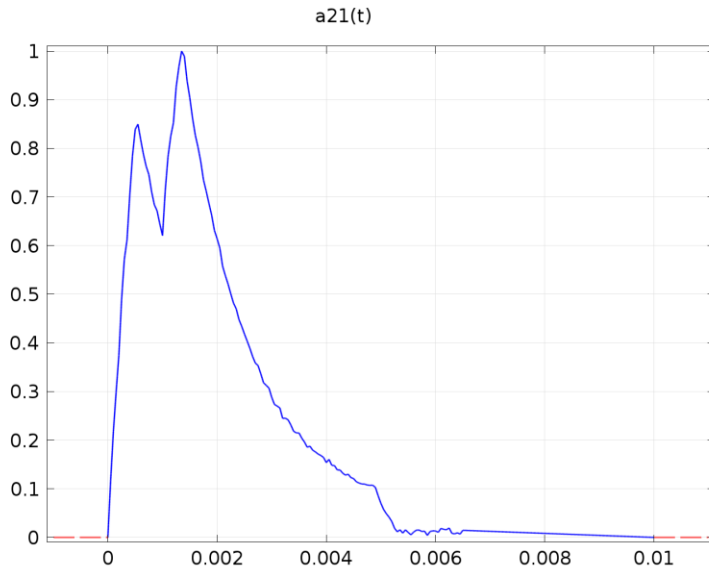
Function name	a20
Function type	Interpolation



Interpolation 20

1.2.21 Interpolation 21

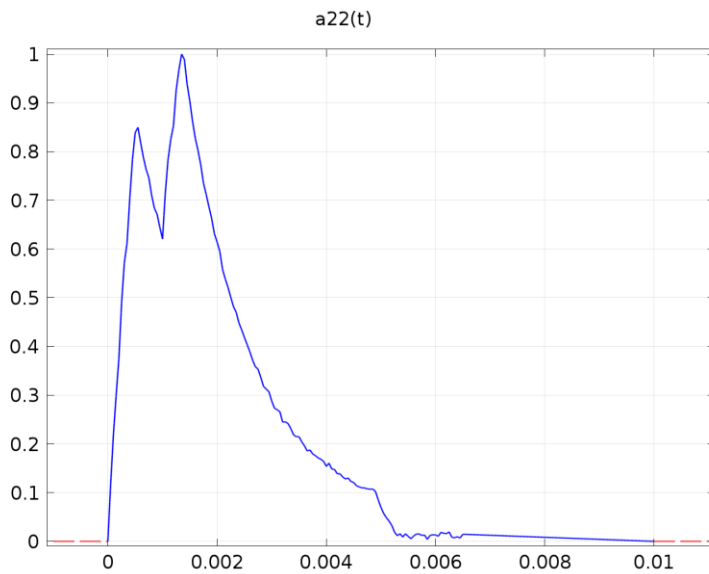
Function name	a21
Function type	Interpolation



Interpolation 21

1.2.22 Interpolation 22

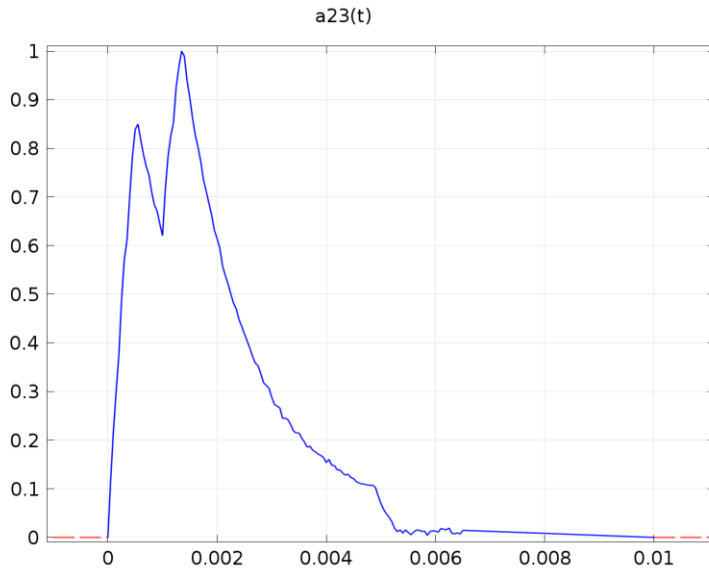
Function name	a22
Function type	Interpolation



Interpolation 22

1.2.23 Interpolation 23

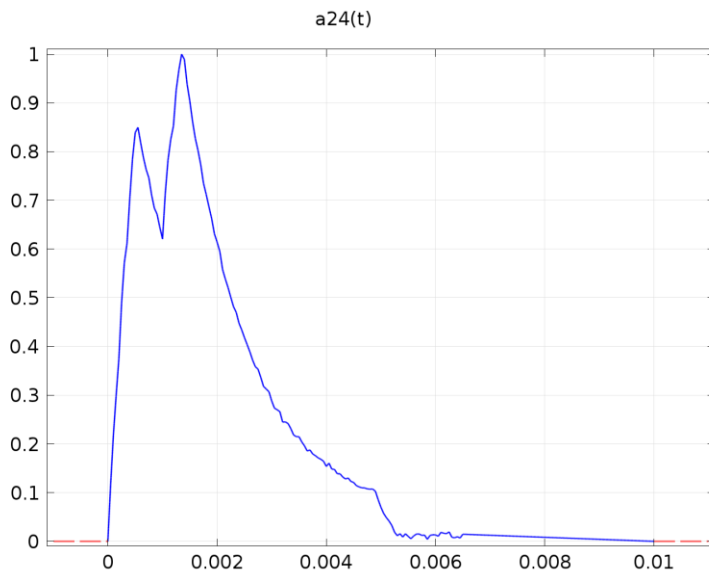
Function name	a23
Function type	Interpolation



Interpolation 23

1.2.24 Interpolation 24

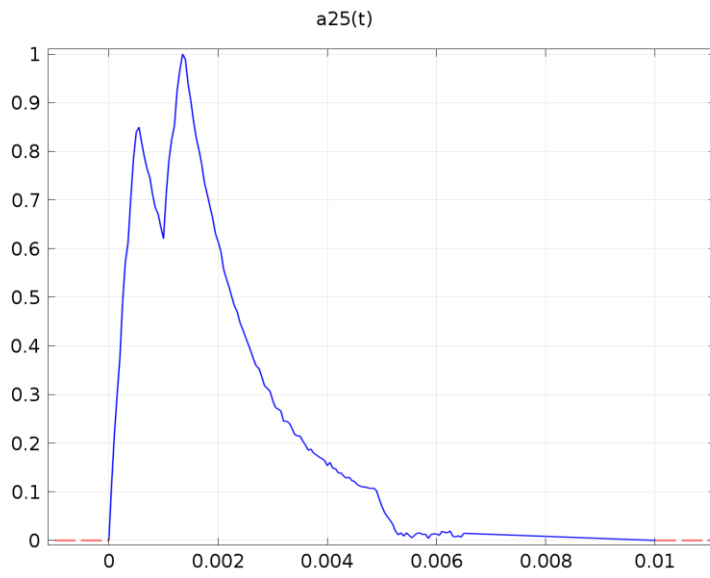
Function name	a24
Function type	Interpolation



Interpolation 24

1.2.25 Interpolation 25

Function name	a25
Function type	Interpolation



Interpolation 25

2 Model 1 (mod1)

2.1 Definitions

2.1.1 Coordinate Systems

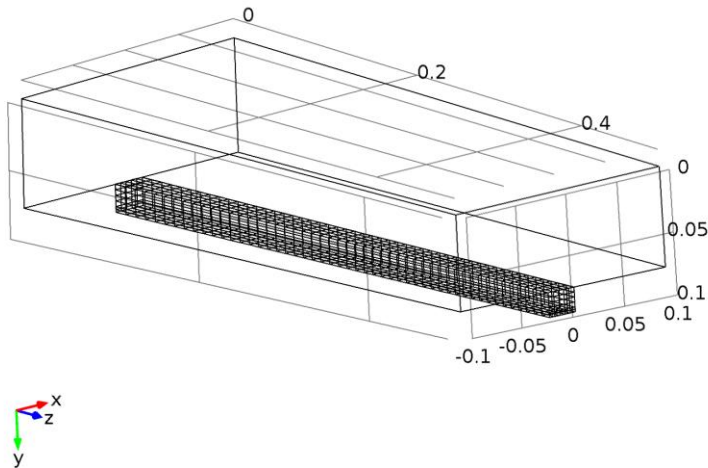
Boundary System 1

Coordinate system type	Boundary system
Identifier	sys1

Settings

Name	Value
Coordinate names	{t1, t2, n}
Create first tangent direction from	Global Cartesian (spatial)

2.2 Geometry 1



Geometry 1

Units

Length unit	m
Angular unit	deg

Geometry statistics

Property	Value
Space dimension	3
Number of domains	1501

Property	Value
Number of boundaries	5087
Number of edges	5735
Number of vertices	2150

2.2.1 Block 1 (blk1)

Position

Name	Value
Position	{-0.1, 0, 0}

Size and shape

Name	Value
Size	{0.2, 0.08, 0.5}

2.2.2 Block 2 (blk2)

Position

Name	Value
Position	{-0.0125, 0.08, 0}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.5}

2.2.3 Block 3 (blk3)

Position

Name	Value
Position	{-0.0075, 0.08, 0}

Size and shape

Name	Value
Size	{0.005, 0.02, 0.5}

2.2.4 Block 4 (blk4)

Position

Name	Value
Position	{0.0025, 0.08, 0}

Size and shape

Name	Value
Size	{0.005, 0.02, 0.5}

2.2.5 Block 5 (blk5)

Position

Name	Value
Position	{-0.0125, 0.096, 0}

Size and shape

Name	Value
Size	{0.025, 0.002, 0.5}

2.2.6 Block 6 (blk6)

Position

Name	Value
Position	{-0.0125, 0.088, 0}

Size and shape

Name	Value
Size	{0.025, 0.004, 0.5}

2.2.7 Block 7 (blk7)

Position

Name	Value
Position	{-0.0125, 0.080, 0}

Size and shape

Name	Value
Size	{0.025, 0.004, 0.5}

2.2.8 Block 8 (blk8)

Position

Name	Value
Position	{-0.0125, 0.080, 0}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.9 Block 9 (blk9)

Position

Name	Value
Position	{-0.0125, 0.080, 0.01}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.10 Block 10 (blk10)

Position

Name	Value
Position	{-0.0125, 0.080, 0.02}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.11 Block 11 (blk11)

Position

Name	Value
Position	{-0.0125, 0.080, 0.03}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.12 Block 12 (blk12)

Position

Name	Value
Position	{-0.0125, 0.080, 0.04}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.13 Block 13 (blk13)

Position

Name	Value
Position	{-0.0125, 0.080, 0.05}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.14 Block 14 (blk14)

Position

Name	Value
Position	{-0.0125, 0.080, 0.06}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.15 Block 15 (blk15)

Position

Name	Value
Position	{-0.0125, 0.080, 0.07}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.16 Block 16 (blk16)

Position

Name	Value
Position	{-0.0125, 0.080, 0.08}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.17 Block 17 (blk17)

Position

Name	Value
Position	{-0.0125, 0.080, 0.09}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.18 Block 18 (blk18)

Position

Name	Value
Position	{-0.0125, 0.080, 0.10}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.19 Block 19 (blk19)

Position

Name	Value
Position	{-0.0125, 0.080, 0.11}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.20 Block 20 (blk20)

Position

Name	Value
Position	{-0.0125, 0.080, 0.12}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.21 Block 21 (blk21)

Position

Name	Value
Position	{-0.0125, 0.080, 0.13}

Size and shape

Name	Value
------	-------

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.22 Block 22 (blk22)

Position

Name	Value
Position	{-0.0125, 0.080, 0.14}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.23 Block 23 (blk23)

Position

Name	Value
Position	{-0.0125, 0.080, 0.15}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.24 Block 24 (blk24)

Position

Name	Value
Position	{-0.0125, 0.080, 0.16}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.25 Block 25 (blk25)

Position

Name	Value
Position	{-0.0125, 0.080, 0.17}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.26 Block 26 (blk26)

Position

Name	Value
Position	{-0.0125, 0.080, 0.18}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.27 Block 27 (blk27)

Position

Name	Value
Position	{-0.0125, 0.080, 0.19}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.28 Block 28 (blk28)

Position

Name	Value
Position	{-0.0125, 0.080, 0.20}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.29 Block 29 (blk29)

Position

Name	Value
Position	{-0.0125, 0.080, 0.21}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.30 Block 30 (blk30)

Position

Name	Value
Position	{-0.0125, 0.080, 0.22}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.31 Block 31 (blk31)

Position

Name	Value
Position	{-0.0125, 0.080, 0.23}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.32 Block 32 (blk32)

Position

Name	Value
Position	{-0.0125, 0.080, 0.24}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.33 Block 33 (blk33)

Position

Name	Value
Position	{-0.0125, 0.080, 0.25}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.34 Block 34 (blk34)

Position

Name	Value
Position	{-0.0125, 0.080, 0.26}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.35 Block 35 (blk35)

Position

Name	Value
Position	{-0.0125, 0.080, 0.27}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.36 Block 36 (blk36)

Position

Name	Value
Position	{-0.0125, 0.080, 0.28}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.37 Block 37 (blk37)

Position

Name	Value
Position	{-0.0125, 0.080, 0.29}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.38 Block 38 (blk38)

Position

Name	Value
Position	{-0.0125, 0.080, 0.30}

Size and shape

Name	Value
------	-------

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.39 Block 39 (blk39)

Position

Name	Value
Position	{-0.0125, 0.080, 0.31}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.40 Block 40 (blk40)

Position

Name	Value
Position	{-0.0125, 0.080, 0.32}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.41 Block 41 (blk41)

Position

Name	Value
Position	{-0.0125, 0.080, 0.33}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.42 Block 42 (blk42)

Position

Name	Value
Position	{-0.0125, 0.080, 0.34}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.43 Block 43 (blk43)

Position

Name	Value
Position	{-0.0125, 0.080, 0.35}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.44 Block 44 (blk44)

Position

Name	Value
Position	{-0.0125, 0.080, 0.36}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.45 Block 45 (blk45)

Position

Name	Value
Position	{-0.0125, 0.080, 0.37}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.46 Block 46 (blk46)

Position

Name	Value
Position	{-0.0125, 0.080, 0.38}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.47 Block 47 (blk47)

Position

Name	Value
Position	{-0.0125, 0.080, 0.39}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.48 Block 48 (blk48)

Position

Name	Value
Position	{-0.0125, 0.080, 0.40}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.49 Block 49 (blk49)

Position

Name	Value
Position	{-0.0125, 0.080, 0.41}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.50 Block 50 (blk50)

Position

Name	Value
Position	{-0.0125, 0.080, 0.42}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.51 Block 51 (blk51)

Position

Name	Value
Position	{-0.0125, 0.080, 0.43}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.52 Block 52 (blk52)

Position

Name	Value
Position	{-0.0125, 0.080, 0.44}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.53 Block 53 (blk53)

Position

Name	Value
Position	{-0.0125, 0.080, 0.45}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.54 Block 54 (blk54)

Position

Name	Value
Position	{-0.0125, 0.080, 0.46}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.55 Block 55 (blk55)

Position

Name	Value
Position	{-0.0125, 0.080, 0.47}

Size and shape

Name	Value
------	-------

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.56 Block 56 (blk56)

Position

Name	Value
Position	{-0.0125, 0.080, 0.48}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.2.57 Block 57 (blk57)

Position

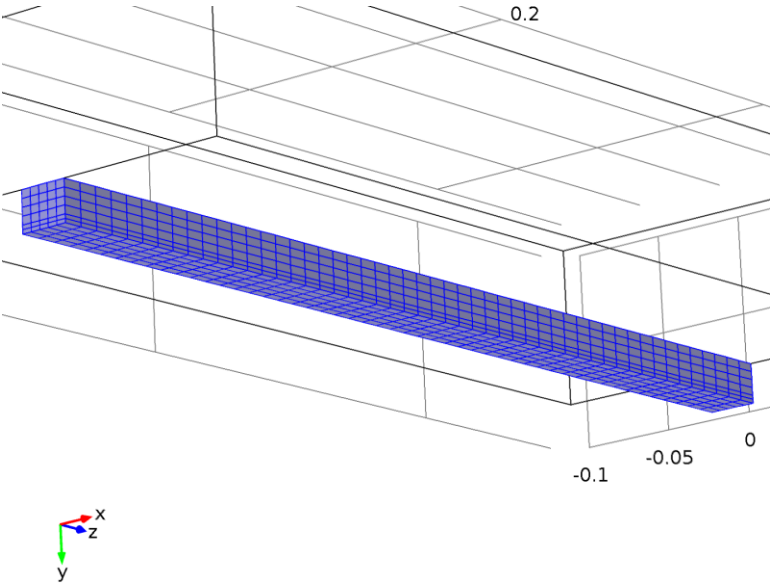
Name	Value
Position	{-0.0125, 0.080, 0.49}

Size and shape

Name	Value
Size	{0.025, 0.02, 0.01}

2.3 Materials

2.3.1 Copper



Copper

Selection

Geometric entity level	Domain
Selection	Domains 2–1501

Material parameters

Name	Value	Unit
Density	8700[kg/m ³]	kg/m ³
Young's modulus	120e9[Pa]	Pa
Poisson's ratio	0.35	1

Basic Settings

Description	Value
Relative permeability	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Electrical conductivity	{{5.998e7[S/m], 0, 0}, {0, 5.998e7[S/m], 0}, {0, 0, 5.998e7[S/m]}}
Coefficient of thermal expansion	{{17e-6[1/K], 0, 0}, {0, 17e-6[1/K], 0}, {0, 0, 17e-6[1/K]}}
Heat capacity at constant pressure	385[J/(kg*K)]
Relative permittivity	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Density	8700[kg/m ³]
Thermal conductivity	{{400[W/(m*K)], 0, 0}, {0, 400[W/(m*K)], 0}, {0, 0, 400[W/(m*K)]}}

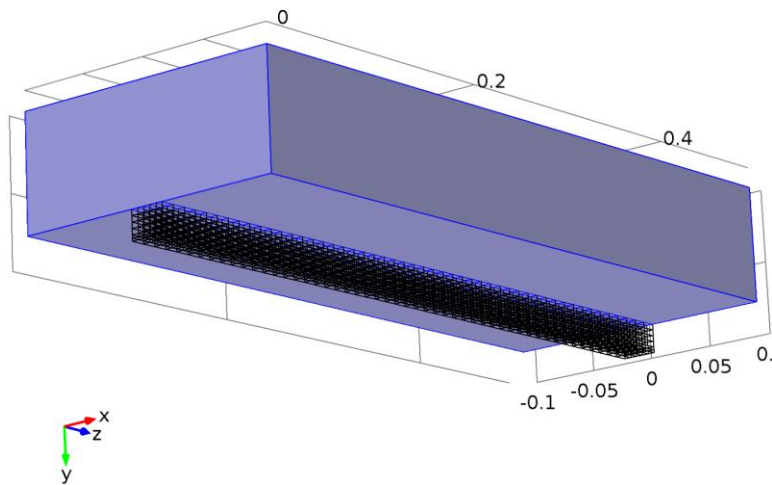
Young's modulus and Poisson's ratio Settings

Description	Value
Young's modulus	120e9[Pa]
Poisson's ratio	0.35

Linearized resistivity Settings

Description	Value
Reference resistivity	1.72e-8[ohm*m]
Resistivity temperature coefficient	0.0039[1/K]
Reference temperature	298[K]

2.3.2 Acrylic plastic



Acrylic plastic

Selection

Geometric entity level	Domain
Selection	Domain 1

Material parameters

Name	Value	Unit
Density	1850[kg/m ³]	kg/m ³
Young's modulus	18e9[Pa]	Pa
Poisson's ratio	0.30	1

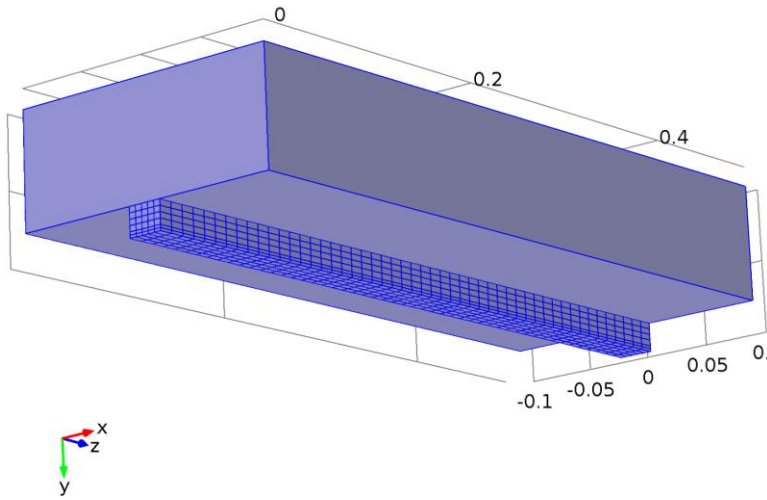
Basic Settings

Description	Value
Coefficient of thermal expansion	{{7.0e-5[1/K], 0, 0}, {0, 7.0e-5[1/K], 0}, {0, 0, 7.0e-5[1/K]}}
Heat capacity at constant pressure	1470[J/(kg*K)]
Density	1850[kg/m ³]
Thermal conductivity	{{0.18[W/(m*K)], 0, 0}, {0, 0.18[W/(m*K)], 0}, {0, 0, 0.18[W/(m*K)]}}

Young's modulus and Poisson's ratio Settings

Description	Value
Young's modulus	18e9[Pa]
Poisson's ratio	0.30

2.4 Solid Mechanics (solid)



Solid Mechanics

Selection

Geometric entity level	Domain
Selection	Domains 1–1501

Equations

Settings

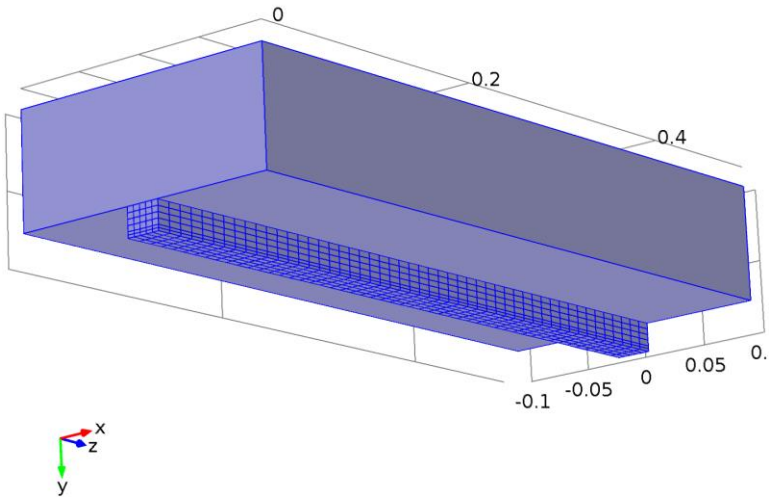
Description	Value
Displacement field	Quadratic
Compute boundary fluxes	0
Value type when using splitting of complex variables	Complex
Frame type	Material
Equation form	Study controlled
Structural transient behavior	Include inertial terms
Reference point for moment computation, x component	0
Reference point for moment computation, y component	0
Reference point for moment computation, z component	0
Typical wave speed for perfectly matched layers	solid.cp
Help-variable	SolidMechanics
Add mixed form pressure everywhere	0

Description	Value
Help-variable	smetffs
Show equation assuming	std2/time

Used products

COMSOL Multiphysics
Acoustics Module

2.4.1 Linear Elastic Material 1



Linear Elastic Material 1

Selection

Geometric entity level	Domain
Selection	Domains 1–1501

Equations

$$\rho \frac{\partial^2 \mathbf{u}}{\partial t^2} - \nabla \cdot \boldsymbol{\sigma} = \mathbf{F}_V, \quad \boldsymbol{\sigma} = \mathbf{s}$$

$$\mathbf{s} - \mathbf{s}_0 = \underline{\underline{\mathbf{C}}} : (\boldsymbol{\epsilon} - \boldsymbol{\epsilon}_0 - \boldsymbol{\epsilon}_{inel})$$

$$\boldsymbol{\epsilon} = \frac{1}{2} [(\nabla \mathbf{u})^T + \nabla \mathbf{u}]$$

Settings

Settings

Description	Value
Solid model	Isotropic

Description	Value
	0
Force linear strains	0
No descr used; This is a dummy resource for controlling anisotropic damping.	Standard (XX, YY, ZZ, XY, YZ, XZ)
Nearly incompressible material	0
Specify	Young's modulus and Poisson's ratio
Calculate dissipated creep energy	0
Young's modulus	From material
Poisson's ratio	From material
Elasticity matrix	{{0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}}
Elasticity matrix, Voigt notation	{{0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0}}
Density	From material

Used products

COMSOL Multiphysics

Properties from material

Property	Material	Property group
Young's modulus	Copper	Young's modulus and Poisson's ratio
Poisson's ratio	Copper	Young's modulus and Poisson's ratio
Density	Copper	Basic
Young's modulus	Acrylic plastic	Young's modulus and Poisson's ratio
Poisson's ratio	Acrylic plastic	Young's modulus and Poisson's ratio
Density	Acrylic plastic	Basic

Variables

Name	Expression	Unit	Description	Selection
solid.D11	$\text{solid.E} \cdot (1 - \text{solid.nu}) / ((1 + \text{solid.nu}) \cdot (1 - 2 \cdot \text{solid.nu}))$	Pa	Elasticity matrix, 11 component	Domains 1–1501
solid.D12	$\text{solid.E} \cdot \text{solid.nu} / ((1 + \text{solid.nu}) \cdot (1 - 2 \cdot \text{solid.nu}))$	Pa	Elasticity matrix, 12	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
solid.D13	$\text{solid.E} * \text{solid.nu} / ((1 + \text{solid.nu}) * (1 - 2 * \text{solid.nu}))$	Pa	Elasticity matrix, 13 component	Domains 1–1501
solid.D14	0	Pa	Elasticity matrix, 14 component	Domains 1–1501
solid.D15	0	Pa	Elasticity matrix, 15 component	Domains 1–1501
solid.D16	0	Pa	Elasticity matrix, 16 component	Domains 1–1501
solid.D22	$\text{solid.E} * (1 - \text{solid.nu}) / ((1 + \text{solid.nu}) * (1 - 2 * \text{solid.nu}))$	Pa	Elasticity matrix, 22 component	Domains 1–1501
solid.D23	$\text{solid.E} * \text{solid.nu} / ((1 + \text{solid.nu}) * (1 - 2 * \text{solid.nu}))$	Pa	Elasticity matrix, 23 component	Domains 1–1501
solid.D24	0	Pa	Elasticity matrix, 24 component	Domains 1–1501
solid.D25	0	Pa	Elasticity matrix, 25 component	Domains 1–1501
solid.D26	0	Pa	Elasticity matrix, 26 component	Domains 1–1501
solid.D33	$\text{solid.E} * (1 - \text{solid.nu}) / ((1 + \text{solid.nu}) * (1 - 2 * \text{solid.nu}))$	Pa	Elasticity matrix, 33 component	Domains 1–1501
solid.D34	0	Pa	Elasticity matrix, 34 component	Domains 1–1501
solid.D35	0	Pa	Elasticity matrix, 35 component	Domains 1–1501
solid.D36	0	Pa	Elasticity matrix, 36 component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.D44	$0.5 * \text{solid.E} / (1 + \text{solid.nu})$	Pa	Elasticity matrix, 44 component	Domains 1–1501
solid.D45	0	Pa	Elasticity matrix, 45 component	Domains 1–1501
solid.D46	0	Pa	Elasticity matrix, 46 component	Domains 1–1501
solid.D55	$0.5 * \text{solid.E} / (1 + \text{solid.nu})$	Pa	Elasticity matrix, 55 component	Domains 1–1501
solid.D56	0	Pa	Elasticity matrix, 56 component	Domains 1–1501
solid.D66	$0.5 * \text{solid.E} / (1 + \text{solid.nu})$	Pa	Elasticity matrix, 66 component	Domains 1–1501
solid.K	$\text{solid.E} / (3 * (1 - 2 * \text{solid.nu}))$	N/m ²	Bulk modulus	Domains 1–1501
solid.Eequ	solid.E	Pa	Equivalent Young's modulus	Domains 1–1501
solid.nuequ	solid.nu	1	Equivalent Poisson's ratio	Domains 1–1501
solid.E	model.input.E	Pa	Young's modulus	Domains 2–1501
solid.E	model.input.E	Pa	Young's modulus	Domain 1
solid.nu	model.input.nu	1	Poisson's ratio	Domains 2–1501
solid.nu	model.input.nu	1	Poisson's ratio	Domain 1
solid.rho	model.input.rho	kg/m ³	Density	Domains 2–1501
solid.rho	model.input.rho	kg/m ³	Density	Domain 1
solid.G	$0.5 * \text{solid.E} / (1 + \text{solid.nu})$	N/m ²	Shear modulus	Domains 1–1501
solid.lambLame	$\text{solid.E} * \text{solid.nu} / ((1 + \text{solid.nu}) * (1 - 2 * \text{solid.nu}))$	N/m ²	Lamé parameter λ	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.muLame	$0.5 * \text{solid.E} / (1 + \text{solid.nu})$	N/m ²	Lamé parameter μ	Domains 1–1501
solid.cp	$\sqrt{(\text{solid.lambLame} + 2 * \text{solid.muLame}) / \text{solid.rho}}$	m/s	Pressure-wave speed	Domains 1–1501
solid.cs	$\sqrt{\text{solid.muLame} / \text{solid.rho}}$	m/s	Shear-wave speed	Domains 1–1501
solid.Cgl11	solid.D11+solid.D12+solid.D13	Pa	C:g tensor, local coordinate system, 11 component	Domains 1–1501
solid.Cgl12	solid.D14+solid.D24+solid.D34	Pa	C:g tensor, local coordinate system, 12 component	Domains 1–1501
solid.Cgl13	solid.D16+solid.D26+solid.D36	Pa	C:g tensor, local coordinate system, 13 component	Domains 1–1501
solid.Cgl22	solid.D12+solid.D22+solid.D23	Pa	C:g tensor, local coordinate system, 22 component	Domains 1–1501
solid.Cgl23	solid.D15+solid.D25+solid.D35	Pa	C:g tensor, local coordinate system, 23 component	Domains 1–1501
solid.Cgl33	solid.D13+solid.D23+solid.D33	Pa	C:g tensor, local coordinate system, 33 component	Domains 1–1501
solid.gradUxX	uX	1	Displacement gradient, xX component	Domains 1–1501
solid.gradUyX	vX	1	Displacement gradient, yX component	Domains 1–1501
solid.gradUzX	wX	1	Displacement gradient, zX component	Domains 1–1501
solid.gradUxY	uY	1	Displacement gradient, xY	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
solid.gradUyY	vY	1	Displacement gradient, yY component	Domains 1–1501
solid.gradUzY	wY	1	Displacement gradient, zY component	Domains 1–1501
solid.gradUxZ	uZ	1	Displacement gradient, xZ component	Domains 1–1501
solid.gradUyZ	vZ	1	Displacement gradient, yZ component	Domains 1–1501
solid.gradUzZ	wZ	1	Displacement gradient, zZ component	Domains 1–1501
solid.FdxX	1+solid.gradUxX	1	Deformation gradient, xX component	Domains 1–1501
solid.FdyX	solid.gradUyX	1	Deformation gradient, yX component	Domains 1–1501
solid.FdzX	solid.gradUzX	1	Deformation gradient, zX component	Domains 1–1501
solid.FdxY	solid.gradUxY	1	Deformation gradient, xY component	Domains 1–1501
solid.FdyY	1+solid.gradUyY	1	Deformation gradient, yY component	Domains 1–1501
solid.FdzY	solid.gradUzY	1	Deformation gradient, zY component	Domains 1–1501
solid.FdxZ	solid.gradUxZ	1	Deformation gradient, xZ component	Domains 1–1501
solid.FdyZ	solid.gradUyZ	1	Deformation gradient, yZ component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.FdzZ	1+solid.gradUzZ	1	Deformation gradient, zZ component	Domains 1–1501
uTXt	root.mod1.uTXTIME	1/s	Tangential gradient of u, first time derivative, X component	Boundaries 1–5087
uTYt	root.mod1.uTYTIME	1/s	Tangential gradient of u, first time derivative, Y component	Boundaries 1–5087
uTZt	root.mod1.uTZTIME	1/s	Tangential gradient of u, first time derivative, Z component	Boundaries 1–5087
uTXtt	root.mod1.uTXTIMETIME	1/s ²	Tangential gradient of u, second time derivative, X component	Boundaries 1–5087
uTYtt	root.mod1.uTYTIMETIME	1/s ²	Tangential gradient of u, second time derivative, Y component	Boundaries 1–5087
uTZtt	root.mod1.uTZTIMETIME	1/s ²	Tangential gradient of u, second time derivative, Z component	Boundaries 1–5087
uXt	root.mod1.uXTIME	1/s	Gradient of u, first time derivative, X component	Domains 1–1501
uYt	root.mod1.uYTIME	1/s	Gradient of u, first time derivative, Y component	Domains 1–1501
uZt	root.mod1.uZTIME	1/s	Gradient of u, first time	Domains 1–

Name	Expression	Unit	Description	Selection
			derivative, Z component	1501
uXtt	root.mod1.uXTIMETIME	1/s ²	Gradient of u, second time derivative, X component	Domains 1–1501
uYtt	root.mod1.uYTIMETIME	1/s ²	Gradient of u, second time derivative, Y component	Domains 1–1501
uZtt	root.mod1.uZTIMETIME	1/s ²	Gradient of u, second time derivative, Z component	Domains 1–1501
vTXt	root.mod1.vTXTIME	1/s	Tangential gradient of v, first time derivative, X component	Boundaries 1–5087
vTYt	root.mod1.vTYTIME	1/s	Tangential gradient of v, first time derivative, Y component	Boundaries 1–5087
vTZt	root.mod1.vTZTIME	1/s	Tangential gradient of v, first time derivative, Z component	Boundaries 1–5087
vXtt	root.mod1.vXTIMETIME	1/s ²	Tangential gradient of v, second time derivative, X component	Boundaries 1–5087
vYtt	root.mod1.vYTIMETIME	1/s ²	Tangential gradient of v, second time derivative, Y component	Boundaries 1–5087
vZtt	root.mod1.vZTIMETIME	1/s ²	Tangential gradient of v, second time derivative, Z component	Boundaries 1–5087

Name	Expression	Unit	Description	Selection
			component	
vXt	root.mod1.vXTIME	1/s	Gradient of v, first time derivative, X component	Domains 1–1501
vYt	root.mod1.vYTIME	1/s	Gradient of v, first time derivative, Y component	Domains 1–1501
vZt	root.mod1.vZTIME	1/s	Gradient of v, first time derivative, Z component	Domains 1–1501
vXtt	root.mod1.vXTIMETIME	1/s ²	Gradient of v, second time derivative, X component	Domains 1–1501
vYtt	root.mod1.vYTIMETIME	1/s ²	Gradient of v, second time derivative, Y component	Domains 1–1501
vZtt	root.mod1.vZTIMETIME	1/s ²	Gradient of v, second time derivative, Z component	Domains 1–1501
wTXt	root.mod1.wTXTIME	1/s	Tangential gradient of w, first time derivative, X component	Boundaries 1–5087
wTYt	root.mod1.wTYTIME	1/s	Tangential gradient of w, first time derivative, Y component	Boundaries 1–5087
wTZt	root.mod1.wTZTIME	1/s	Tangential gradient of w, first time derivative, Z component	Boundaries 1–5087
wTXtt	root.mod1.wTXTIMETIME	1/s ²	Tangential gradient of w,	Boundaries 1–5087

Name	Expression	Unit	Description	Selection
			second time derivative, X component	
wTYtt	root.mod1.wTYTIMETIME	1/s ²	Tangential gradient of w, second time derivative, Y component	Boundaries 1–5087
wTZtt	root.mod1.wTZTIMETIME	1/s ²	Tangential gradient of w, second time derivative, Z component	Boundaries 1–5087
wXt	root.mod1.wXTIME	1/s	Gradient of w, first time derivative, X component	Domains 1–1501
wYt	root.mod1.wYTIME	1/s	Gradient of w, first time derivative, Y component	Domains 1–1501
wZt	root.mod1.wZTIME	1/s	Gradient of w, first time derivative, Z component	Domains 1–1501
wXtt	root.mod1.wXTIMETIME	1/s ²	Gradient of w, second time derivative, X component	Domains 1–1501
wYtt	root.mod1.wYTIMETIME	1/s ²	Gradient of w, second time derivative, Y component	Domains 1–1501
wZtt	root.mod1.wZTIMETIME	1/s ²	Gradient of w, second time derivative, Z component	Domains 1–1501
ut	root.mod1.uTIME	m/s	Structural velocity field, X component	Domains 1–1501
vt	root.mod1.vTIME	m/s	Structural velocity field, Y	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
wt	root.mod1.wTIME	m/s	Structural velocity field, Z component	Domains 1–1501
utt	root.mod1.uTIMETIME	m/s ²	Acceleration field, X component	Domains 1–1501
vtt	root.mod1.vTIMETIME	m/s ²	Acceleration field, Y component	Domains 1–1501
wtt	root.mod1.wTIMETIME	m/s ²	Acceleration field, Z component	Domains 1–1501
solid.eXX	uX	1	Strain tensor, XX component	Domains 1–1501
solid.eXY	0.5*(uY+vX)	1	Strain tensor, XY component	Domains 1–1501
solid.eXZ	0.5*(uZ+wX)	1	Strain tensor, XZ component	Domains 1–1501
solid.eYY	vY	1	Strain tensor, YY component	Domains 1–1501
solid.eYZ	0.5*(vZ+wY)	1	Strain tensor, YZ component	Domains 1–1501
solid.eZZ	wZ	1	Strain tensor, ZZ component	Domains 1–1501
solid.el11	solid.eXX	1	Strain tensor, local coordinate system, 11 component	Domains 1–1501
solid.el12	solid.eXY	1	Strain tensor, local coordinate system, 12 component	Domains 1–1501
solid.el13	solid.eXZ	1	Strain tensor, local coordinate system, 13 component	Domains 1–1501
solid.el22	solid.eYY	1	Strain tensor, local coordinate system, 22	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
solid.el23	solid.eYZ	1	Strain tensor, local coordinate system, 23 component	Domains 1–1501
solid.el33	solid.eZZ	1	Strain tensor, local coordinate system, 33 component	Domains 1–1501
solid.eil11	0	1	Initial strain tensor, local coordinate system, 11 component	Domains 1–1501
solid.eil12	0	1	Initial strain tensor, local coordinate system, 12 component	Domains 1–1501
solid.eil13	0	1	Initial strain tensor, local coordinate system, 13 component	Domains 1–1501
solid.eil22	0	1	Initial strain tensor, local coordinate system, 22 component	Domains 1–1501
solid.eil23	0	1	Initial strain tensor, local coordinate system, 23 component	Domains 1–1501
solid.eil33	0	1	Initial strain tensor, local coordinate system, 33 component	Domains 1–1501
solid.eiel11	0	1	Inelastic strain tensor, local coordinate system, 11	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
solid.eiel12	0	1	Inelastic strain tensor, local coordinate system, 12 component	Domains 1–1501
solid.eiel13	0	1	Inelastic strain tensor, local coordinate system, 13 component	Domains 1–1501
solid.eiel22	0	1	Inelastic strain tensor, local coordinate system, 22 component	Domains 1–1501
solid.eiel23	0	1	Inelastic strain tensor, local coordinate system, 23 component	Domains 1–1501
solid.eiel33	0	1	Inelastic strain tensor, local coordinate system, 33 component	Domains 1–1501
solid.eel11	solid.el11-solid.eil11-solid.eiel11	1	Elastic strain tensor, local coordinate system, 11 component	Domains 1–1501
solid.eel12	solid.el12-solid.eil12-solid.eiel12	1	Elastic strain tensor, local coordinate system, 12 component	Domains 1–1501
solid.eel13	solid.el13-solid.eil13-solid.eiel13	1	Elastic strain tensor, local coordinate system, 13 component	Domains 1–1501
solid.eel22	solid.el22-solid.eil22-	1	Elastic strain tensor, local	Domains 1–

Name	Expression	Unit	Description	Selection
	solid.eiel22		coordinate system, 22 component	1501
solid.eel23	solid.el23-solid.eil23-solid.eiel23	1	Elastic strain tensor, local coordinate system, 23 component	Domains 1–1501
solid.eel33	solid.el33-solid.eil33-solid.eiel33	1	Elastic strain tensor, local coordinate system, 33 component	Domains 1–1501
solid.evol	solid.eXX+solid.eYY+solid.eZZ	1	Volumetric strain	Domains 1–1501
solid.J	solid.FdxX*solid.FdyY*solid.FdzZ+solid.FdxY*solid.FdyZ*solid.FdzX+solid.FdxZ*solid.FdyX*solid.FdzY-solid.FdxX*solid.FdyZ*solid.FdzY-solid.FdxY*solid.FdyX*solid.FdzZ-solid.FdxZ*solid.FdyY*solid.FdzX	1	Volume ratio	Domains 1–1501
solid.eX	solid.eXX	1	Strain tensor, X component	Domains 1–1501
solid.eY	solid.eYY	1	Strain tensor, Y component	Domains 1–1501
solid.eZ	solid.eZZ	1	Strain tensor, Z component	Domains 1–1501
solid.Sil11	0	N/m ²	Initial stress tensor, local coordinate system, 11 component	Domains 1–1501
solid.Sil12	0	N/m ²	Initial stress tensor, local coordinate system, 12 component	Domains 1–1501
solid.Sil13	0	N/m ²	Initial stress	Domains 1–

Name	Expression	Unit	Description	Selection
			tensor, local coordinate system, 13 component	1501
solid.Sil22	0	N/m ²	Initial stress tensor, local coordinate system, 22 component	Domains 1–1501
solid.Sil23	0	N/m ²	Initial stress tensor, local coordinate system, 23 component	Domains 1–1501
solid.Sil33	0	N/m ²	Initial stress tensor, local coordinate system, 33 component	Domains 1–1501
solid.SI11	solid.Sil11+solid.D11*solid.eel11+solid.D12*solid.eel22+solid.D13*solid.eel33+2*solid.D14*solid.eel12+2*solid.D15*solid.eel23+2*solid.D16*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 11 component	Domains 1–1501
solid.SI12	solid.Sil12+solid.D14*solid.eel11+solid.D24*solid.eel22+solid.D34*solid.eel33+2*solid.D44*solid.eel12+2*solid.D45*solid.eel23+2*solid.D46*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 12 component	Domains 1–1501
solid.SI13	solid.Sil13+solid.D16*solid.eel11+solid.D26*solid.eel22+solid.D36*solid.eel33+2*solid.D46*solid.eel12+2*solid.D56*solid.eel23+2*solid.D66*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 13 component	Domains 1–1501
solid.SI22	solid.Sil22+solid.D12*solid.eel11+solid.D22*solid.eel22+solid.D23*solid.eel33+2*solid.D24*solid.eel12+2*solid.D25*solid.eel23+2*solid.D26*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 22 component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.SI23	solid.SI123+solid.D15*solid.eel11+solid.D25*solid.eel22+solid.D35*solid.eel33+2*solid.D45*solid.eel12+2*solid.D55*solid.eel23+2*solid.D56*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 23 component	Domains 1–1501
solid.SI33	solid.SI133+solid.D13*solid.eel11+solid.D23*solid.eel22+solid.D33*solid.eel33+2*solid.D34*solid.eel12+2*solid.D35*solid.eel23+2*solid.D36*solid.eel13	N/m ²	Second Piola-Kirchhoff stress, local coordinate system, 33 component	Domains 1–1501
solid.Ws_tot	root.mod1.solid.lemm1.int1(0.5*((solid.SI11+solid.SI11)*solid.eel11+2*(solid.SI12+solid.SI12)*solid.eel12+2*(solid.SI13+solid.SI13)*solid.eel13+(solid.SI22+solid.SI22)*solid.eel22+2*(solid.SI23+solid.SI23)*solid.eel23+(solid.SI33+solid.SI33)*solid.eel33))	J	Total elastic strain energy	Global
solid.Ldx	d(solid.gradUxX,TIME)	1/s	Rate of strain tensor, x component	Domains 1–1501
solid.Ldxy	0.5*(d(solid.gradUxY,TIME)+d(solid.gradUyX,TIME))	1/s	Rate of strain tensor, xy component	Domains 1–1501
solid.Ldxz	0.5*(d(solid.gradUxZ,TIME)+d(solid.gradUzX,TIME))	1/s	Rate of strain tensor, xz component	Domains 1–1501
solid.Ldy	d(solid.gradUyY,TIME)	1/s	Rate of strain tensor, y component	Domains 1–1501
solid.Ldyz	0.5*(d(solid.gradUyZ,TIME)+d(solid.gradUzY,TIME))	1/s	Rate of strain tensor, yz component	Domains 1–1501
solid.Ldz	d(solid.gradUzZ,TIME)	1/s	Rate of strain tensor, z component	Domains 1–1501
solid.Lwx	0	1/s	Spin tensor, x component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.Lwxy	$0.5 * (d(\text{solid.gradUxY}, \text{TIME}) - d(\text{solid.gradUyX}, \text{TIME}))$	1/s	Spin tensor, xy component	Domains 1–1501
solid.Lwxz	$0.5 * (d(\text{solid.gradUxZ}, \text{TIME}) - d(\text{solid.gradUzX}, \text{TIME}))$	1/s	Spin tensor, xz component	Domains 1–1501
solid.Lwy	0	1/s	Spin tensor, y component	Domains 1–1501
solid.Lwyz	$0.5 * (d(\text{solid.gradUyZ}, \text{TIME}) - d(\text{solid.gradUzY}, \text{TIME}))$	1/s	Spin tensor, yz component	Domains 1–1501
solid.Lwz	0	1/s	Spin tensor, z component	Domains 1–1501
solid.Ws	$0.5 * ((\text{solid.SI11} + \text{solid.Sil11}) * \text{solid.eel11} + 2 * (\text{solid.SI12} + \text{solid.Sil12}) * \text{solid.eel12} + 2 * (\text{solid.SI13} + \text{solid.Sil13}) * \text{solid.eel13} + (\text{solid.SI22} + \text{solid.Sil22}) * \text{solid.eel22} + 2 * (\text{solid.SI23} + \text{solid.Sil23}) * \text{solid.eel23} + (\text{solid.SI33} + \text{solid.Sil33}) * \text{solid.eel33})$	J/m ³	Elastic strain energy density	Domains 1–1501
solid.disp	$\text{sqrt}(\text{real}(u)^2 + \text{real}(v)^2 + \text{real}(w)^2)$	m	Total displacement	Domains 1–1501
solid.u_ttX	$d(\text{root.mod1.uTIME}, \text{TIME})$	m/s ²	Acceleration, X component	Domains 1–1501
solid.u_ttY	$d(\text{root.mod1.vTIME}, \text{TIME})$	m/s ²	Acceleration, Y component	Domains 1–1501
solid.u_ttZ	$d(\text{root.mod1.wTIME}, \text{TIME})$	m/s ²	Acceleration, Z component	Domains 1–1501
solid.u_tX	root.mod1.uTIME	m/s	Velocity, X component	Domains 1–1501
solid.u_tY	root.mod1.vTIME	m/s	Velocity, Y component	Domains 1–1501
solid.u_tZ	root.mod1.wTIME	m/s	Velocity, Z component	Domains 1–1501
solid.SX	solid.SI11	N/m ²	Second Piola-Kirchhoff stress, X component	Domains 1–1501
solid.SXY	solid.SI12	N/m ²	Second Piola-Kirchhoff stress, XY component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.SXZ	solid.SI13	N/m ²	Second Piola-Kirchhoff stress, XZ component	Domains 1–1501
solid.SY	solid.SI22	N/m ²	Second Piola-Kirchhoff stress, Y component	Domains 1–1501
solid.SYZ	solid.SI23	N/m ²	Second Piola-Kirchhoff stress, YZ component	Domains 1–1501
solid.SZ	solid.SI33	N/m ²	Second Piola-Kirchhoff stress, Z component	Domains 1–1501
solid.PxX	solid.FdxX*solid.SX+solid.FdxY*solid.SXY+solid.FdxZ*solid.SXZ	N/m ²	First Piola-Kirchhoff stress, xX component	Domains 1–1501
solid.PyX	solid.FdyX*solid.SX+solid.FdyY*solid.SXY+solid.FdyZ*solid.SXZ	N/m ²	First Piola-Kirchhoff stress, yX component	Domains 1–1501
solid.PzX	solid.FdzX*solid.SX+solid.FdzY*solid.SXY+solid.FdzZ*solid.SXZ	N/m ²	First Piola-Kirchhoff stress, zX component	Domains 1–1501
solid.PxY	solid.FdxX*solid.SXY+solid.FdxY*solid.SY+solid.FdxZ*solid.SYZ	N/m ²	First Piola-Kirchhoff stress, xY component	Domains 1–1501
solid.PyY	solid.FdyX*solid.SXY+solid.FdyY*solid.SY+solid.FdyZ*solid.SYZ	N/m ²	First Piola-Kirchhoff stress, yY component	Domains 1–1501
solid.PzY	solid.FdzX*solid.SXY+solid.FdzY*solid.SY+solid.FdzZ*solid.SYZ	N/m ²	First Piola-Kirchhoff stress, zY component	Domains 1–1501
solid.PxZ	solid.FdxX*solid.SXZ+solid.FdxY*solid.SYZ+solid.FdxZ*solid.SZ	N/m ²	First Piola-Kirchhoff stress, xZ component	Domains 1–1501
solid.PyZ	solid.FdyX*solid.SXZ+solid.FdyY*solid.SYZ+solid.FdyZ*solid.SZ	N/m ²	First Piola-Kirchhoff stress, yZ component	Domains 1–1501
solid.PzZ	solid.FdzX*solid.SXZ+solid.FdzY*solid.SYZ+solid.FdzZ*solid.SZ	N/m ²	First Piola-Kirchhoff stress, zZ component	Domains 1–1501
solid.sx	solid.SX	N/m ²	Stress tensor, x	Domains 1–

Name	Expression	Unit	Description	Selection
			component	1501
solid.sxy	solid.SXY	N/m ²	Stress tensor, xy component	Domains 1–1501
solid.sxz	solid.SXZ	N/m ²	Stress tensor, xz component	Domains 1–1501
solid.sy	solid.SY	N/m ²	Stress tensor, y component	Domains 1–1501
solid.syz	solid.SYZ	N/m ²	Stress tensor, yz component	Domains 1–1501
solid.sz	solid.SZ	N/m ²	Stress tensor, z component	Domains 1–1501
solid.sl11	solid.sx	N/m ²	Stress tensor, local coordinate system, 11 component	Domains 1–1501
solid.sl12	solid.sxy	N/m ²	Stress tensor, local coordinate system, 12 component	Domains 1–1501
solid.sl13	solid.sxz	N/m ²	Stress tensor, local coordinate system, 13 component	Domains 1–1501
solid.sl22	solid.sy	N/m ²	Stress tensor, local coordinate system, 22 component	Domains 1–1501
solid.sl23	solid.syz	N/m ²	Stress tensor, local coordinate system, 23 component	Domains 1–1501
solid.sl33	solid.sz	N/m ²	Stress tensor, local coordinate system, 33 component	Domains 1–1501
solid.sdevx	solid.sx-(solid.sx+solid.sy+solid.sz)/3	N/m ²	Deviatoric stress tensor, x component	Domains 1–1501
solid.sdevxy	solid.sxy	N/m ²	Deviatoric stress tensor, xy	Domains 1–1501

Name	Expression	Unit	Description	Selection
			component	
solid.sdevxz	solid.sxz	N/m ²	Deviatoric stress tensor, xz component	Domains 1–1501
solid.sdevy	solid.sy-(solid.sx+solid.sy+solid.sz)/3	N/m ²	Deviatoric stress tensor, y component	Domains 1–1501
solid.sdevyz	solid.syz	N/m ²	Deviatoric stress tensor, yz component	Domains 1–1501
solid.sdevz	solid.sz-(solid.sx+solid.sy+solid.sz)/3	N/m ²	Deviatoric stress tensor, z component	Domains 1–1501
solid.SdevX	solid.SX-(solid.SX+solid.SY+solid.SZ)/3	N/m ²	Deviatoric second Piola-Kirchhoff stress, X component	Domains 1–1501
solid.SdevXY	solid.SXY	N/m ²	Deviatoric second Piola-Kirchhoff stress, XY component	Domains 1–1501
solid.SdevXZ	solid.SXZ	N/m ²	Deviatoric second Piola-Kirchhoff stress, XZ component	Domains 1–1501
solid.SdevY	solid.SY-(solid.SX+solid.SY+solid.SZ)/3	N/m ²	Deviatoric second Piola-Kirchhoff stress, Y component	Domains 1–1501
solid.SdevYZ	solid.SYZ	N/m ²	Deviatoric second Piola-Kirchhoff stress, YZ component	Domains 1–1501
solid.SdevZ	solid.SZ-(solid.SX+solid.SY+solid.SZ)/3	N/m ²	Deviatoric second Piola-Kirchhoff stress, Z component	Domains 1–1501
solid.I1s	solid.sx+solid.sy+solid.sz	N/m ²	First principal invariant of stress	Domains 1–1501
solid.I2s	0.5*(solid.I1s ² -solid.sx ² -	kg ² /(m ² *s ⁴)	Second	Domains 1–

Name	Expression	Unit	Description	Selection
	$2 \cdot \text{solid.sxy}^2 - 2 \cdot \text{solid.sxz}^2 - \text{solid.sy}^2 - 2 \cdot \text{solid.syz}^2 - \text{solid.sz}^2$		principal invariant of stress	1501
solid.I3s	$\text{solid.sx} \cdot \text{solid.sy} \cdot \text{solid.sz} + 2 \cdot \text{solid.sxy} \cdot \text{solid.syz} \cdot \text{solid.sxz} - \text{solid.sx} \cdot \text{solid.syz}^2 - \text{solid.sxy}^2 \cdot \text{solid.sz} - \text{solid.sy} \cdot \text{solid.sxz}^2$	$\text{kg}^3/(\text{m}^3 \cdot \text{s}^6)$	Third principal invariant of stress	Domains 1–1501
solid.II2s	$0.5 \cdot (\text{solid.sdevx}^2 + 2 \cdot \text{solid.sdevxy}^2 + 2 \cdot \text{solid.sdevxz}^2 + \text{solid.sdevy}^2 + 2 \cdot \text{solid.sdevyz}^2 + \text{solid.sdevz}^2)$	$\text{kg}^2/(\text{m}^2 \cdot \text{s}^4)$	Second invariant of stress deviator	Domains 1–1501
solid.II3s	$\text{solid.sdevx} \cdot \text{solid.sdevy} \cdot \text{solid.sdevz} + 2 \cdot \text{solid.sdevxy} \cdot \text{solid.sdevyz} \cdot \text{solid.sdevxz} - \text{solid.sdevx} \cdot \text{solid.sdevyz}^2 - \text{solid.sdevxy}^2 \cdot \text{solid.sdevz} - \text{solid.sdevy} \cdot \text{solid.sdevxz}^2$	$\text{kg}^3/(\text{m}^3 \cdot \text{s}^6)$	Third invariant of stress deviator	Domains 1–1501
solid.thetaL	$\text{atan2}(\text{sqrt}(\max(0.14814814814814814 \cdot \text{solid.II2s}^3 - \text{solid.II3s}^2, \text{eps}))), \text{solid.II3s}) / 3$	rad	Lode angle	Domains 1–1501
solid.eelvol	$\text{solid.eel11} + \text{solid.eel22} + \text{solid.eel33}$	1	First invariant of elastic strain tensor	Domains 1–1501
solid.eeldev	$0.5 \cdot ((\text{solid.eel11} - (\text{solid.eel11} + \text{solid.eel22} + \text{solid.eel33})/3)^2 + 2 \cdot \text{solid.eel12}^2 + 2 \cdot \text{solid.eel13}^2 + (\text{solid.eel22} - (\text{solid.eel11} + \text{solid.eel22} + \text{solid.eel33})/3)^2 + 2 \cdot \text{solid.eel23}^2 + (\text{solid.eel33} - (\text{solid.eel11} + \text{solid.eel22} + \text{solid.eel33})/3)^2)$	1	Second invariant of deviatoric elastic strain tensor	Domains 1–1501
solid.pm	$-(\text{solid.sx} + \text{solid.sy} + \text{solid.sz}) / 3$	N/m^2	Pressure	Domains 1–1501
solid.curlUX	$wY - vZ$	1	Curl of displacement, X component	Domains 1–1501

Name	Expression	Unit	Description	Selection
solid.curlUY	$-wX + uZ$	1	Curl of displacement, Y component	Domains 1–1501
solid.curlUZ	$vX - uY$	1	Curl of displacement, Z component	Domains 1–1501
solid.mises	$(3 * \text{solid.II2s})^{0.5}$	N/m ²	von Mises stress	Domains 1–1501
solid.tresca	$\text{solid.sp1} - \text{solid.sp3}$	N/m ²	Tresca stress	Domains 1–1501
solid.RFx	$\text{react}(u)$	N	Reaction force, x component	Domains 1–1501
solid.RFy	$\text{react}(v)$	N	Reaction force, y component	Domains 1–1501
solid.RFz	$\text{react}(w)$	N	Reaction force, z component	Domains 1–1501
solid.RMx	$\text{solid.RFz} * (y - \text{solid.refpnty}) - \text{solid.RFy} * (z - \text{solid.refpntz})$	N*m	Reaction moment, x component	Domains 1–1501
solid.RMy	$-\text{solid.RFz} * (x - \text{solid.refpntx}) + \text{solid.RFx} * (z - \text{solid.refpntz})$	N*m	Reaction moment, y component	Domains 1–1501
solid.RMz	$\text{solid.RFy} * (x - \text{solid.refpntx}) - \text{solid.RFx} * (y - \text{solid.refpnty})$	N*m	Reaction moment, z component	Domains 1–1501
solid.Tax	$\text{solid.sx} * \text{solid.nx} + \text{solid.sxy} * \text{solid.ny} + \text{solid.sxz} * \text{solid.nz}$	N/m ²	Traction (force/area), x component	Boundaries 1–5087
solid.Tay	$\text{solid.sxy} * \text{solid.nx} + \text{solid.sy} * \text{solid.ny} + \text{solid.syz} * \text{solid.nz}$	N/m ²	Traction (force/area), y component	Boundaries 1–5087
solid.Taz	$\text{solid.sxz} * \text{solid.nx} + \text{solid.syz} * \text{solid.ny} + \text{solid.sz} * \text{solid.nz}$	N/m ²	Traction (force/area), z component	Boundaries 1–5087

Shape functions

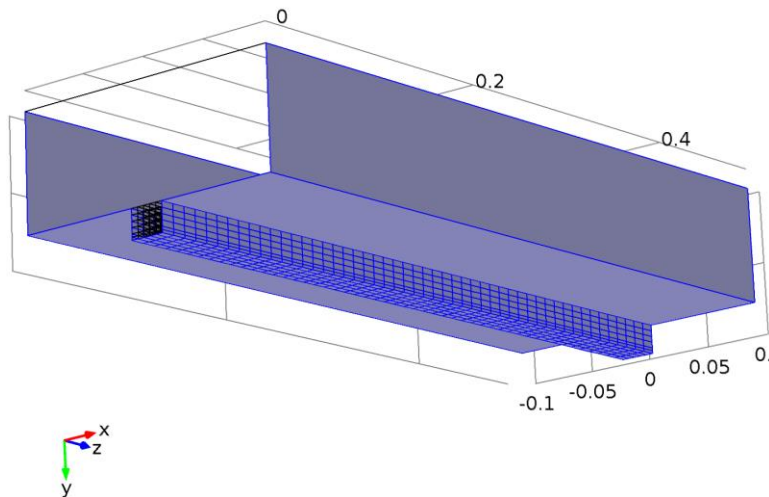
Name	Shape function	Unit	Description	Shape frame	Selection
u	Lagrange (Quadratic)	m	Displacement field, X component	Material	Domains 1–1501

Name	Shape function	Unit	Description	Shape frame	Selection
v	Lagrange (Quadratic)	m	Displacement field, Y component	Material	Domains 1–1501
w	Lagrange (Quadratic)	m	Displacement field, Z component	Material	Domains 1–1501

Weak expressions

Weak expression	Integration frame	Selection
-solid.SI11*test(solid.el11)-2*solid.SI12*test(solid.el12)-2*solid.SI13*test(solid.el13)-solid.SI22*test(solid.el22)-2*solid.SI23*test(solid.el23)-solid.SI33*test(solid.el33)	Material	Domains 1–1501

2.4.2 Free 1



Free 1

Selection

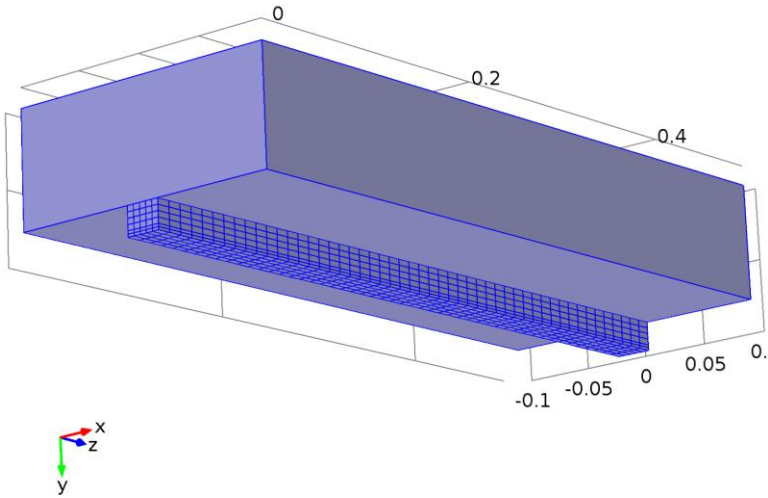
Geometric entity level	Boundary
Selection	Boundaries 1, 5–6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90, 93, 96, 99, 102, 105, 108, 111, 114, 117, 120, 123, 126, 129, 132, 135, 138, 141, 144, 147, 150, 153, 157, 160, 163, 166, 169, 172, 175, 178, 181, 184, 187, 190, 193, 196, 199, 202, 205, 208, 211, 214, 217, 220, 223, 226, 229, 232, 235, 238, 241, 244, 247, 250, 253, 256, 259, 262, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292, 295, 298, 301, 304, 308, 311, 314, 317, 320, 323, 326, 329, 332, 335, 338, 341, 344, 347, 350, 353, 356, 359, 362, 365, 368, 371, 374, 377, 380, 383, 386, 389, 392, 395, 398, 401, 404, 407, 410, 413, 416, 419, 422, 425, 428, 431, 434, 437, 440, 443,

	446, 449, 452, 455, 459, 462, 465, 468, 471, 474, 477, 480, 483, 486, 489, 492, 495, 498, 501, 504, 507, 510, 513, 516, 519, 522, 525, 528, 531, 534, 537, 540, 543, 546, 549, 552, 555, 558, 561, 564, 567, 570, 573, 576, 579, 582, 585, 588, 591, 594, 597, 600, 603, 606, 610, 613, 616, 619, 622, 625, 628, 631, 634, 637, 640, 643, 646, 649, 652, 655, 658, 661, 664, 667, 670, 673, 676, 679, 682, 685, 688, 691, 694, 697, 700, 703, 706, 709, 712, 715, 718, 721, 724, 727, 730, 733, 736, 739, 742, 745, 748, 751, 754, 757, 761, 764, 767, 770, 773, 776, 779, 782, 785, 788, 791, 794, 797, 800, 803, 806, 809, 812, 815, 818, 821, 824, 827, 830, 833, 836, 839, 842, 845, 848, 851, 854, 857, 860, 863, 866, 869, 872, 875, 878, 881, 884, 887, 890, 893, 896, 899, 902, 905, 908, 912–961, 1868–1917, 2824–2873, 3780–3829, 4736–5087
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Used products

COMSOL Multiphysics

2.4.3 Initial Values 1



Initial Values 1

Selection

Geometric entity level	Domain
Selection	Domains 1–1501

Settings

Settings

Description	Value
Displacement field	{0, 0, 0}

Description	Value
Structural velocity field	{0, 0, 0}

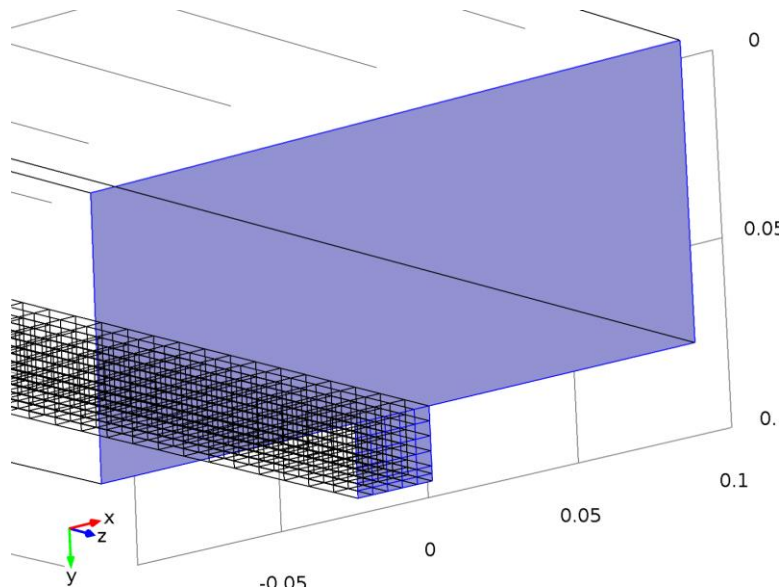
Used products

COMSOL Multiphysics

Variables

Name	Expression	Unit	Description	Selection
solid.ulnitx	0	m	Initial value of displacement, x component	Domains 1–1501
solid.ulnity	0	m	Initial value of displacement, y component	Domains 1–1501
solid.ulnitz	0	m	Initial value of displacement, z component	Domains 1–1501
solid.utlnitx	0	m/s	Initial value of structural velocity, x component	Domains 1–1501
solid.utlnity	0	m/s	Initial value of structural velocity, y component	Domains 1–1501
solid.utlnitz	0	m/s	Initial value of structural velocity, z component	Domains 1–1501

2.4.4 Symmetry 1



Symmetry 1

Selection

Geometric entity level	Boundary
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Selection	Boundaries 4, 156, 307, 458, 609, 760, 911, 1112, 1263, 1414, 1565, 1716, 1867, 2068, 2219, 2370, 2521, 2672, 2823, 3024, 3175, 3326, 3477, 3628, 3779, 3980, 4131, 4282, 4433, 4584, 4735
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Equations

$$\mathbf{n} \cdot \mathbf{u} = 0$$

Settings

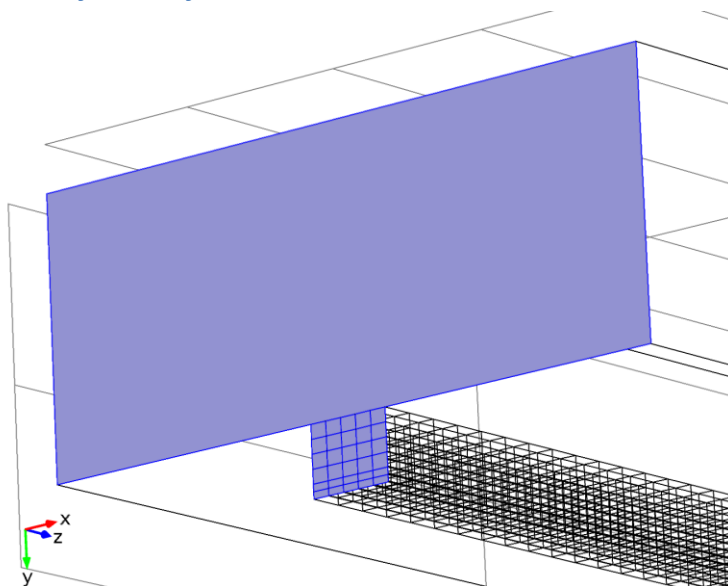
Settings

Description	Value
Apply reaction terms on	All physics (symmetric)
Use weak constraints	0

Constraints

Constraint	Constraint force	Shape function	Selection
-solid.nX*u-solid.nY*v-solid.nZ*w	test(-solid.nX*u-solid.nY*v-solid.nZ*w)	Lagrange (Quadratic)	Boundaries 4, 156, 307, 458, 609, 760, 911, 1112, 1263, 1414, 1565, 1716, 1867, 2068, 2219, 2370, 2521, 2672, 2823, 3024, 3175, 3326, 3477, 3628, 3779, 3980, 4131, 4282, 4433, 4584, 4735

2.4.5 Symmetry 2



Symmetry 2

Selection

Geometric entity level	Boundary
Selection	Boundaries 3, 8, 159, 310, 461, 612, 763, 964, 1115, 1266, 1417, 1568, 1719, 1920, 2071, 2222, 2373, 2524, 2675, 2876, 3027, 3178, 3329, 3480, 3631, 3832, 3983, 4134, 4285, 4436, 4587

Equations

$$\mathbf{n} \cdot \mathbf{u} = 0$$

Settings

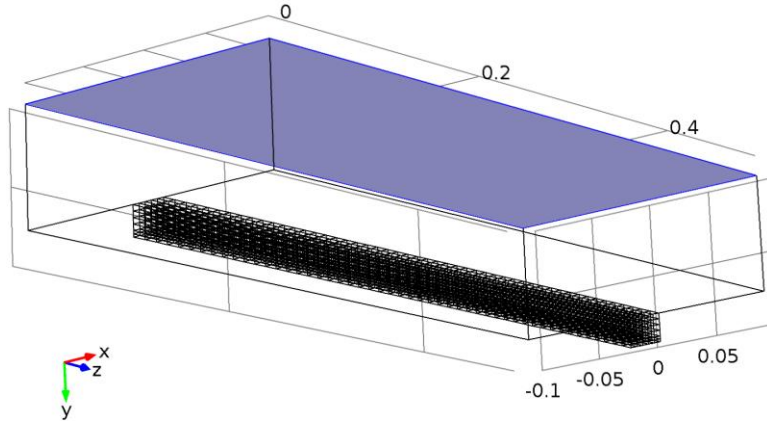
Settings

Description	Value
Apply reaction terms on	All physics (symmetric)
Use weak constraints	0

Constraints

Constraint	Constraint force	Shape function	Selection
-solid.nX*u-solid.nY*v-solid.nZ*w	test(-solid.nX*u-solid.nY*v-solid.nZ*w)	Lagrange (Quadratic)	Boundaries 3, 8, 159, 310, 461, 612, 763, 964, 1115, 1266, 1417, 1568, 1719, 1920, 2071, 2222, 2373, 2524, 2675, 2876, 3027, 3178, 3329, 3480, 3631, 3832, 3983, 4134, 4285, 4436, 4587

2.4.6 Spring Foundation 1



Spring Foundation 1

Selection

Geometric entity level	Boundary
Selection	Boundary 2

Equations

$$\sigma \cdot \mathbf{n} = -\mathbf{k}_A(\mathbf{u} - \mathbf{u}_0) - \mathbf{d}_A\left(\frac{\partial \mathbf{u}}{\partial t} - \frac{\partial \mathbf{u}_0}{\partial t}\right)$$

Settings

Settings

Description	Value
Spring type	Spring constant per unit area
Spring constant per unit area, x component	0
Spring constant per unit area, y component	4747680000
Spring constant per unit area, z component	0
Loss factor for spring, x component	0
Loss factor for spring, y component	0
Loss factor for spring, z component	0
Damping type	Viscous force per unit area
Viscous force per unit area, x component	0
Viscous force per unit area, y component	0

Description	Value
Viscous force per unit area, z component	0

Variables

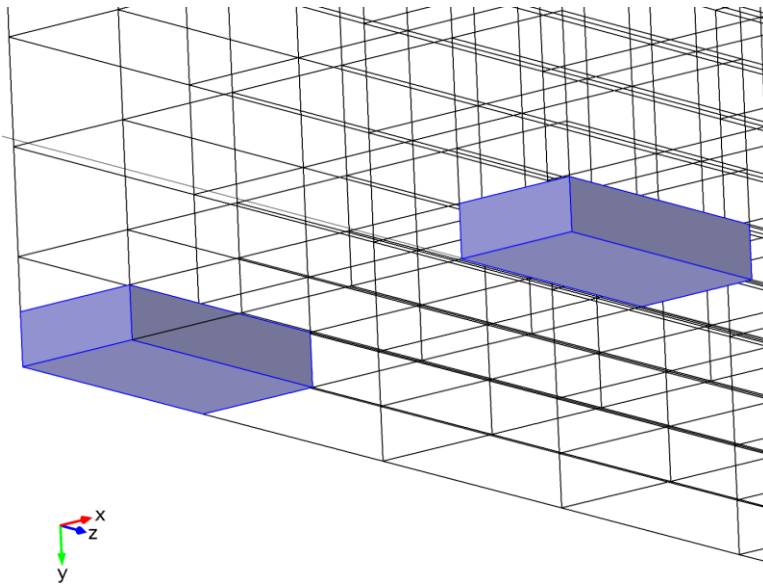
Name	Expression	Unit	Description	Selection
solid.spf1.usx	u	m	Displacement, spatial coordinate system, x component	Boundary 2
solid.spf1.usy	v	m	Displacement, spatial coordinate system, y component	Boundary 2
solid.spf1.usz	w	m	Displacement, spatial coordinate system, z component	Boundary 2
solid.spf1.fsx	- solid.spf1.kPerAreax*solid.uspring1_spf1	N/m ²	Spring force, x component	Boundary 2
solid.spf1.fsy	- solid.spf1.kPerAreay*solid.uspring2_spf1	N/m ²	Spring force, y component	Boundary 2
solid.spf1.fsz	- solid.spf1.kPerAreaz*solid.uspring3_spf1	N/m ²	Spring force, z component	Boundary 2
solid.spf1.kPerAreax	0	N/(m*m ²)	Spring constant per unit area, x component	Boundary 2
solid.spf1.kPerAreay	4.74768E9	N/(m*m ²)	Spring constant per unit area, y component	Boundary 2
solid.spf1.kPerAreaz	0	N/(m*m ²)	Spring constant per unit area, z component	Boundary 2
solid.spf1.DampPerAreax	0	N*s/(m*m ²)	Viscous force per unit area, x component	Boundary 2
solid.spf1.DampPerAreay	0	N*s/(m*m ²)	Viscous force	Boundary 2

Name	Expression	Unit	Description	Selection
ay			per unit area, y component	
solid.spf1.DampPerArea_z	0	N*s/(m*m^2)	Viscous force per unit area, z component	Boundary 2
solid.uspring01_spf1	0	m	Local spring pre-deformation, x component	Boundary 2
solid.uspring02_spf1	0	m	Local spring pre-deformation, y component	Boundary 2
solid.uspring03_spf1	0	m	Local spring pre-deformation, z component	Boundary 2
solid.uspring1_spf1	- solid.uspring01_spf1+solid.spf1.usx	m	Local spring extension, x component	Boundary 2
solid.uspring2_spf1	- solid.uspring02_spf1+solid.spf1.usy	m	Local spring extension, y component	Boundary 2
solid.uspring3_spf1	- solid.uspring03_spf1+solid.spf1.usz	m	Local spring extension, z component	Boundary 2
solid.Ws_tot	solid.spf1.intArea(-0.5*(solid.spf1.fsx*solid.uspring1_spf1+solid.spf1.fsy*solid.uspring2_spf1+solid.spf1.fsz*solid.uspring3_spf1))	J	Total elastic strain energy	Global

Weak expressions

Weak expression	Integration frame	Selection
solid.spf1.fsx*test(solid.spf1.usx)+solid.spf1.fsy*test(solid.spf1.usy)+solid.spf1.fsz*test(solid.spf1.usz)	Material	Boundary 2

2.4.7 Body Load 1



Body Load 1

Selection

Geometric entity level	Domain
Selection	Domains 252, 1452

Equations

$$\rho \frac{\partial^2 \mathbf{u}}{\partial t^2} - \nabla \cdot \boldsymbol{\sigma} = \mathbf{F}_V$$

$$\mathbf{F}_V = \frac{\mathbf{F}_{\text{tot}}}{V}$$

Settings

Settings

Description	Value
Load type	Total force
Total force, x component	a1(t)*b111
Total force, y component	a1(t)*n111
Total force, z component	a1(t)*m111

Used products

COMSOL Multiphysics

Variables

Name	Expression	Unit	Description	Selection
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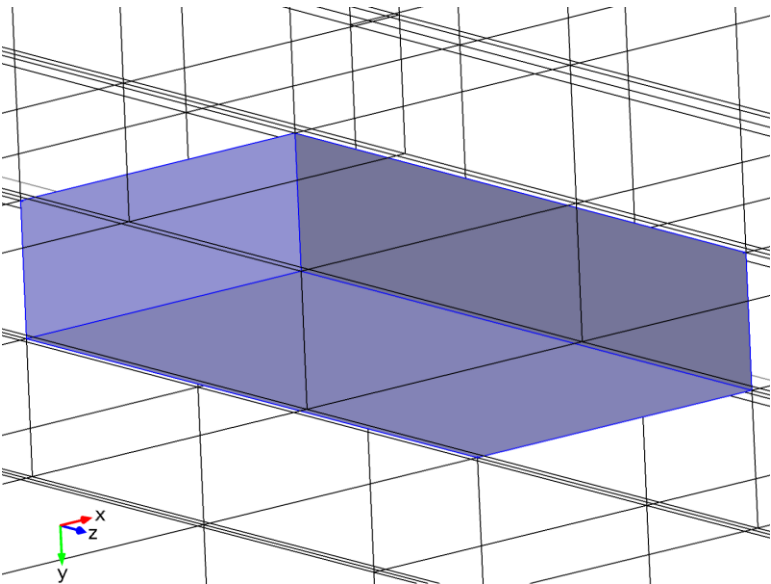
Name	Expression	Unit	Description	Selection
solid.bl1.Ftotx	$a1(t)*b111$	N	Total force, x component	Domains 252, 1452
solid.bl1.Ftoty	$a1(t)*n111$	N	Total force, y component	Domains 252, 1452
solid.bl1.Ftotz	$a1(t)*m111$	N	Total force, z component	Domains 252, 1452
solid.bl1.ux	u	m	Displacement, x component	Domains 252, 1452
solid.bl1.uy	v	m	Displacement, y component	Domains 252, 1452
solid.bl1.uz	w	m	Displacement, z component	Domains 252, 1452
solid.bl1.FTx	solid.bl1.Ftotx	N	Total force, x component	Domains 252, 1452
solid.bl1.FTy	solid.bl1.Ftoty	N	Total force, y component	Domains 252, 1452
solid.bl1.FTz	solid.bl1.Ftotz	N	Total force, z component	Domains 252, 1452
solid.bl1.selV	solid.bl1.intop1(1)	m ³	Selection volume	Domains 252, 1452
solid.FperVolx	solid.bl1.FTx/solid.bl1.selV	N/m ³	Body load, x component	Domains 252, 1452
solid.FperVoly	solid.bl1.FTy/solid.bl1.selV	N/m ³	Body load, y component	Domains 252, 1452
solid.FperVolz	solid.bl1.FTz/solid.bl1.selV	N/m ³	Body load, z component	Domains 252, 1452

Weak expressions

Weak expression	Integration frame	Selection
$(\text{solid.bl1.FTx}*\text{test}(\text{solid.bl1.ux})+\text{solid.bl1.FTy}*\text{test}(\text{solid.bl1.uy})+\text{solid.bl1.FTz}*\text{test}(\text{solid.bl1.uz}))/\text{solid.bl1.selV}$	Material	Domains 252, 1452

2.4.8 Other 448 Loads are the same principle

2.4.9 Body Load 450



Body Load 450

Selection

Geometric entity level	Domain
Selection	Domain 835

Equations

$$\rho \frac{\partial^2 \mathbf{u}}{\partial t^2} - \nabla \cdot \boldsymbol{\sigma} = \mathbf{F}_V$$
$$\mathbf{F}_V = \frac{\mathbf{F}_{tot}}{V}$$

Settings

Settings

Description	Value
Load type	Total force
Total force, x component	a17(t)*b3234
Total force, y component	a17(t)*n3233
Total force, z component	a17(t)*m3233

Used products

COMSOL Multiphysics

Variables

Name	Expression	Unit	Description	Selection
solid.FperVolx	solid.bl450.FTx/solid.bl450.selV	N/m ³	Body load, x component	Domain 835
solid.FperVoly	solid.bl450.FTy/solid.bl450.selV	N/m ³	Body load, y component	Domain 835
solid.FperVolz	solid.bl450.FTz/solid.bl450.selV	N/m ³	Body load, z component	Domain 835
solid.bl450.Ftotx	a17(t)*b3234	N	Total force, x component	Domain 835
solid.bl450.Ftoty	a17(t)*n3233	N	Total force, y component	Domain 835
solid.bl450.Ftotz	a17(t)*m3233	N	Total force, z component	Domain 835
solid.bl450.ux	u	m	Displacement, x component	Domain 835
solid.bl450.uy	v	m	Displacement, y component	Domain 835
solid.bl450.uz	w	m	Displacement, z component	Domain 835
solid.bl450.FTx	solid.bl450.Ftotx	N	Total force, x component	Domain 835
solid.bl450.FTy	solid.bl450.Ftoty	N	Total force, y component	Domain 835
solid.bl450.FTz	solid.bl450.Ftotz	N	Total force, z component	Domain 835
solid.bl450.selV	solid.bl450.intop1(1)	m ³	Selection volume	Domain 835

Weak expressions

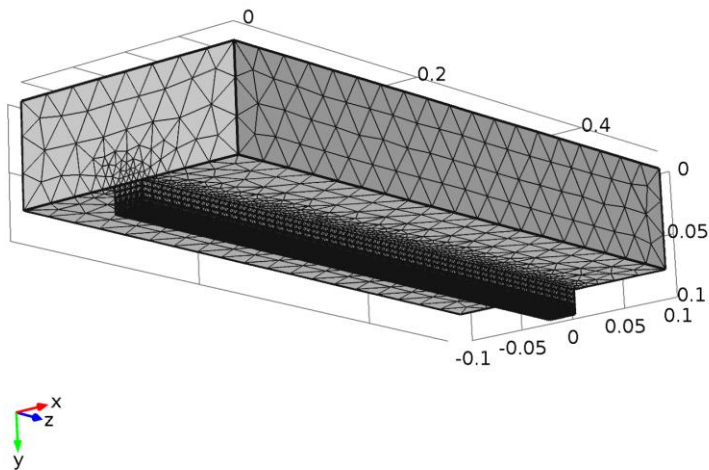
Weak expression	Integration frame	Selection
(solid.bl450.FTx*test(solid.bl450.ux)+solid.bl450.FTy*test(solid.bl450.uy)+solid.bl450.FTz*test(solid.bl450.uz))/solid.bl450.selV	Material	Domain 835

2.5 Mesh 1

Mesh statistics

Property	Value
Minimum element quality	0.04258

Property	Value
Average element quality	0.6109
Tetrahedral elements	141728
Triangular elements	60571
Edge elements	12491
Vertex elements	2150



Mesh 1

2.5.1 Size (size)

Settings

Name	Value
Maximum element size	0.0275
Minimum element size	0.0020
Resolution of curvature	0.4
Resolution of narrow regions	0.7
Maximum element growth rate	1.4
Predefined size	Finer

2.5.2 Free Tetrahedral 1 (ftet1)

Selection

Geometric entity level	Remaining
------------------------	-----------

3 Study 2

3.1 Time Dependent

Study settings

Property	Value
Include geometric nonlinearity	Off

Times: range(0,0.00002,0.0014)

Mesh selection

Geometry	Mesh
Geometry 1 (geom1)	mesh1

Physics selection

Physics	Discretization
Solid Mechanics (solid)	physics

3.2 Solver Configurations

3.2.1 Solver 1

Compile Equations: Time Dependent (st1)

Study and step

Name	Value
Use study	Study 2
Use study step	Time Dependent

Dependent Variables 1 (v1)

General

Name	Value
Defined by study step	Time Dependent

Initial values of variables solved for

Name	Value
Solution	Zero

Values of variables not solved for

Name	Value
Solution	Zero

Displacement field (Material) (mod1.u) (mod1_u)

General

Name	Value
Field components	{mod1.u, mod1.v, mod1.w}

Scaling

Name	Value
Method	Manual
Scale	1e-2*0.5477225575051661

Time-Dependent Solver 1 (t1)

General

Name	Value
Defined by study step	Time Dependent
Time	{0, 2.0E-5, 4.0E-5, 6.000000000000001E-5, 8.0E-5, 1.0E-4, 1.2000000000000002E-4, 1.4000000000000001E-4, 1.6E-4, 1.8E-4, 2.0E-4, 2.2E-4, 2.4000000000000003E-4, 2.6000000000000003E-4, 2.8000000000000003E-4, 3.0000000000000003E-4, 3.2E-4, 3.4E-4, 3.6E-4, 3.8E-4, 4.0E-4, 4.2E-4, 4.4E-4, 4.6E-4, 4.8000000000000007E-4, 5.0E-4, 5.2000000000000001E-4, 5.4E-4, 5.6000000000000001E-4, 5.8E-4, 6.0000000000000001E-4, 6.2E-4, 6.4E-4, 6.6000000000000001E-4, 6.8E-4, 7.0000000000000001E-4, 7.2E-4, 7.4000000000000001E-4, 7.6E-4, 7.8000000000000001E-4, 8.0E-4, 8.2000000000000001E-4, 8.4E-4, 8.6000000000000001E-4, 8.8E-4, 9.0000000000000001E-4, 9.2E-4, 9.4000000000000001E-4, 9.6000000000000001E-4, 9.8000000000000002E-4, 0.0010, 0.00102, 0.0010400000000000001, 0.0010600000000000002, 0.00108, 0.0011, 0.0011200000000000001, 0.0011400000000000002, 0.00116, 0.00118, 0.0012000000000000001, 0.0012200000000000002, 0.00124, 0.00126, 0.00128, 0.0013000000000000002, 0.0013200000000000002, 0.00134, 0.00136, 0.0013800000000000002, 0.0014000000000000002}

Time stepping

Name	Value
Method	Generalized alpha

Log

Time-Dependent Solver 1 in Solver 1 started at 18-Feb-2018 15:25:55.

Time-dependent solver (Generalized-alpha)

Number of degrees of freedom solved for: 610806.

Symmetric matrices found.

Scales for dependent variables:

Displacement field (Material) (mod1.u): 0.0055

Step	Time	Stepsize	Res	Jac	Sol	Order	Tfail	NLfail
0	0	out	2	3	2			0
1	1.4e-006	1.4e-006	3	4	3	2	0	0
2	4.2e-006	2.8e-006	4	5	4	2	0	0
3	9.8e-006	5.6e-006	5	6	5	2	0	0
	2e-005	- out						
4	2.1e-005	1.12e-005	7	7	7	2	0	0
	4e-005	- out						
5	4.34e-005	2.24e-005	9	8	9	2	0	0
	6e-005	- out						
	8e-005	- out						
6	8.82e-005	4.48e-005	11	9	11	2	0	0
	0.0001	- out						
	0.00012	- out						
7	0.000133	4.48e-005	12	9	12	2	0	0
	0.00014	- out						
	0.00016	- out						
8	0.0001778	4.48e-005	13	9	13	2	0	0
	0.00018	- out						
	0.0002	- out						
	0.00022	- out						
9	0.0002226	4.48e-005	14	9	14	2	0	0
	0.00024	- out						
	0.00026	- out						
	0.00028	- out						
	0.0003	- out						
10	0.0003122	8.96e-005	16	10	16	2	0	0
	0.00032	- out						
	0.00034	- out						
	0.00036	- out						
	0.00038	- out						
11	0.00039284	8.064e-005	18	10	18	2	0	0
	0.0004	- out						
	0.00042	- out						
	0.00044	- out						
	0.00046	- out						
12	0.00046542	7.2576e-005	21	10	21	2	0	0
	0.00048	- out						
	0.0005	- out						
	0.00052	- out						
13	0.00053799	7.2576e-005	23	10	23	2	0	0
	0.00054	- out						
	0.00056	- out						
	0.00058	- out						
	0.0006	- out						
14	0.00061057	7.2576e-005	25	10	25	2	0	0
	0.00062	- out						
	0.00064	- out						
	0.00066	- out						
	0.00068	- out						

15	0.00068314	7.2576e-005		28	10	28	2	0	0
	0.0007	- out							
	0.00072	- out							
	0.00074	- out							
16	0.00075572	7.2576e-005		31	10	31	2	0	0
	0.00076	- out							
	0.00078	- out							
	0.0008	- out							
	0.00082	- out							
17	0.0008283	7.2576e-005		35	10	35	2	0	0
	0.00084	- out							
	0.00086	- out							
	0.00088	- out							
	0.0009	- out							
18	0.00090087	7.2576e-005		39	10	39	2	0	0
	0.00092	- out							
	0.00094	- out							
	0.00096	- out							
19	0.00097345	7.2576e-005		42	10	42	2	0	0
	0.00098	- out							
	0.001	- out							
	0.00102	- out							
	0.00104	- out							
20	0.001046	7.2576e-005		45	10	45	2	0	0
	0.00106	- out							
	0.00108	- out							
	0.0011	- out							
21	0.0011186	7.2576e-005		48	10	48	2	0	0
	0.00112	- out							
	0.00114	- out							
	0.00116	- out							
	0.00118	- out							
22	0.0011839	6.5318e-005		54	11	54	2	0	0
	0.0012	- out							
	0.00122	- out							
23	0.001234	5.0069e-005		61	12	61	2	1	0
	0.00124	- out							
	0.00126	- out							
24	0.001279	4.5062e-005		63	12	63	2	1	0
	0.00128	- out							
	0.0013	- out							
	0.00132	- out							
25	0.0013241	4.5062e-005		65	12	65	2	1	0
	0.00134	- out							
	0.00136	- out							
26	0.0013692	4.5062e-005		67	12	67	2	1	0
	0.00138	- out							
	0.0014	- out							
27	0.0014142	4.5062e-005		69	12	69	2	1	0

Time-Dependent Solver 1 in Solver 1: Solution time: 1191 s (19 minutes, 51 seconds)
Physical memory: 8.15 GB
Virtual memory: 9.05 GB

Fully Coupled 1 (fc1)

General

Name	Value
Linear solver	Direct

4 Results

4.1 Data Sets

4.1.1 Solution 1

Selection

Geometric entity level	Domain
Selection	Geometry geom1

Solution

Name	Value
Solution	Solver 1
Model	Save Point Geometry 1

4.1.2 Function 1D 1

Function

Name	Value
Function	Interpolation 25

Parameter bounds

Name	Value
Name	t
Maximum	0.01

4.1.3 Function 1D 2

Function

Name	Value
Function	Interpolation 25

Parameter bounds

Name	Value
Name	t
Minimum	-0.0010
Maximum	0

4.1.4 Function 1D 3

Function

Name	Value
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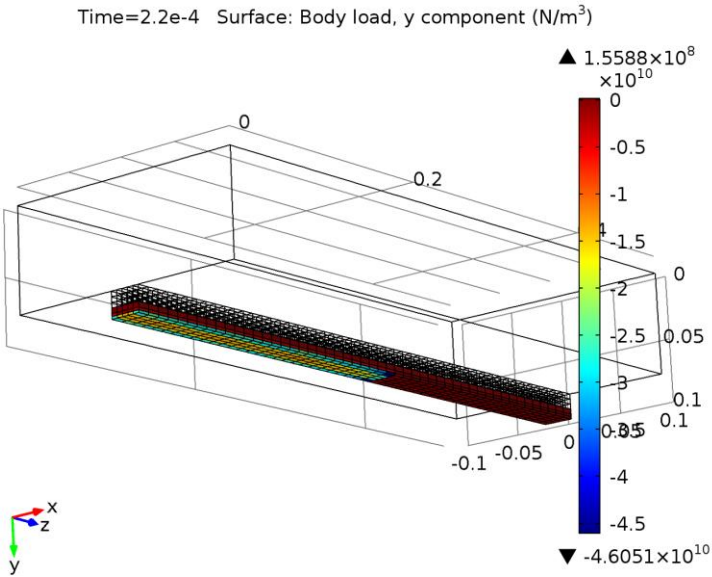
Name	Value
Function	Interpolation 25

Parameter bounds

Name	Value
Name	t
Minimum	0.01
Maximum	0.011

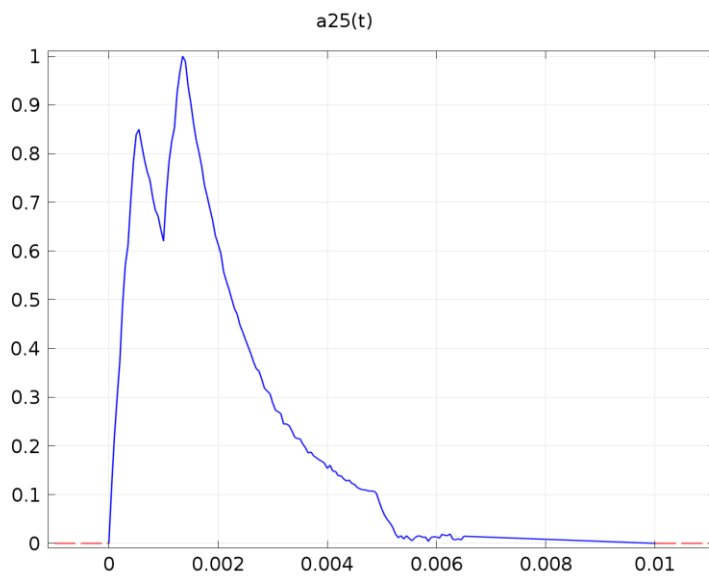
4.2 Plot Groups

4.2.1 Stress (solid)



Time=2.2e-4 Surface: Body load, y component (N/m³)

4.2.2 1D Plot Group 2



$a_{25}(t)$