

ISO 13232-3:2005-12 (E)

Motorcycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles - Part 3: Motorcyclist anthropometric impact dummy

Contents		Page
Foreword		viii
Introduction		ix
1	Scope	1
2	Normative references	1
3	Definitions	2
4	Mechanical requirements for the motorcyclist anthropometric impact dummy	2
4.1	Basis dummy	2
4.2	Motorcyclist dummy head and head skins	3
4.3	Motorcyclist dummy neck components	3
4.4	Motorcyclist dummy upper torso components	4
4.5	Motorcyclist dummy lower torso components	4
4.6	Arms and modified elbow bushing	5
4.7	Motorcyclist dummy hands	5
4.8	Motorcyclist dummy upper leg components	5
4.9	Motorcyclist dummy frangible knee assembly	6
4.10	Leg retaining cables	7
4.11	Motorcyclist dummy lower leg components	7
4.12	Complete motorcyclist dummy	7
4.13	Certification documentation	7
5	Sampling of frangible components	8
5.1	Initial conformity of production	8
5.2	Subsequent conformity of production	8
5.3	Condition of sampled frangible components	8
6	Test methods	8
6.1	Frangible bone static bending deflection test	8
6.2	Frangible bone static torsional deflection test	9
6.3	Frangible bone dynamic bending fracture test	9
6.4	Frangible bone dynamic torsional fracture test	9
6.5	Frangible femur bone static axial load fracture test	10
6.6	Frangible knee static strength and deflection test	10
6.7	Frangible abdomen test	10
6.8	Motorcyclist neck dynamic test for initial conformity of production	10
6.9	Motorcyclist neck static tests for subsequent conformity of production	20
7	Marking and documentation of frangible components	20
7.1	Marking	20
7.2	Documentation	20
Annex A (normative) Drawings for motorcyclist anthropometric impact dummy special components		21
Annex C (normative) Motorcyclist neck subsequent conformity of production test procedures		81

Figures Figure 1 -- Extension moment vs. head angle	12
Figure 2 -- Neck flexion bending moment vs. head angle	15
Figure 3 -- Neck flexion occipital condyle and head centre of gravity position	15
Figure 4 -- Flexion neck angle vs. head angle	16
Figure 5 -- Lateral head angle vs. time	18
Figure 6 -- Lateral head centre of gravity position	18
Figure 7 -- Neck torsion stiffness	19
Figure A.1 -- Motorcyclist head skins and extensions	22
Figure A.2 -- Neck shroud specifications	23
Figure A.3 -- Hybrid III modified lower neck mount	24
Figure A.4 -- Motorcyclist neck and interface requirements	25
Figure A.5 -- Lower lumbar spine transducer mount and ballast block for the six-axis load cell	26
Figure A.6 -- Lower lumbar spine transducer mount and ballast block for the three-axis load cell	27
Figure A.7 -- Lumbar spine abdomen reaction plate for the six-axis load cell	28
Figure A.8 -- Lumbar spine abdomen reaction plate for the three-axis load cell	29
Figure A.9 -- Replacement frangible solid abdominal insert	30
Figure A.10 -- Elbow joint scribe marks for 10° arm pivot	31
Figure A.11 -- Frangible femur bone to knee adaptor	32
Figure A.12 -- Frangible femur bone interface and size requirements	33
Figure A.13 -- Upper femur load cell simulator	34
Figure A.14 -- Frangible knee and knee clevis assembly	35
Figure A.15 -- Frangible tibia bone to ankle joint adaptor	36
Figure A.16 -- Frangible tibia interface and size requirements	37
Figure A.17 -- Modified lower skin	38
Figure A.18 -- Frangible leg bone extensions for the bone bending tests	39
Figure A.19 -- Specimen supports for the bone dynamic bending fracture test	40
Figure A.20 -- Impactor head for the bone dynamic bending fracture test	41
Figure A.21 -- Impactor box for the bone dynamic bending fracture test	42
Figure A.22 -- Impactor accelerometer support for the bone dynamic bending fracture tests	43
Figure A.23 -- Impactor end plate and bearing mount for the bone dynamic bending fracture test ...	44
Figure A.24 -- Impactor rail support for the bone dynamic bending fracture test	45

Figure A.25 -- Frangible femur bone static axial load fracture test apparatus	46
Figure A.26 -- Frangible knee test apparatus	47
Figure A.27 -- Frangible abdomen test apparatus	48
Figure A.28 -- Neck torsion test schematic	49
Figure B.1 -- Sample extension acceleration pulse	52
Figure B.2 -- Sample flexion acceleration pulse	53
Figure B.3 -- Sample lateral acceleration pulse	53
Figure B.4 -- Human neck elongation observed in Navy volunteer testing	57
Figure B.5 -- Human response corridor and modified lumbar spine response of static moment vs. thoracic angular displacement	59
Figure B.6 -- Lower leg dynamic impact tests impact force vs. time: Hybrid III and cadaver legs	62
Figure B.7 -- Lower leg dynamic impact tests impact force vs. time: Hybrid III legs and frangible leg, as defined in 4.11.1	63
Figure B.8 -- Instrumented lower leg impact tests mid-tibia moment vs. time for drop height = 1,016 m: Hybrid III leg and frangible leg, as defined in 4.11.1	63
Figure B.9 -- Instrumented lower leg impact tests mid-tibia moment vs. time for drop height = 1,778 m: Hybrid III leg and frangible leg, as defined in 4.11.1	64
Figure B.10 -- Lower leg impact tests mid-tibia bending moment M_y vs. impact velocity: Hybrid III leg and frangible leg, as defined in 4.11.1	64
Figure B.11 -- View of ATB simulated offset frontal impact, medium conventional motorcycle, with and without frangible leg bones, as defined in 4.8.1 and 4.11.1	65
Figure B.12 -- Head trajectory comparison of frangible and non-frangible legs	65
Figure B.13 -- Shoulder trajectory comparison of frangible and non-frangible legs	66
Figure B.14 -- Hip trajectory comparison of frangible and non-frangible legs	66
Figure B.15 -- Knee trajectory comparison of frangible and non-frangible legs	67
Figure B.16 -- Ankle trajectory comparison of frangible and non-frangible legs	67
Figure B.17 -- Pelvis trajectory comparison of frangible and non-frangible bones, full-scale test, offset frontal impact, large conventional motorcycle	67
Figure B.17 -- Pelvis trajectory comparison of frangible and non-frangible bones, full-scale test, offset frontal impact, large conventional motorcycle	68
Figure B.18 -- Sensed upper and lower tibia bending moments vs. time in Hybrid III tibia, for three point impact test sufficient to fracture human tibia	68
Figure B.19 -- Impactor time histories for nine cadaver tibia specimens from Fuller and Snyder, 1989	69
Figure B.20 -- Comparison of composite tibia fracture force response with envelopes of cadaver tibia fracture force response	69

Figure B.21 -- Lower leg dynamic impact tests impact force vs. time: frangible and cadaver legs	70
Figure C.1 -- Neck load cell simulator	85
Figure C.2 -- Neck calibration test fixture	86
Figure C.3 -- Neck calibration torque extension arm	87
Figure C.4 -- Neck calibration assembly	88
Tables Table 1 -- Neck subsequent conformity of production specifications	4
Table 2 -- Specified values for certification of replacement abdominal insert	5
Table 3 -- Specified values for certification of frangible femur components	6
Table 4 -- Specified values for certification of frangible knee assembly components	6
Table 5 -- Specified values for certification of frangible tibia components	7
Table 6 -- Frangible component subsequent conformity of production characteristics	8
Table 7 -- Frangible bone static bending deflection test specifications	9
Table 8 -- Neck extension sled pulse criteria	11
Table 9 -- Neck extension bending corridor	11
Table 10 -- Neck flexion sled pulse criteria	12
Table 11 -- Neck flexion bending corridor	13
Table 12 -- Neck flexion head centre of gravity corridor	13
Table 13 -- Neck flexion occipital condyle corridor	14
Table 14 -- Neck flexion change in neck angle vs. change in head angle corridor	14
Table 15 -- Lateral sled pulse criteria	16
Table 16 -- Lateral head angle vs. time corridor	17
Table 17 -- Lateral head centre of gravity corridor	17
Table 18 -- Neck torsion stiffness corridor	19
Table B.1 -- Neck biofidelity criteria	52
Table B.2 -- Subsequent conformity of production test results	54
Table B.3 -- Neck FST loads comparison	55
Table B.4 -- Neck moments produced by pendulum drop tests	55
Table B.5 -- History of subsequent conformity of production test results	56
Table B.6 -- Sampled static bending stiffness of composite femurs	72
Table B.7 -- Sampled static torsional stiffness of composite femurs	73
Table B.8 -- Sampled dynamic bending strength of composite femurs	73

Table B.9 -- Sampled dynamic torsional strength of composite femurs	74
Table B.10 -- Sampled static bending stiffness of composite tibias	74
Table B.11 -- Sampled static torsional stiffness of composite tibias	75
Table B.12 -- Sampled dynamic bending strength of composite tibias	75
Table B.13 -- Sampled dynamic torsional strength of composite tibias	76
Table B.14 -- Sampled deflection of abdominal inserts	76
Table B.15 -- Sampled static torsion strength and deflection of knees	77
Table B.16 -- Sampled static valgus strength and deflection of knees	77
Table B.17 -- Sampled static axial strength of composite femurs	78
Table C.1 -- Procedures for flexion bending and head forward displacement static tests	81
Table C.2 -- Procedure for extension-bending static test	82
Table C.3 -- Procedures for lateral-bending static test	83
Table C.4 -- Procedures for torsion static test	84