

Supplemental Materials

Section A: Finite element model, element type and number

Table A1: Number and type of element for each neck tissue

Tissue	Solids	Shells	Beams
Cancellous Bone	44,342		
Cortical Bone		22,636	
Facet Cartilage	3,364		
Annulus Fibrosus Ground Substance	6,576		
Annulus Fibrosus Fibres		16,440	
Nucleus Pulposus	7,112		
Adipose Tissue	9,744		
Skin		3,248	
Ligaments		18	895
Passive Muscle	135,726		
Active Muscle			975
Support Elements			2,591
Total	206,864	42,072	4,461

Table A2: Neck muscle physiological cross-sectional area (Hill-type active elements) and muscle volume (passive muscle, hexahedral element mesh)

Muscle Groups	Hill-type Element PCSA (cm ²)	Solid Element Volume (cm ³)
Oblique Capitus Inferior	1.95	8.26
Oblique Capitus Superior	0.88	6.97
Rectus Capitis Major	1.68	10.95
Rectus Capitis Minor	0.92	3.42
Longus Capitis	1.37	10.29
Longus Colli	2.75	15.71
Rectus Capitis Anterior	0.8	1.10
Rectus Capitis Lateral	0.9	1.29
Anterior Scalene	1.88	14.92
Middle Scalene	1.6	13.35
Posterior Scalene	1.05	11.95
Sternocleidomastoid	4.92	89.79
Iliocostalis	1.04	12.12
Longus Capitis	0.98	17.59
Longus Cervicis	1.48	11.99
Multifidus	2.8	15.33
Semisplenius Capitus	5.52	87.86
Semisplenius Cervicis	3.06	26.91
Splenius Capitus	3.09	59.98
Splenius Cervicis	1.43	37.00
Levator Scapula	3.12	56.94
Minor Rhomboid	1.02	17.95
Trapezius	13.73	307.63
Omohyoid	0.75	No Solid Element Part
Sternohyoid	1.23	No Solid Element Part

Section B: Impact Scenario

Table B1: List of NHTSA database test references for the frontal impact group, organized by maximum sled acceleration

Test #	2g	3g	6g	8g	10g	12g	13g	14g	15g
1	1536	1522	1526	1587	1530	1607	1533	1534	1535
2	1537	1523	1527	1588	1598	1608	1618	1625	1635
3	1538	1545	1573	1590	1599	1609	1619	1627	1636
4	1539	1546	1574	1592	1600	1610	1620	1628	1637
5	1540	1547	1575	1593	1601	1611	1621	1629	1638
6	1541	1548	1576	1594	1602	1613	1622	1631	1639
7	1542	1549	1577	1595	1603	1614	1623	1632	1641
8	1543	1551	1578	1596	1604	1615	1624	1633	1644
9	1544	1552	1579	1597	1605	1616	1626	1634	
10	1550	1553	1580	1649	1606	1617	1630	1642	
11		1554	1581		1612				
12		1555	1582		1640				
13		1556	1583		1643				
14		1569	1584		1645				
15		1570	1585		1646				
16		1571	1586		1647				
17		1572	1589		1648				
18			1591		1650				
19					1651				

Table B2: List of NHTSA database test references for the lateral impact groups, organized by maximum sled acceleration

Test #	4g	5g	6g	7g
1	1460	1446	1448	1451
2	1462	1458	1449	1452
3	1663	1463	1450	1453
4	1664	1464	1465	1454
5	1666	1476	1466	1474
6	1667	1479	1477	1475
7	1669	1517	1688	1478
8	1670	1676	1689	1699
9	1671	1677	1690	1700
10	1672	1678	1691	1701
11	1673	1679	1692	1702
12	1674	1680	1693	1703
13	1675	1682	1694	1704
14	1723	1683	1695	1705
15		1684	1696	1706
16		1685	1697	1707
17		1686	1698	1708
18		1687	1710	1709
19			1711	1722
20			1712	
21			1713	
22			1714	
23			1715	
24			1716	
25			1717	
26			1718	
27			1719	
28			1720	
29			1721	

Table B3: 7g rear impact simulation corridor and cross-correlation ratings

Head Kinematic	Corridor	Cross-correlation		
		Shape	Size	Phase
X-Accel	0.838	0.550	0.898	0.000
Z-Accel	0.649	0.645	0.450	1.000
Yrot-Accel	0.979	0.994	0.668	1.000
Mean	0.822	0.730	0.672	0.667

Table B4: Frontal impact corridor and cross-correlation ratings using average T1 kinematics

Group	Corridor	Cross-correlation		
		Shape	Size	Phase
2g	0.333	0.661	0.736	0.000
3g	0.301	0.711	0.702	0.038
6g	0.419	0.915	0.827	0.379
8g	0.478	0.918	0.632	0.462
10g	0.510	0.946	0.704	0.765
12g	0.472	0.948	0.788	0.795
13g	0.554	0.962	0.765	0.871
14g	0.531	0.957	0.727	0.894
15g	0.498	0.954	0.704	0.886
Mean	0.455	0.886	0.732	0.566

Table B5: Frontal impact cross-correlation ratings using test-specific using T1 kinematics

Group	Cross-correlation		
	Shape	Size	Phase
2g	0.698	0.640	0.124
3g	0.664	0.601	0.134
6g	0.864	0.621	0.379
8g	0.895	0.692	0.434
10g	0.926	0.727	0.678
12g	0.932	0.751	0.708
13g	0.943	0.763	0.756
14g	0.935	0.732	0.768
15g	0.931	0.696	0.762
Mean	0.865	0.691	0.527

Table B6: Lateral impact corridor and cross-correlation ratings using average T1 kinematics

Group	Corridor	Cross-correlation		
		Shape	Size	Phase
4g	0.521	0.832	0.428	0.139
5g	0.649	0.848	0.579	0.231
6g	0.683	0.858	0.555	0.333
7g	0.656	0.885	0.611	0.412
Mean	0.627	0.856	0.543	0.279

Table B7: Lateral impact cross-correlation ratings using test-specific using T1 kinematics

Group	Cross-correlation		
	Shape	Size	Phase
4g	0.820	0.517	0.244
5g	0.829	0.607	0.313
6g	0.826	0.504	0.579
7g	0.838	0.606	0.411
Mean	0.828	0.558	0.387

Section C: NBDL Frontal and Lateral Impact – Head Kinematic Response

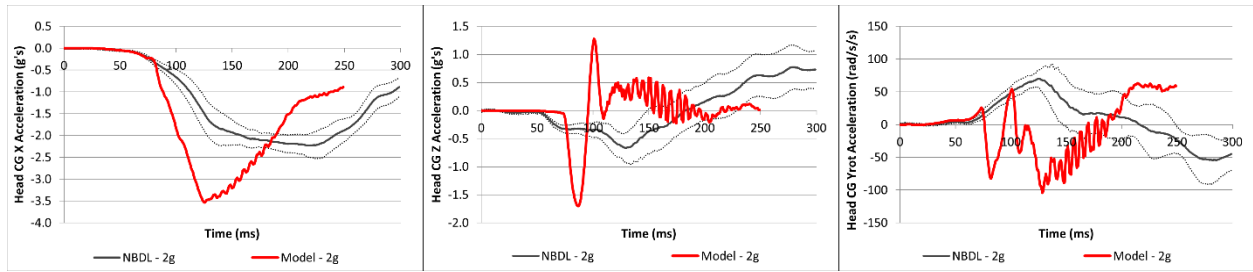


Figure C1: Model head response – 2g frontal impact

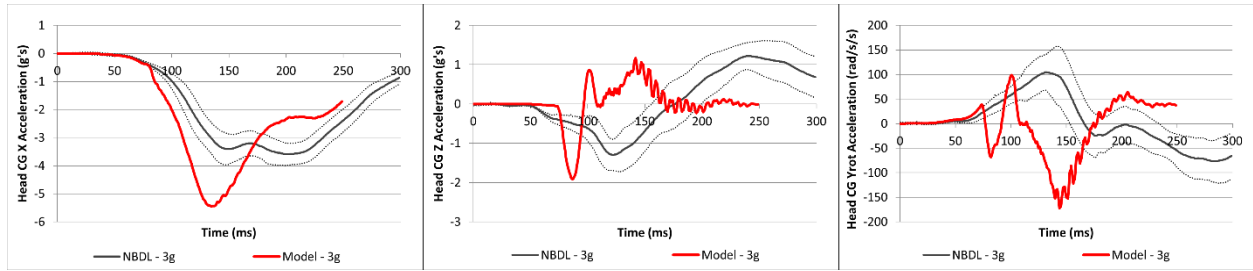


Figure C2: Model head response – 3g frontal impact

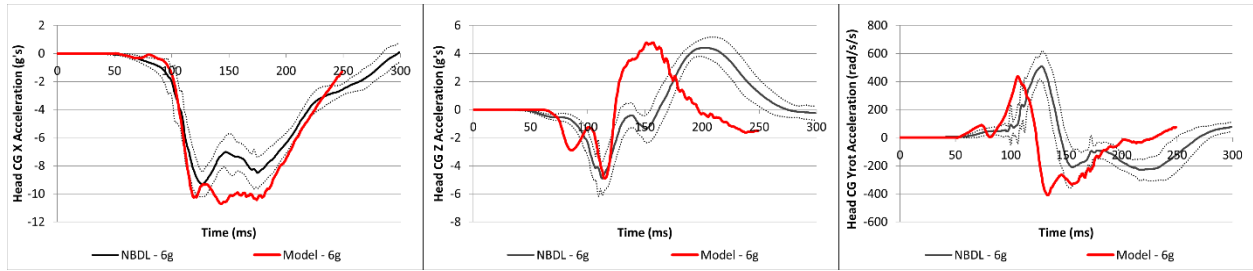


Figure C3: Model head response – 6g frontal impact

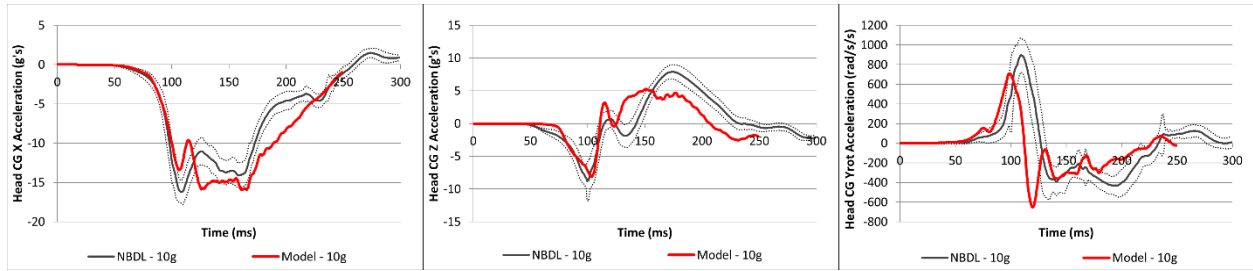


Figure C4: Model head response – 10g frontal impact

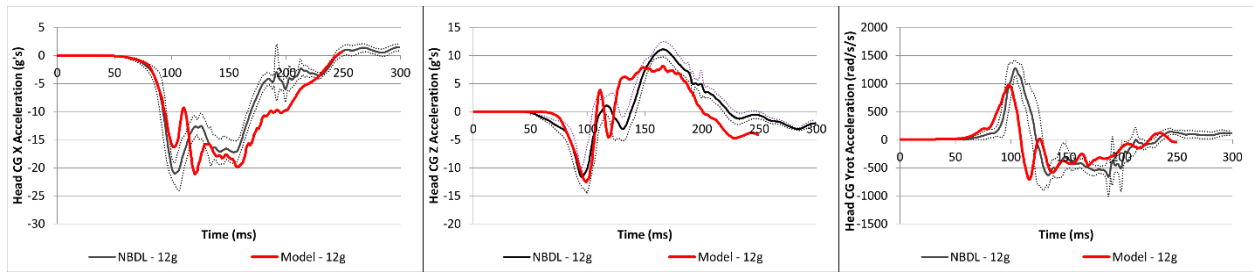


Figure C5: Model head response – 12g frontal impact

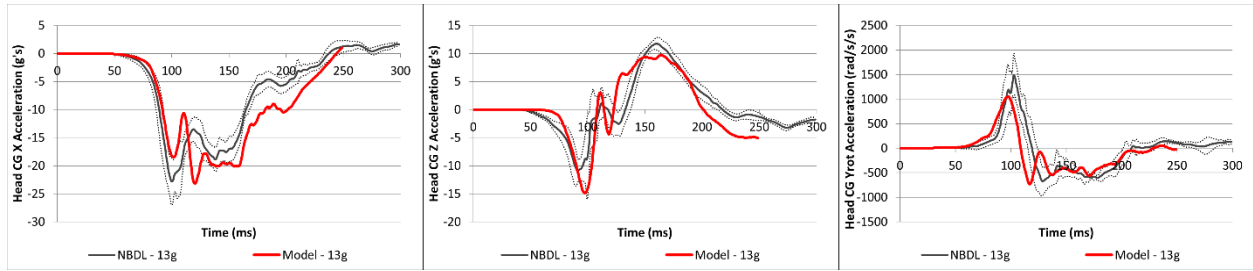


Figure C6: Model head response – 13g frontal impact

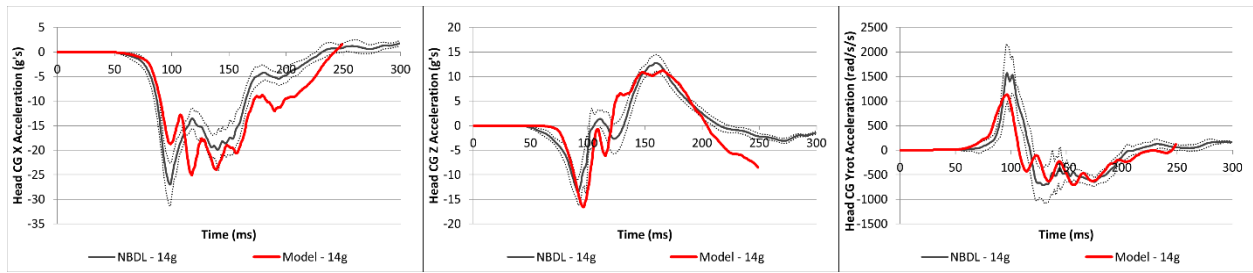


Figure C7: Model head response – 14g frontal impact

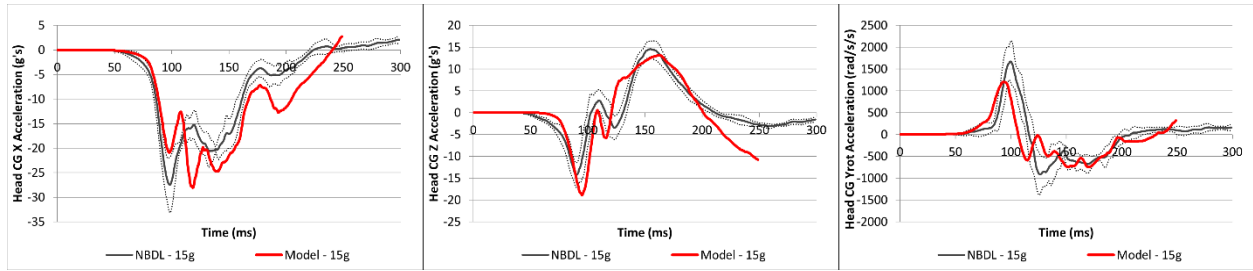


Figure C8: Model head response – 15g frontal impact

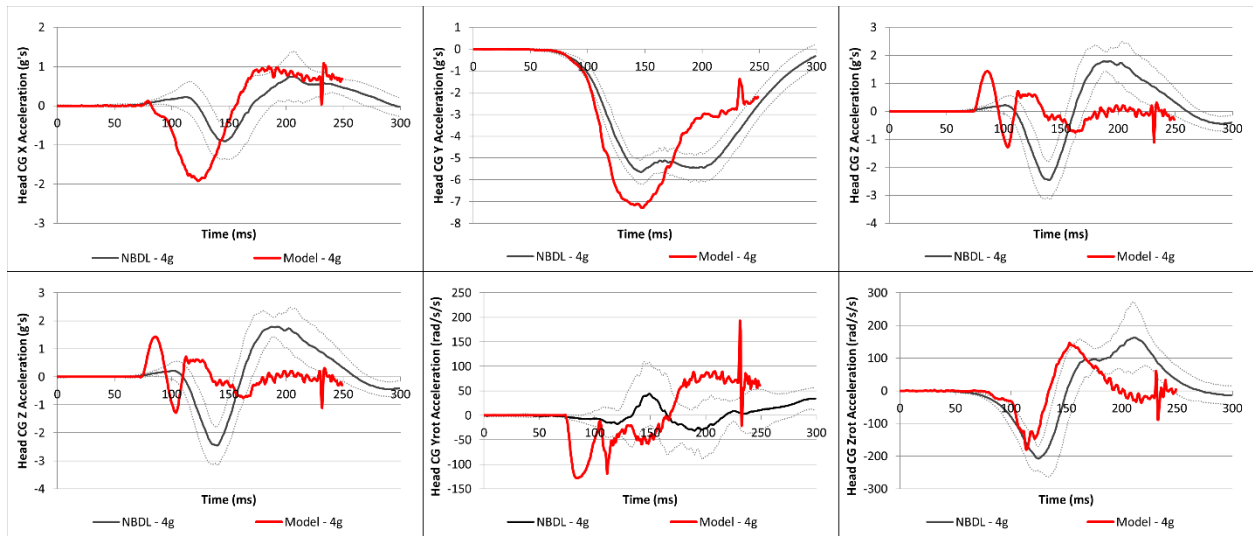


Figure C9: Model head response – 4g lateral impact

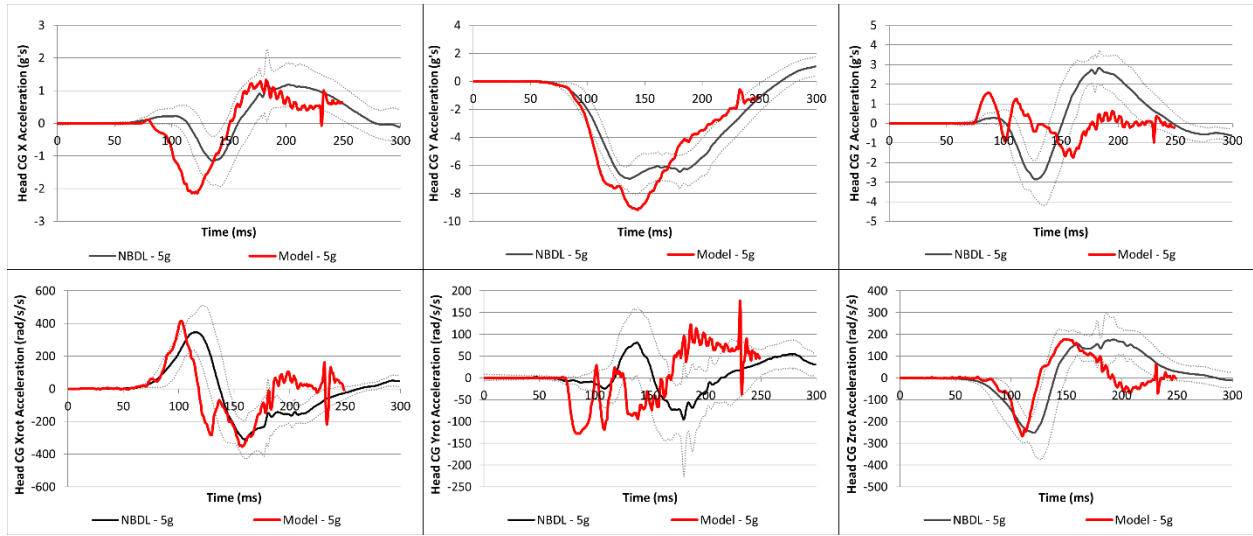


Figure C10: Model head response – 5g lateral impact

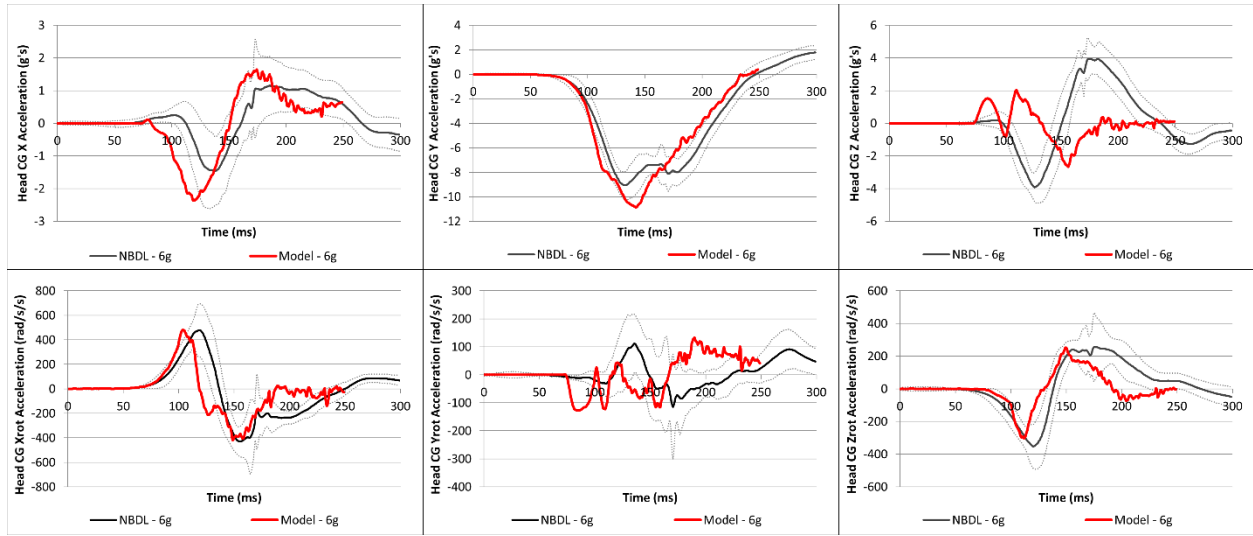


Figure C7: Model head response – 6g lateral impact