

Second edition
2005-12-15

AMENDMENT 1
2012-07-15

**Motorcycles — Test and analysis
procedures for research evaluation of
rider crash protective devices fitted to
motorcycles —**

Part 5:

Injury indices and risk/benefit analysis

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Amendment 1: Ground impact and injury costs

*Motocycles — Méthodes d'essai et d'analyse de l'évaluation par la
recherche des dispositifs, montés sur les motocycles, visant à la
protection des motocyclistes contre les collisions —*

Partie 5: Indices de blessure et analyse risque/bénéfice

Amendement 1: Impact au sol et coûts des blessures



Reference number
ISO 13232-5:2005/Amd.1:2012(E)

© ISO 2012

iTeh STANDARD PREVIEW (standards.iteh.ai)

<https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2012

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

Amendment 1 to ISO 13232-5:2005 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 13232-5:2005/Amd 1:2012](https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012)

<https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13232-5:2005/Amd 1:2012](https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012)

<https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012>

Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles —

Part 5: Injury indices and risk/benefit analysis

Amendment 1: Ground impact and injury costs

IMPORTANT This Amendment may require re-interpretation by users of numerous directly related clauses among the eight parts of ISO 13232. It is expected that consequential amendments to these clauses would be part of any future revision of ISO 13232.

Page 2, Clause 3

Add the following terms:

- economic costs; iTeh STANDARD PREVIEW
- comprehensive costs; (standards.iteh.ai)
- quality adjusted life costs;

<https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012>

Page 23, 5.9

Insert the following at the beginning of the subclause and before the Note.

“The risk/benefit analysis for each collision shall include, at a minimum, the primary impact period, which shall be considered to be the time period until but not including ground impact, or 0,500 s after the first MC/OV contact, whichever is sooner.

The risk/benefit analysis for each collision should also include a separate analysis for the entire impact sequence, which shall be considered to be the time period from first MC/OV contact until at least 1 s and no longer than 3 s after the first MC/OV contact, and to the extent applicable, within this period, until the dummy’s head, spine, and pelvis centres-of-gravity resultant velocities are all less than 1 m/s, or until 500 ms after ground impact, whichever is sooner.

Ground impact shall be considered to be the first point in time when any portion of the dummy’s head or helmet shapes is in contact with the ground.”

Page 153, O.3.8

Insert the following at the beginning of O.3.8:

“Injuries resulting from ground contact are often a substantial portion of the total injuries in MC/OV crashes (e.g., ACEM, MAIDS Report, 2004). Advances in computational speeds have made it feasible to conduct computer simulation analyses that include ground contact. However, in order to place reasonable upper limits on the computational requirements for simulations that include the ground contact period, the simulation is considered to be complete when the dummy’s velocities are nearly zero or 500 ms after head or helmet to ground impact, whichever is sooner. In order to account for cases in which, during the first 3 s after MC/OV contact, the dummy’s key body region velocities are not reduced to nearly zero and the dummy’s head or helmet does not impact the ground, the simulation may be considered to be complete after 3 s.

These upper limits on the required duration of the computer simulation allow virtually all important injuries to be included in the risk/benefit analysis without requiring excessive computer time. Using typical contemporary (i.e., 2008 production) personal computers, simulations of the primary impact period for the 2 X 200 impact configurations using an example fully ISO-compliant multi-body model (Kebschull et al, 1998) can be run in approximately 8 CPU hours. Extending the simulation time to include the entire impact period as described in subclause 5.9 requires less than 48 CPU hours. In cases where the researcher wishes to model higher levels of detail, it is expected that finite element models would require less than 10 000 CPU hours to simulate the primary impact period for these 2 X 200 impact configurations and less than 60 000 CPU hours to simulate the entire impact period. Hybrid multi-body/FE models would require CPU hours somewhere between those for a pure multi-body model and for a pure finite element model. Another technological advance that enables such computational loads to be feasible is the increasingly popular usage of "computer clusters" or "computer grids" for processing, i.e., involving many CPUs, running in parallel."

Comment: Add a calculation for injury costs based on comprehensive costs in addition to the current calculation based on ancillary costs. Document changes are as follows:

Rename all occurrences of the following variables based on only medical and ancillary costs as given below.

Old Variable	Old Description	New Variable	New Description
CF	Cost of fatality	CF_{eco}	Economic cost of fatality
IC_{norm}	Injury cost, normalized	$IC_{norm,eco}$	Injury economic cost, normalized
CS_{norm}	Normalized cost of survival	$CS_{norm,eco}$	Normalized economic cost of survival

Page 18, 5.5.3

iTeh STANDARD PREVIEW

Renumber 5.5.3 on Fatality cost to 5.5.4. **(standards.iteh.ai)**

Insert the following new subclause immediately above the newly numbered 5.5.4:

<https://standards.iteh.ai/catalog/standards/sist/c2fd3f76-c013-402b-8d89-f3d849cc61c6/iso-13232-5-2005-amd-1-2012>

5.5.3 Quality adjusted life costs

Tabulate the injuries by body region and AIS injury severity level. Determine the quality adjusted life costs associated with each body region injury and each discrete AIS injury severity level, for each country in the cost data listed in Annex A. Calculate the total quality adjusted life cost associated with the injuries for each of the four body regions, including the head, neck, thorax, and abdomen, using the equation given below:

$$QC_{i,tot} = \sum_{j=1}^5 P_{i,j} \times QC_{i,j}$$

where

- $QC_{i,tot}$ is the total quality adjusted life cost associated with injuries sustained to the body region i ;
- $P_{i,j}$ is the probability of sustaining an injury of AIS injury severity level j to the body region i ;
- $QC_{i,j}$ is the quality adjusted life cost associated with an injury to the body region i of AIS injury severity level j .

Determine the total quality adjusted life cost associated with lower extremity injuries using the maximum PPI value, as determined in 5.4.2.3, and the respective cost data table given in Annex A.

Determine the overall quality adjusted life cost of injuries to the head, neck, thorax, abdomen, and lower extremities as given below:

$$QC = \max(QC_{i,tot})$$

where

QC is the overall quality adjusted life cost;

$QC_{i,tot}$ is the total quality adjusted life cost associated with injuries sustained to the body region i .

Insert the following text at the end of 5.8:

“Calculate the normalized comprehensive cost of survival as shown in the equation below:

$$CS_{norm,co} = \frac{\left(\text{minimum of } ((MDC + AC + QC) \text{ or } CF_{co}) \right) (1 - P_{fatal})}{CF_{co}}$$

where

$CS_{norm,co}$ is the normalized comprehensive cost of survival;

MDC is the medical cost;

AC is the ancillary cost;

P_{fatal} is the probability of fatality;

CF_{co} is the comprehensive cost of fatality (medical, ancillary, and quality of life);

the maximum value of $CS_{norm,co}$ is $(1 - P_{fatal})$.

The normalized cost of fatality (CF_{norm}) is equal to the probability of fatality (P_{fatal}).

Calculate the total normalized injury comprehensive cost as shown in the equation below:

$$IC_{norm,co} = CS_{norm,co} + CF_{norm}$$

where

$IC_{norm,co}$ is the total normalized injury comprehensive cost;

$CS_{norm,co}$ is the normalized comprehensive cost of survival;

CF_{norm} is the normalized cost of fatality;

the maximum value of IC_{norm} is 1,0.”

Page 23, 5.9

Insert the following at the beginning of the subclause and before the Note.

“The risk/benefit analysis for each collision shall, at a minimum, include the primary impact period, which is the time period up to but not including dummy to ground contact, or 0,500 s after the first MC/OV contact, whichever is sooner. The risk/benefit analysis for each collision should also include a separate analysis for the entire impact sequence, which is defined as the time period from first MC/OV contact until the dummy’s head, spine, and pelvis velocities are all less than 1 m/s or until 500 ms after ground impact, whichever is sooner. Ground impact is defined as the first point in time when any portion of the dummy’s head or helmet is in contact with the ground. The entire impact sequence shall be at least 1 s and shall be no longer than 3 s after the first MC/OV contact.”

Page 26, 5.9.4.2

Replace the equation for “average risk” with the following:

$$\text{average risk } j = \text{average increase in injury index } j = \frac{1}{N} \sum_{k=1}^{N_{risk}} (\Delta x_{k,j} \times FO_k)$$

Replace the first two paragraphs in Annex A with the following text:

“Use the tables in Annex A to determine the medical, ancillary, and quality of life costs for each body region and AIS injury severity level when calculating the overall costs in 5.5.1, 5.5.2, and 5.5.3, respectively.

Tables A.1, A.2, and A.3 list respective medical, ancillary, and quality of life costs in 2000 U.S. dollars.”

Replace Table A.1 with the following table:

Table A.1 — Medical costs

Body region	AIS injury severity level	Cost (USD)
Head	1	30 405
Head	2	31 323
Head	3	193 785
Head	4	206 592
Head	5	280 228
Neck	3	355 082
Neck	4	824 887
Neck	5	1 088 896
Thorax	1	1 248
Thorax	2	11 384
Thorax	3	32 692
Thorax	4	52 963
Thorax	5	62 967
Abdomen	1	1 248
Abdomen	2	11 384
Abdomen	3	32 692
Abdomen	4	52 963
Lower extremities	2	8 592
Lower extremities	3	31 258

Page 29, Annex A

Replace Table A.2 with the following table:

Table A.2 — Ancillary costs

Body region	AIS injury severity level	PPI	Cost (USD)
Head	1	-	10 225
Head	2	-	36 539
Head	3	-	121 644
Head	4	-	232 423
Head	5	-	943 054 ^a
Neck	3	-	262 761
Neck	4	-	399 937
Neck	5	-	476 360
Thorax	1	-	3 058
Thorax	2	-	51 882
Thorax	3	-	86 592
Thorax	4	-	119 742
Thorax	5	-	240 645
Abdomen	1	-	3 058
Abdomen	2	-	51 882
Abdomen	3	-	86 592
Abdomen	4	-	119 742
Lower extremities	-	07	27 996
Lower extremities	-	15	59 991
Lower extremities	-	22	87 986
Lower extremities	-	27	107 983
Lower extremities	-	38	151 976
NOTE The medical and ancillary cost of fatality is 919 834 in 2000 U.S. dollars.			
^a Although the ancillary cost of a head AIS5 injury exceeds that of a fatality, the equations which calculate normalized injury costs do not produce normalized costs which exceed a value of 1			

Update the costs in Annex D accordingly and prepare other consequential amendments.

Add the following Table A.3 based on Miller, et al. (2001) to the end of Annex A:

Table A.3 — Quality of life costs

Body region	AIS injury severity level	PPI	Cost (USD)
Head	1	-	46 102
Head	2	-	202 455
Head	3	-	315 330
Head	4	-	681 113
Head	5	-	1 695 212
Neck	3	-	174 066
Neck	4	-	1 520 370
Neck	5	-	2 164 209
Thorax	1	-	3 552
Thorax	2	-	53 310
Thorax	3	-	91 870
Thorax	4	-	156 950
Thorax	5	-	203 090
Abdomen	1	-	3 552
Abdomen	2	-	53 310
Abdomen	3	-	91 870
Abdomen	4	-	156 950
Lower extremities	-	07	106 426
Lower extremities	-	15	228 056
Lower extremities	-	22	334 481
Lower extremities	-	27	410 500
Lower extremities	-	38	577 741
NOTE The quality of life cost of fatality is 2 389 179 in 2000 U.S. dollars.			

Page 31, Annex C

Add the following variable definitions to Annex C:

Variable	Definition
CF_{co}	Comprehensive cost of fatality
$IC_{norm,co}$	Injury comprehensive cost, normalized
$CS_{norm,co}$	Normalized comprehensive cost of survival

Page 34, Annex D

Replace the computer code in Annex D with the following:

```

c...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8
c
c      This is the verison in ISO/DIS 13232-5 Annex D (2008)
c
c...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8

      subroutine icm2009(Idatin,Rdatin,Table,Datout,Ierr)
      implicit none
      integer Idatin(5), Ierr
      real Rdatin(6), Table(9,6), Datout(12)

c*****
c
c      name
c
c      icm - Evaluate the Injury Cost Model
c
c      description
c
c      This subroutine evaluates the Injury Cost Model for the inputs
c      in arrays Idatin and Rdatin. Output is returned in arrays Table
c      and Datout.
c
c      calling sequence
c
c      argument  i/o  description
c      -----  ---  -----
c      Idatin    i    integer data input array, elements as follows:
c                  element  symbol  description
c                  -----  -----  -----
c                  1      FF3    number of AIS 3 femur fractures
c                  2      TF2    number of AIS 2 tibia fractures
c                  3      TF3    number of AIS 3 tibia fractures
c                  4      KDI2    number of AIS 2 knee dislocated
c                              injuries
c                  5      KDI3    number of AIS 3 knee dislocated
c                              injuries
c
c      Rdatin    i    real data input array, elements as follows:
c                  element  symbol  units  description
c                  -----  -----  -----  -----
c                  1      AP      mm     maximum abdomen
c                              penetration
c                  2      Gmax    -      maximum GAMBIT
c                  3      Cmax    %      maximum normalized chest
c                              compression
c                  4      VCmax   m/s   maximum chest viscous
c                              criteria when V>3 m/s
c                  5      HIC     -      Head Injury Criteria
c                  6      NII     -      Neck Injury Index
c
c      Table     o    table 1 values
c
c      Datout    o    real data output array, elements as follows:
c                  element  symbol  units  description
c                  -----  -----  -----  -----
c                  1      MAIS    -      maximum AIS
c                  2      TAIS    -      total AIS
c                  3      NICE    -      Normalized Injury
c                              Economic Cost
c                  4      NCOSE   -      Normalized Economic Cost of

```