

A European Perspective of In-Depth Data Sampling on Cognitive Aspects of Motorcycle Helmets within COST 357

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ABSTRACT

In the context of the COST357 research project, the climatic conditions and requirements for protective helmets for motorcyclists have been examined. The extent to which these factors would influence motorbike handling and accidents in which motorcyclists are involved have also been examined. This project addresses how cognitive abilities of motorcyclists relate to helmet construction factors. In particular, the aspects of motorcycle driver helmets are to be parameterized in order that they may be used subsequently as a basis for future requirement profiles. The task of one working group of the COST357 project has been to analyse accident events and to identify helmet design issues which affect motorcycle drivers while wearing a helmet. This has been achieved by collating accident data across different countries recorded in the course of in-depth investigations at the site of accidents and by combining this with field studies of motorcyclists participating in traffic, but not involved in accidents. This paper presents the study methodology, database and first results of this international survey. The basis of the study has been a total of 424 interviews of motorcyclists and 134 motorcycle accidents, which were collected across Germany, Greece, Italy, Ireland, Portugal and Turkey and combined in a single database.

DESCRIPTION OF THE PROJECT AND OBJECTIVE

Two-wheeled motor vehicles are involved in 14% of all traffic accidents occurring in the European Union. This directly affects over 6000 people annually. Statistics show that a full face helmet with its full facial protection can be a life saver in an accident and protect against severe head injuries. Given the multiplicity of factors which lead to such accidents, this project considers those cases where the field of view of the motorcyclist was impaired by negative characteristics of the helmet or where there were construction defects in the helmet, which constituted an accident hazard. Previous analyses of accidents usually provide no information as to whether the helmet was optimized for the cognitive needs of the wearer or whether it influenced the accident event. A well-arranged study containing a literature research about aero-acoustics, temperature behaviour and ventilation problems as well as psycho physiological performance features of the helmet during driving has been published in 2007 by the University of Heidelberg on behalf of the Bundesanstalt für Straßenwesen (Federal Highway Research Institute - 1). It contains references that in helmets particularly sound pressure and ventilation contribute substantially to the well-being of the driver, a relation to accidents could not be established, however. At higher speeds high sound pressure levels occur (Hüttenbring - 2). The visor seems to contribute considerably to the noise emission (Lower M.C. et al. - 3). An impairment of the perception of acoustic signals as for example of sirens doesn't seem to exist, in fact with attenuated full face helmets the signal quality in this frequency range is improved (Van Moorhem - 4 and Mc Knight - 5). Differences up to 5 °C and humidity differences up to 35% are supposedly possible (Jung und Schenk - 6). Brühwiler determined in an experimental investigation that the removal of humidity for closed helmets is similar, but diverges strongly for open ventilation. This raised the question of physiological effects from heat on the psychomotor efficiency of motorcyclists (Brühwiler - 7). A study relating helmets to accidents is an analysis of 463 motorcycle accidents in the years from 1993 to 1996 in Auckland (New Zealand), which was compared to a control group of 1233 interviewed motorcyclists. The colour of the helmet thus plays a role in the accident event, wearers of white helmets had a lower accident risk than drivers with black helmets (Wells et al. - 8), lower by about 24%. The BAST study conducted experiments at 12 different protective helmets and found inside temperatures of 20°C to 37°C at most for outside temperatures of 15°C to 36°C measured and found room for improvement because of functional and design errors. A temperature of 24°C to 27°C can be classified as comfortable (Deetjen et al. - 9). The colour of the helmet has an influence on the temperature level inside the helmet, inside black helmets temperatures of up to 37 °C occurred during exposure to summer sun, whereas for helmets in light colours only up to

30°C were measured, which would result in physiologically unfavourable wearing conditions particularly at lower speeds. During the psycho physiological investigations conducted, no characteristics and/or correlation could be established in the EEG and ECG, except for one significantly affected pulse frequency, thus no requirements could be formulated on this account.

These ergonomic factors include minimizing distractions from noise or overheating, maximizing useful visual information, limited fields of view through the visor, and the construction of helmet openings for the visor and for air ventilation. While car drivers and motorcycle drivers are respectively responsible for two thirds (2/3) and one thirds (1/3) of accidents, the helmet can actually play a significant, albeit unknown, role in improving perception. It is usually the helmet that is the highest part of a motorcycle driver and is consequently visible from all sides.

In the context of the COST357 research project, with the acronym "PRO HELM", for "Accident **P**Revention **O**ptions with motorcycle **HELM**et", the climatic conditions and requirements of the protective helmet for motorcyclists are examined. The project aims to provide insight into how the cognitive abilities of motorcyclists and other road users are affected by the helmet construction. Various parameters of motorcycle drivers' helmets are quantified for the first time ever in order to provide scientists with the necessary background information required in subsequent study of interactions between complex factors. The range of member countries cooperating in this study should provide interested researchers with additional data pertaining to geographical and climatic variations.

This 4-year project (2005-09) is led by a management committee which is represented by all signatory nations [COST357]. The activities are divided into 10 tasks, which are implemented by four working groups. This present study has been undertaken by WG 1. WG 1 was charged with carrying out a prospective study on data sampling of cognitive aspects of motorcycle helmets and how these conditions influence accidents of motorcyclists.

STUDY APPROACH AND METHODOLOGY

The objective of the present study has been to find out when motorcycle helmets do not work optimally; such incidences could relate to when the driver is influenced by adverse thermal, visibility or acoustic conditions from inside the helmet or if the helmet visor provided an inadequate field of view of surrounding traffic. Two practical approaches were followed to obtain information on these topics. Firstly, accidents were reviewed as a source of information; secondly, a prospective survey of motorcycle drivers who had not necessarily been involved in any accidents was used to glean information on failures and problems in relation to the use of helmets. The following important influences on the field of vision of a helmet were assessed:

- temperature, humidity and comfort
- limits for physiological properties like ventilation, weight of helmet, view of driver
- helmet visibility from all directions for reasons of conspicuity

A field survey in different European countries was initiated and a suitable questionnaire was developed to determine the current conditions of helmets within an accident event as well as in the general field of traffic users. The questionnaire considered personal data as well as general helmet data, data on helmet features, conditions, sensations, usage and a comprehensive measurement of vision limitations through the visor of the helmet. Figure 1 describes the questionnaire. In total a number of between 87 to 95 different items were queried in the survey.

The data collected with the questionnaire includes a total of:

87 variables at a survey with motorcycle riders or
95 variables when collecting data after a motorcycle accident

- Personal data: 20 variables
- General helmet data: 11 variables
- Helmet features: 5 variables
- Helmet condition: 5 variables
- Helmet sensation: 14 variables
- Helmet usage: 13 variables
- (Accident situation: 8 variables)
- Additional information in Expert findings/Measurements: 19 variables

Figure 1. Questionnaire for the pan-European survey on helmet conditions.

Motorcyclists were asked for their experiences while driving wearing a helmet without having been involved in an accident (“field study”). They were also asked the same questions after an accident and the relevant helmets were investigated (“accident study”). The motorcyclists reported any negative effects pertaining to vision, heat, conspicuity and ventilation and they also made suggestions for further developments of helmets. This personalised information was recorded at the same time as the measurement results, for which a separate form had been developed for use during the survey at the accident scene.

The precise methodology differed depending on the research activities and procedures in the individual countries. Germany and Italy have an in-depth-investigation team with access to the scene of the event directly after an accident, Greece surveys drivers retrospectively in their homes and some countries only conduct field studies (Ireland, Turkey). Of these teams, those in Ireland, Portugal and Turkey carry out their activities by following the same methodology of other national research sources i.e. police surveys, forensic expert activities. These COST357 Investigation centres were mostly ready to implement the methodology and to commence investigations in March 2007. By April 2008, all investigations had started and been carried out in a total of 6 different countries. The scheduled deadline for completing data collection is the end of September 2008.

DESCRIPTION OF QUESTIONNAIRE AND MEASUREMENTS

As well as developing a suitable questionnaire, some measurement tools were prepared to determine the maximum geometry of the vision hatch and the horizontal and vertical vision field. A special device, a so-called gonimeter or perimeter, was developed for this purpose, as shown in Figure 2. The subject fixes his eyes on the midpoint of the perimeter's semicircle while the tester moves a pointer to identify the limits of the subject's peripheral vision.

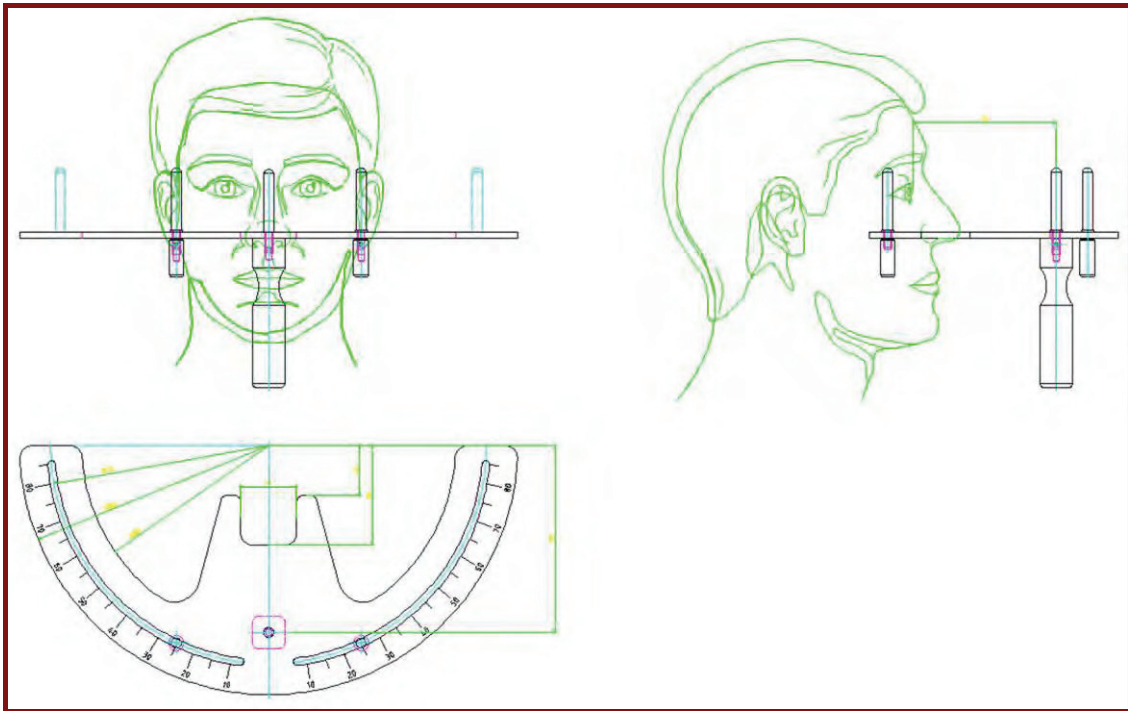


Figure 2. For the horizontal field of vision test, the goniometer is placed orthogonally on the nose of the rider. The rider is told to focus on the centre-pin of the device and to move the pin of the protractor horizontally to each side until it can no longer be seen. The angle of the field of vision of both sides is recorded.

Sets of different reference lenses were prepared from real visors to measure the light transmittance of the motorcyclists' visors. This required prior treatment by a grinding machine and validation with a transmittance testing device as shown in Figure 3. By comparing the tested visors against the reference lenses, it was possible to measure light transmittance values in the range of $\tau = 14\%$ to 91% . The same method, but with a different set of reference lenses, was used for light diffusion tests. The light diffusion of the visor or goggles was compared against the different reference lenses. The diffusion value of the reference lenses that matched closest to the light diffusion of the visor or goggles was recorded. 4 different reference lenses were used for light diffusion, ranging from $D = 2\%$ to 25% .



Figure 3. There are 6 different reference discs L with light transmittance values of $\tau = 14\%$, 57% , 64% , 81% , 83% and 91% . There are also 4 different reference discs with light diffusion values of $D = 2\%$, 8% , 16% and 25% .

SAMPLING OF DATA BY TEAMS IN DIFFERENT COUNTRIES

The cases were collected by the teams in different countries by using the same questionnaire and the same measurement tools and a similar data sampling process was used in all countries. A database, COST357, was developed and the data stored at the MUH Germany. All of the data were submitted to the MUH on Microsoft Access-Format 2003.

Greek Case Data

The research was conducted in the county of Heraklion, the capital of the island Crete, at the Technological Educational Institute of Crete. The sample comprised 100 subjects. For the “accident study”, a prior survey by the Institute was used. That included 300 people and was carried out in 2006. Those motorcyclists who had been involved in an accident while wearing a helmet and who still had their helmet were contacted to conduct the necessary measurements. The Greek COST 357 study used 50 cases retrospectively from this survey.

Italian Case Data

The study in Italy was carried out by two CORSS (Centro Interdipartimentale di Studi e Ricerche sulla Sicurezza Stradale) teams. They prepared the Italian documentation at Pavia University and compiled data on the basis of the developed protocol and questionnaire of COST357.

Cases of helmet users who were involved in an accident were collected for the “accident study”. Participants were interviewed a few days after the accident after the team leader had contacted the police forces (Polizia Locale, Polizia Stradale, Carabinieri) and obtained their cooperation for the accident study. The team leader provided the police forces with an abstract of the Ethics Committee approval and provided them with a description of the research project. They also discussed the significance and scientific merit of the study with the police forces. The police, in turn, informed the team when an accident had occurred and pertinent information regarding accidents and riders was extracted from the police reports. The motorcycle drivers were contacted by phone and an appointment was made to interview them and to obtain measurements from their helmets. The investigation area is the District of Pavia, from where more than 40 cases have been examined.

The cases of the “field study” came from two areas of Italy: Pavia, in northern Italy and Messina, in the south. The Pavia team collected data at four petrol stations in District of Pavia. The investigation team contacted each petrol station manager and explained the study to him. The riders that this identifies are not representative of the population in this sample region. The team from Messina collected data both at petrol stations and at two high schools. They contacted the petrol station managers to use the station as a site for data collection and contacted the principals of the schools to obtain cooperation and consent to distribute the questionnaire among the students. The students’ parents were asked to give their informed consent to permit their sons (if aged under 18) to participate in the study.

German Case Data

In Germany the study is carried out at the Accident Research Unit of the Medical University Hannover (ARU-MUH) applying two different approaches. Accident files of GIDAS (German In-Depth-Accident-Study) are used to select cases in which a motorcyclist wearing a helmet was injured and to identify whether the motorcyclist was able to participate in the survey and the helmet was available for measuring the relevant COST issues. The Accident Research Unit ARU at the Medical University Hannover has many years of experience in accident documentation, in-depth-investigation and accident reconstruction (Otte - 10). In Germany, specialist teams in Hannover and Dresden go directly to the scene of the accident to collect the necessary information to complete detailed accident reconstructions as well as medical data about how those involved were injured and treated. The COST 357 team member

collects information of an accident that has taken place and goes out to interview the motorcyclist and measure the helmet. Secondly, a “field study” (case control study) was carried out on a survey of motorcycle drivers who were not involved in an accident. The test persons were found at petrol stations, at motorcycle meeting points and were stopped by the police. They were requested to be interviewed and to allow their helmet to be examined and measured. The investigation area is the region of Hannover. The cases are randomly selected motorcycle drivers in traffic accidents from different places in the area of Hannover.

Portuguese Case Data

The study in Portugal is conducted by the IDMEC IST Technical University of Lisbon. The sampling area was the region of Lisbon. During weekday daytime hours between 08.00 to 18.00 hours the police randomly stopped motorcycle riders, who were then interviewed by members of the COST team. They were asked if they were willing to participate in the control study. Interviews were carried out at motorcycle meeting points and at petrol stations.

Irish Case Data

The investigation started in Ireland in September 2007 and was undertaken by the School of Electrical, Electronic & Mechanical Engineering of University College Dublin (UCD) to gather survey data from an urban area (Dublin city) and a rural area (Co. Donegal). Participants were contacted by four different means, namely:

1. *Online internet sites for motorcycle enthusiasts*

Threads requesting participants for the survey were placed in the relevant sections of some popular enthusiast websites in Ireland: (www.biker.ie; www.irishbikerforum.com; www.ukgser.com (Irish section)). Contact was made with interested respondents via email prior to meeting at a suitable location to collect data: this was generally the participant's home, workplace, UCD campus or another mutual location.

2. *Motorcyclist known to the researcher*

A small number of motorcyclists known personally to the researcher were surveyed. This led to further contact with other riders in the area. These riders were telephoned and invited to participate. The general location was mid to south Donegal; this is a mainly rural area.

3. *M.A.G. Ireland*

Motorcycle Action Group (M.A.G.) Ireland is a voluntary organisation representing Irish motorcyclists. Their URL is www.magireland.org; they also publish “*Roadrunner*”, a quarterly magazine which is issued to their approximately 2000 members. An advertisement was placed in *Roadrunner* describing COST 357 and inviting readers to participate in the survey. Those who did respond were similarly met at their workplace, home, UCD campus or some other mutual location. They also tended to come from the Dublin region.

4. *Gardaí (National Police)*

200 letters were given to the Gardaí for distribution. Half were given to riders in their Traffic Division and half were sent to civilian riders involved in road traffic accidents informing them of the study and inviting people to participate. The traffic divisions of two major Garda stations in Dublin, Pearse Street and Blackrock, were contacted directly and both agreed to participate. In both cases the stations had to be visited several times as the riders worked in shifts. As the helmets examined are standard issue, they were of the same model. Also several of the Garda riders had accidents in the past and some recently damaged helmets were available to examine.

Turkish Case Data

Two types of data collection procedures were used. First, non-professional riders were approached in two motorcycle shops in Ankara. Measurements and interviews were

conducted among customers and acquaintances of the customers who visited the shops. Second, in addition to non-professional riders, a sample of professional riders was collected in the police stations, pizza delivery shops and post offices in Ankara. Measurements and interviews were conducted among police motorcyclists, post officers delivering mail by motorcycle and pizza delivery riders.

DATA AVAILABILITY:

The following table shows the data stored in the COST 357 database for analysis purposes, as collated *by the end of May 2008*.

Partner	Total number of cases	Accident cases
Germany	60	6
Greece	100	48
Ireland	54	11
Italy	148	46
Portugal	21	9
Turkey	41	14
Total	424	134

Table 1. Total numbers of database cases and “accident study” cases at end May 2008 (“field study” = total – “accident study”).

The COST 357 data set contains a total of 424 subjects from field questionings and 134 “accident cases”. To analyse the results it appears particularly important to first regard the epidemiological data such as age of the motorcyclists, their driving experience and the type of protective helmet used (full face helmets, half shells or open face helmets), as well as their proportional incidence, the different driving behaviour and habits when carrying protective clothing and helmets in the different European countries. Concerning the age of the motorcyclists it is noticeable (c.f. Figure 4) that in Germany almost all age groups are relatively evenly distributed, whereas in Italy 45% are aged 15 - 25 years, in Ireland 35% are aged 26 - 35 years, while in Portugal 52 % are between the 26 – 35. In Greece and Turkey the two age groups 15 - 25 years and 26 - 35 occurred with nearly the same frequency of approximately 30%. The highest portion of older motorcyclists (older than 55 years) was 13% in Germany.

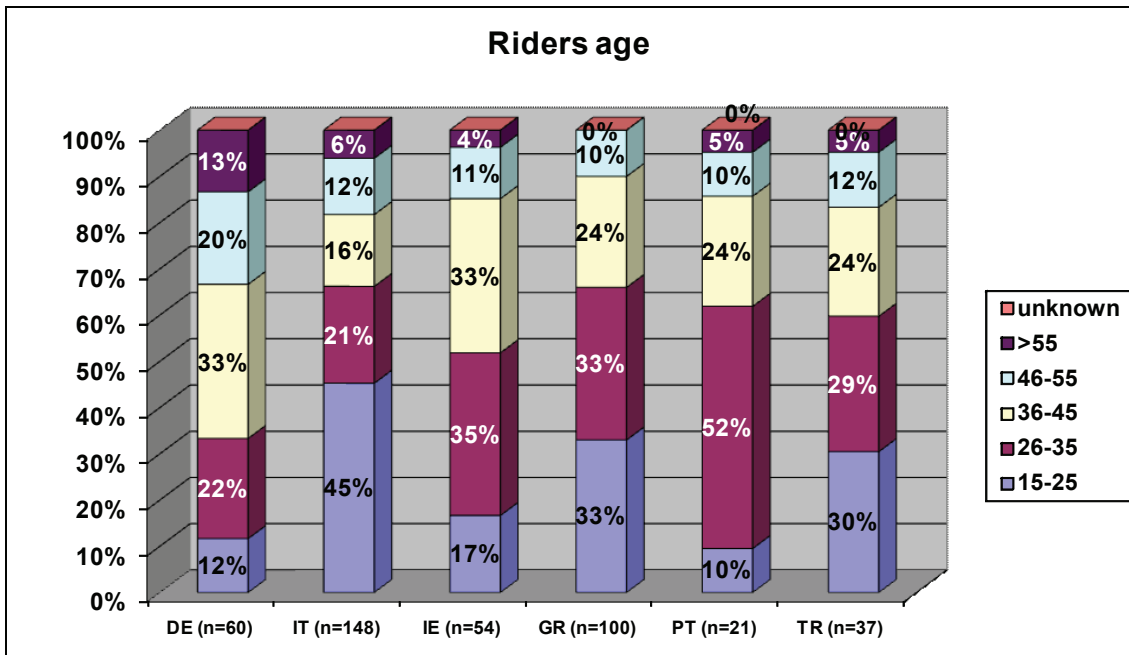


Figure 4. Riders' age distribution of interviewed motorcyclists.

The motorcyclists that took part in the investigation usually had many years of motorcycling experience. Thus about ¼ of all had been driving motor cycles for more than 20 years, respectively had a licence for so many years. The riders were asked about “how long they are motorcycle riding”. Remarkably and contrary to the trend of all other countries was Portugal with predominantly motorcyclists of many years standing and Turkey where 2/3 of all investigated drivers reported no more than 2 years driving experience.

It can be assumed that half of the investigated motorcyclists had already been involved in an accident before. Only in Greece and Portugal was the incidence of previous accidents higher (Greece: 72.2%, Portugal 85.7%). In Ireland and Turkey the motorcyclists owned their helmets on average for less than 3 years when the investigation was carried out, while they had been worn for 3.5 years in Italy, 3.9 years in Greece, 4.5 years in Germany and 5.1 years in Portugal. Full face helmets were predominantly used across Europe, from 51% (Turkey) to 63% in Germany and 80% in Ireland. In Italy, however, only 20% of riders wore full-face helmets; 70% wore open-face helmets.

RESULTS OF INTERVIEWING MOTORCYCLISTS

The questionnaires dealt with the protective helmet, the wearing conditions of the helmet and the general motorcycle driving characteristics. For motorcycle accidents, approximately 30 characteristics were incorporated into the interview to record the condition of the protective helmet: these were collected by the interviewers – i.e. the experts. These also included the measured values of the horizontal and vertical opening angle, field of view, transmittance degrees and light diffusion values of the glass insert of the protective helmet glass, the so-called visor.

Motorcycle helmets in accident events

69% of the helmets registered in accidents had abrasions on the outside; 12% were partly cracked. Only 20% of the protective helmets involved in accidents were considered to be completely intact. 47% of the helmets were damaged at the side, 12% at the back, 12% at the front and only 7% showed damage on the upper section (top). In 7.7% of the cases the motorcyclists lost the helmet during the actual accident (n=7 of those who had closed the chin strap). Helmet loss occurred at an frequency of 40% mainly during lateral impacts, i.e. to either the right (30%) or left side (40%), and also in frontal impact situations 20% of loss of helmets (Figure 5).

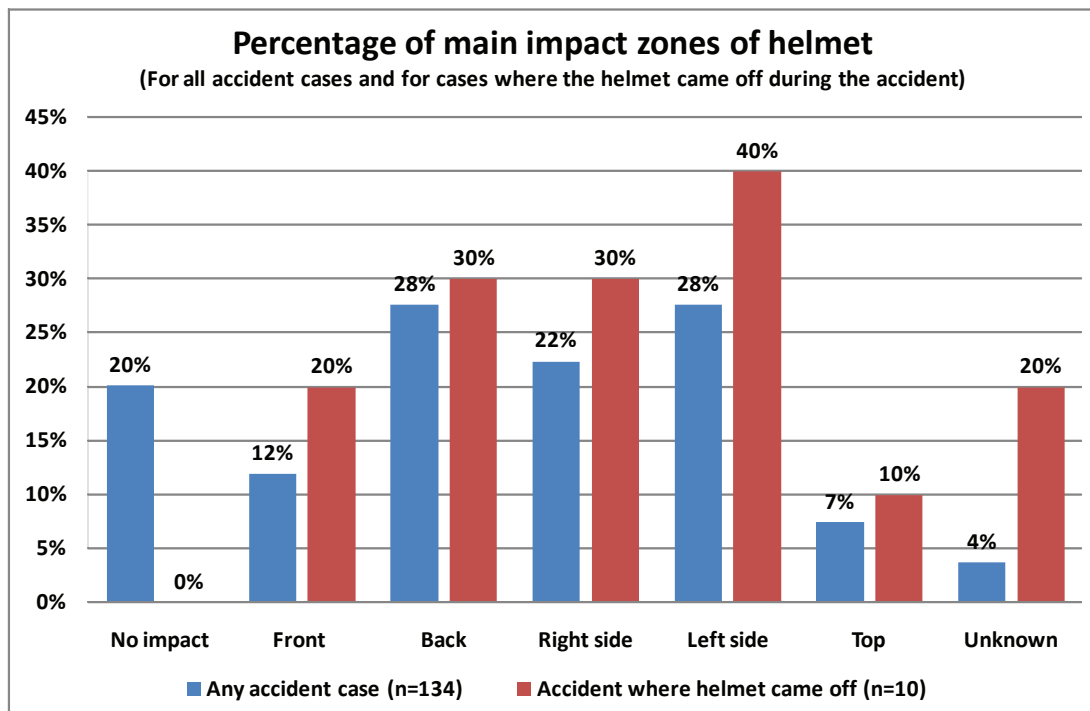


Figure 5. Loss of helmet in the course of an accident.

It is remarkable that for these cases the proportional frequency of the impact zones at the rear of the helmet (30%) is only slightly higher than for helmets which had not been lost (28%). This implies that helmet loss rarely occurs due to a primary impact at the back of the head. In contrast to the strip-off conditions, where a helmet is pulled off a test-head from the rear according to standard ECE 22, real-world accidents allow for relative motion of the head in lateral and dorsal directions: such motions can lead to helmet loss.

Protective helmets in the “field study”

18.6% of those motorcyclists questioned indicated that the helmet significantly limits their field of view. 27% of the interviewed riders reported that visors frequently opened of their own accord. 32.6% considered their helmet to be too noisy and 14% regarded the chin strap as being uncomfortable. 2/3 of the causes of noisy helmets were from wind noise (68.9% air flow noise), while 11.9% was from air turbulences, 3.7% from rattling noises, and 8.9% from whispering noises. It is noteworthy that taller people particularly complained of noise. Figure 6 shows the percentages of helmet noise to be only 14% for people less than 165cm tall, 30% for people between 170 and 174cm high and 46% for those between 185 and 189cm.

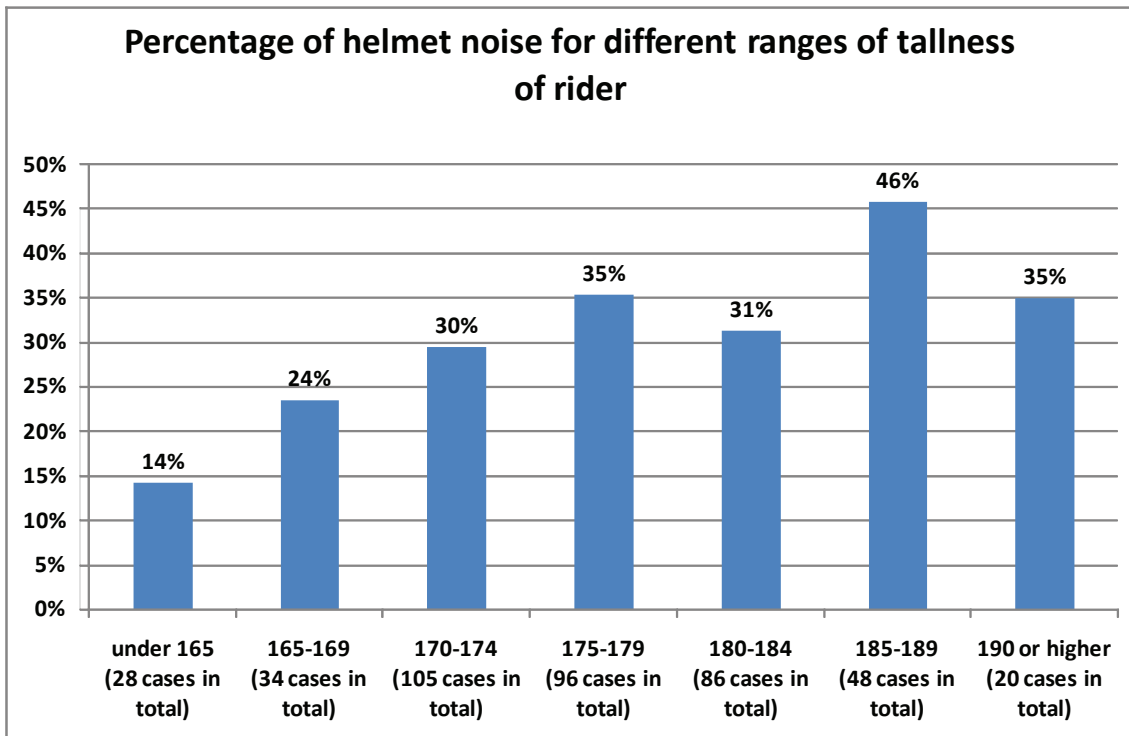


Figure 6. Percentages of helmet noise for different heights of riders (heights given in cm).

The measured fields of view of the helmets indicated quite a different distribution between the different countries. Thus, over 80% of the helmets in Portugal had view angles between 140 and 180 degree, most of them between 150 and 170 degrees. In Ireland, also approximately 80% were between 160 and 180 degrees. In Turkey, 65% had field of view angles of only 140 to 160 degrees. It is possible, however, that these differences are due to the goniometer being used differently or interpreted differently by the various measuring team members within the same country. The variations that have been reported cannot be explained solely from a technical perspective. Since relatively identical fields of view have been reported for the right and left sides in each country, it is likely that the measurement teams in each country followed a consistent process. The measured fields of view for Germany show an approximate normal distribution with a maximum between 130 and 170 degrees, and no measurements above 170 degree field of view through the visor field. Figure 7 shows also the general distribution of all measurements of the horizontal field of view as a result of all measured helmets.

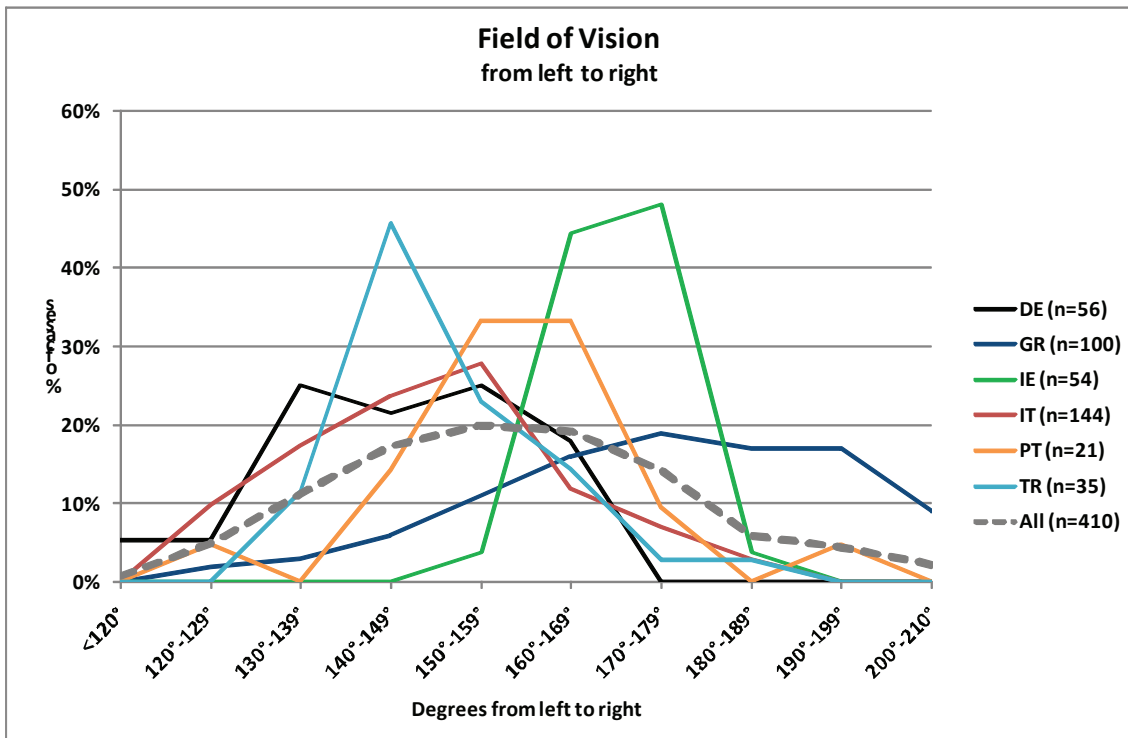


Figure 7. Frequencies of measured degree of horizontal field of vision of driver.

The light transmittance degree of each visor was determined by comparing the individually validated lenses having known light transmittance values against the visors of the protective helmets. Transmittance values of $\tau > 91\%$ were predominantly reported in all countries except Portugal where the majority could be found with $\tau = 58 > 64\%$ (c.f. Figure 8).

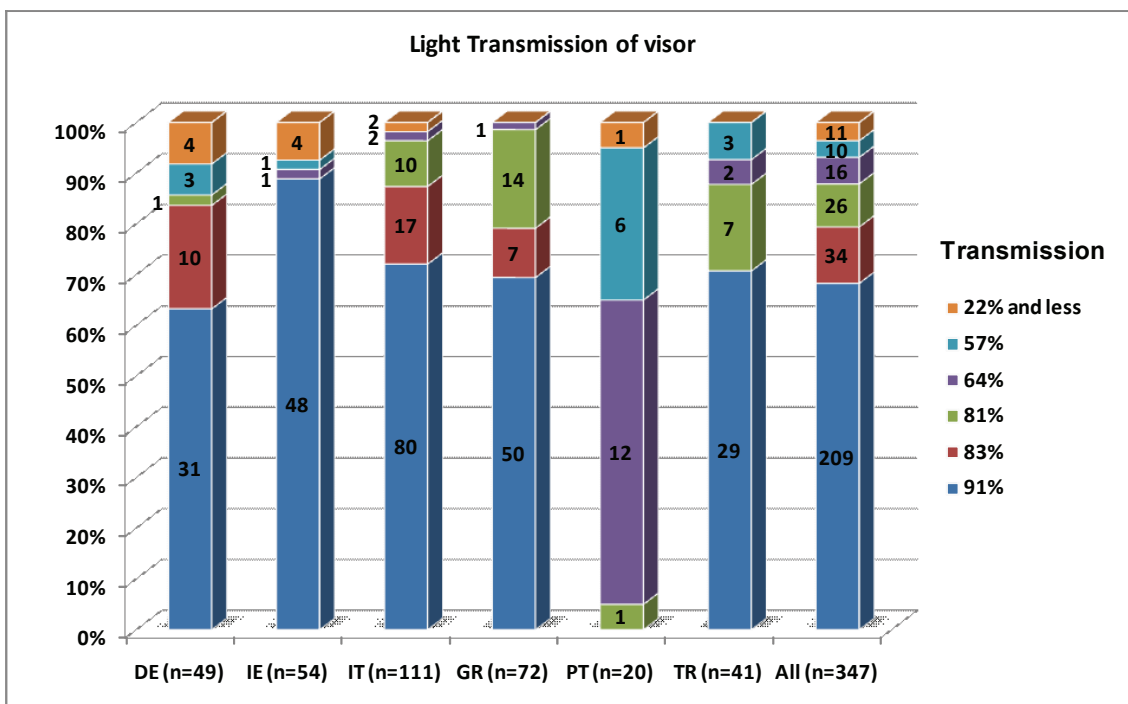


Figure 8. Frequencies of measured light transmittance values of visors. The values for light transmittance are grouped in 22% and lower, 57%, 64%, 81%, 83% and 91 to 100% light transmittance

It is remarkable that such high transmittance values were reported so frequently (about 85%) in Ireland and seldom in Portugal. It is possible, however, that these extremes may be due to inherent climatic differences between these countries, but could be also the result of very low registered number of cases in Portugal. The Column of all measurements together is shown in 68.3% light transmittance degrees of more than 83%, pointing out high level of quality concerning light transmission on current helmets.

The light diffusion values of the visors were determined by a similar comparison against sets of validated lenses. Here, the predominantly high-quality helmets yielded very small light diffusion values of $D < 8\%$ in all countries (60,4% of all measurements) although this was proportionally lower in helmets in Italy, Turkey and Greece (c.f. Figure 9). In Greece, Italy and Turkey helmets with visors with light diffusion values $D = 25\%$ were also found.

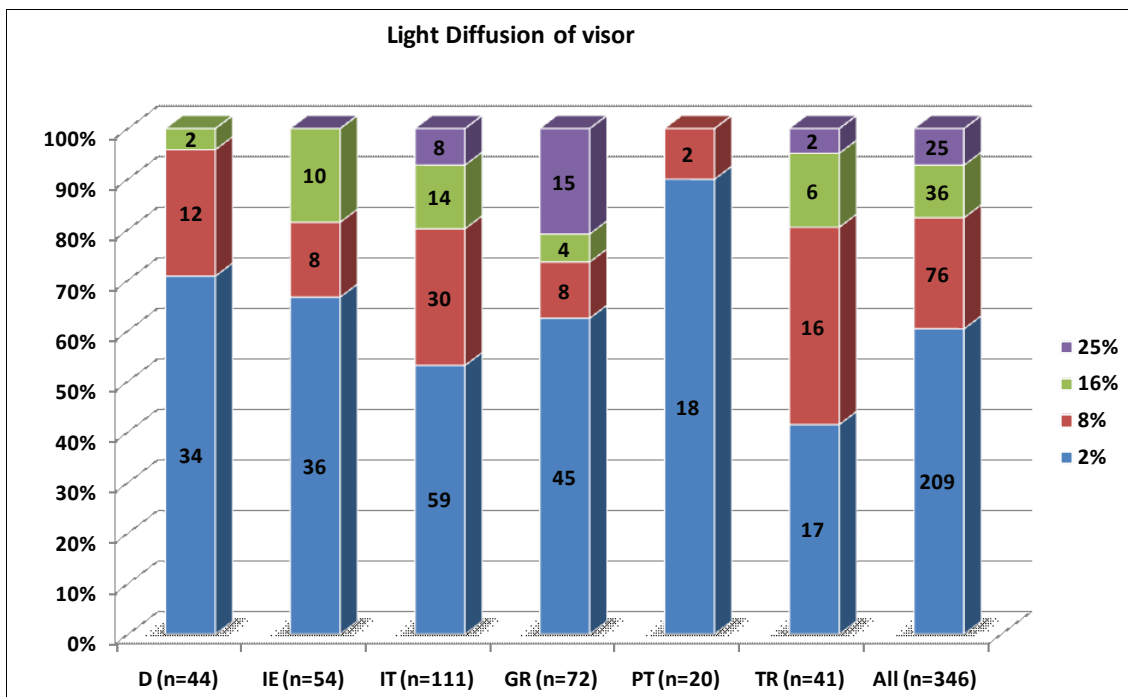


Figure 9. Frequencies of measured light diffusion values of visors, the values of light diffusion are grouped in less than 2%, 8%, 16% and 25% diffusion.

CONCLUSIONS

Within the framework of the COST357 research project, the environmental requirements for protective helmets for motorcyclists have been examined. This has been achieved by interviewing motorcyclists to determine existing problem areas with their motorcycle helmets. A comprehensive questionnaire with more than 100 different items of request was used during interviews and helmet inspections to address wearing comfort, age and condition of helmets and, by using customized instrumentation, to measure the field of view, light transmittance and light diffusion of helmets visor.

First, and as expected, differences showed up in the different countries, largely as a result of the climatic differences in these countries. Thus, in southern countries such as Italy, Greece, Portugal and Turkey as opposed to northern countries including Germany and Ireland, more open face helmets were worn frequently than full face helmets.

The study of 424 interviewed drivers without accident and 134 interviewed drivers with accident is shown important parameter of the conditions of their helmets and visors. First of all most of the inspected helmets were under good conditions. 68.3% of all helmets are given light transmittance degrees of more than 83%, pointing out high level of quality

concerning light transmission on current helmets. The predominantly high-quality helmets yielded very small light diffusion values of $D < 8\%$ in all countries (60.4% of all measurements) although this was proportionally lower in helmets in Italy, Turkey and Greece. A poor general state having light transmittance values of less than 80% and light diffusion values of more than 25% were more frequently found in the southern countries, while in northern European countries significantly lower diffusion values were measured. Nevertheless, approximately 1/3 of all motorcyclists who were questioned indicated that their helmet was too noisy and 18.6% regarded their field of view as being too small. The helmet measurements confirmed these data. The measured fields of view of the helmets indicated quite a different distribution between the different countries. Thus, over 80% of the helmets in Portugal had view angles between 140 and 180 degree, In Ireland, also approximately 80% were between 160 and 180 degrees.

In Turkey, 65% had field of view angles of only 140 to 160 degrees. It is possible, however, that these differences are due to the measurement device being used differently or interpreted differently by the various measuring team members within the same country. The variations that have been reported cannot be explained solely from a technical perspective. Since relatively identical fields of view have been reported for the right and left sides in each country, it is likely that the measurement teams in each country followed a consistent process. The measured fields of view for Germany show an approximate normal distribution with a maximum between 130 and 170 degrees, and no measurements above 170 degree field of view through the visor field. These measurements of field of vision are conformable with the test regulation regarding ECE 22. The current ECE 22-guideline [ECE 22-05] specifies a minimum opening angle of horizontally 105 degree for helmets (c.f. Figure 10). The default values of the standard regarding light diffusion (ECE 6.15.3.5) is given with $D < 2.5\%$ (abrasion $< 20\%$), nearly 60% of the helmets are reaching this demand, 40% had visors with default values in light diffusion criteria. Luminous transmittance (ECE 6.15.3.4) with ECE standard values of at least 50 to 80% appear not to be always attainable in practice in nearly 70% of the worn helmets.

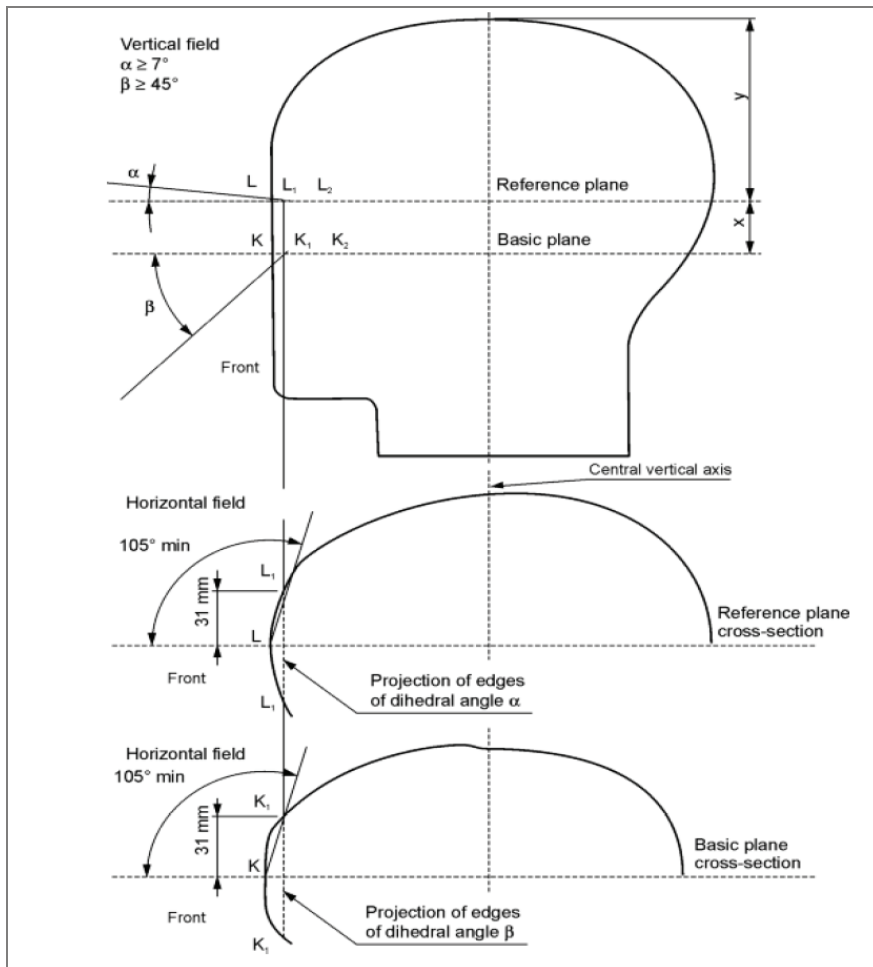


Figure 10. Peripheral vision of the helmet standard ECE 22.

The study yielded further interesting results. It is clear that the helmets worn by motorcyclists are not as old as might have been expected, being typically 2.8 years old in Ireland and 5.1 years old in Portugal. Even if southern countries have a perceived image of poor helmet use, the fact is that full face helmets, which provide better protection than half shells or open face helmets, are predominantly worn (usage rates exceed 50%) in all countries, except for Italy (only 20%). Special attention needs to be given to improving the helmet fastener, as the study showed a relatively high incidence (7.7%) of helmet loss during accidents. A detailed investigation of impact situations revealed that lateral and frontal impact situations provided the greatest hazards in this respect. This suggests that ECE 22 test conditions ought to be more closely representative of real-world accidents.

This present research also highlights the difficulty of obtaining comparable results from different countries when using different collection methodologies and basic conditions with relatively close tolerances. In spite of using a uniform questionnaire and test chart that was created by international mutual agreement, the results nevertheless showed large variations. Intensive training for all people actively involved in testing and measurement seems indispensable to ensure uniform handling of the developed measurement equipment. This study also indicates that co-operation between existing In-Depth-Teams in different countries is successfully able to collect data at short notice and to implement new collection systems, as was achieved by the COST 357 programme. In all six of the participating countries (Germany, Greece, Ireland, Italy, Portugal and Turkey) some prior experience of collecting "in-depth" data existed.

The results represented here are to be regarded as the first advance results of the COST 357 project. This study of WG1 will continue until the end of September 2008, following which the final results will appear in a subsequent publication and/or the final report (Website: www.cost357.org).

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