Voluntary and Mandatory Motorcycle Helmet Standards

Freiwillige und gesetzlich vorgeschriebene Prüfungsstandards von Motorradhelmen

Edward B. Becker

Snell Memorial Foundation

Abstract

Helmet technology has improved considerably since 1968 but many motorcycle helmets have not. The current United States Federal Motor Vehicle Safety Standard 218 also known as the DOT motorcycle helmet standard makes virtually the same demands for helmet performance as the 1968 American Standards Institute's Motor Vehicle Helmet Standard. Yet even the DOT standard demands more protection from severe impact than the current UNECE R 22-05 requirement. This paper will explore the inadequacies of DOT and ECE 22-05 and compare their demands for protective capability to voluntary standards for motorcycle helmets as well as current standards for auto racing helmets and bicycle helmets. It will be seen that much more protective capability can be demanded of motorcycle helmets with no appreciable differences in cost, comfort and utility. Test results for various helmets tested to the several standards show that inadequacies in the standard to which a helmet is built become inadequacies in the helmet itself. It is possible for a voluntary standards organization to advance helmetry in the absence of any mandatory standard but where government standards exist, they must be maintained and improved, if not to advance the development of better helmets, then at least not to retard it unduly.

Voluntary and Mandatory Motorcycle Helmet Standards

Introduction

Mandatory motorcycle helmet standards lay out a set of specifications and performance requirements which all helmets must meet. Voluntary standards might then identify motorcycle helmets which, in one way or another, exceed the mandatory demands and confer an additional protective benefit to their users. Motorcyclists could then choose between helmets satisfying the mandatory minimums or helmets which meet and demonstrably exceed these minimums. If the voluntary standard can justify their claim to the helmet industry and to the public that complying helmets are somehow better, some portion of the motorcycling public will be attracted and helmet manufacturers will seek to cater to that portion. Otherwise, the voluntary standard, whatever its other virtues, is economically irrelevant; without some perception of added value, it can have no immediate bearing on helmets commercially available to the riding public.

Mandatory standards are relevant by fiat and voluntary standards are constrained by current mandatory requirements. They must remain compatible with the mandatory requirements even when compatibility conflicts with the standard developers' conceptions of superior capability. Furthermore, with the imprimatur of a government, helmets meeting mandatory standards will have an almost automatic acceptance as a sufficient precaution against injury. The appeal of better protection than what is taken to be sufficient will be much more strongly offset by other factors such as cost, styling, sleekness etc. In a sense, voluntary standards are prisoners of existing mandatory standards; unless the mandatory requirements are subjected to regular review and revision, voluntary standards and advances in helmets and helmet standards may be unnecessarily limited.

The critical issue in all of this is protection. In motorcycle helmets, protection is largely invisible; riders may easily evaluate helmets for fit, comfort, looks etc. but for an assessment of protective capability, they must almost certainly rely on the helmet's homologations. The value of these homologations rests in turn on the helmet testing and, especially, on the validity of the standards to which the testing was performed.

Ideally, an assessment of a motorcycle helmet standard's protective benefit would be based on the outcomes of motorcycle crashes. Helmet authorities have been promulgating helmet standards for at least 60 years and urging, if not requiring, the use of headgear meeting these standards. We ought, by now, to know what is happening to the people who wear them. However, although there are many studies documenting the injury reduction among riders who crash wearing helmets versus those who crash without them, there are few, if any, comparing the relative advantage of different helmets qualified to different standards. Any such study is likely to be frustrated since few motorcycle crash surveys contain any information about the type of helmet worn or the standards to which the helmet was qualified. Even so, some studies may provide a few hints.

Compliant vs. Non-compliant Helmets

One such study (U.S. Deptartment of Transportation NHTSA 2005) drew on observations of helmet use and motorcycle crash outcomes in Florida just before and just after the repeal of a state law requiring the use of motorcycle helmets complying with Federal Motor Vehicles Safety Standard (FMVSS) 218 (U.S. Department of Transportation NHTSA 1988) also known as DOT. The data presented included roadside counts of motorcyclists riding bareheaded or wearing either "compliant" or "non-compliant" headgear and fatality statistics broken out in terms of whether the victim had been wearing a helmet. The data presented were sufficient to estimate the relative benefits of these two broad categories of helmet.

The distinction between compliant and non-compliant was based on whether the helmet wall was at least an inch thick. Compliance with DOT generally requires that the helmet wall be at least an inch thick but many riders in localities where helmet use is required will wear a particular helmet configuration amounting to a rigid skull cap with a minimal chin strap. These helmets do not comply with DOT and are often referred to as "novelty" or "bogus" helmets. Even though this configuration is easily identified and is known not to comply with legal requirements, its use conveys at least a ritual observance of the law; traffic authorities often will not interfere with riders who wear these non-compliant helmets.

After the repeal of the Florida helmet use law, the use of legitimate helmets dropped by about a third but the use of these "novelty" helmets practically disappeared. Analysis of helmet usage and motorcycle crash fatality data collected pre and post repeal was sufficient to estimate the relative protective benefit of compliant helmets, non-compliant helmets and riding bareheaded. An analysis yields risks of 6.6, 11.1 and 11.6 fatalities per ten thousand registrations for compliant helmets, non-compliant helmets and riding bareheaded respectively. Since the data almost certainly includes fatalities due to injuries to body parts other than the head, the reductions in fatal head injury these numbers imply is reasonably much greater than the reductions in overall fatality. It is evident that compliant helmets are much more effective than non-compliant helmets which, at least for serious injuries, seem to be of little or no benefit.

Earlier Helmets vs. More Recent

Studies of motorcycle crash fatalities relying on data from the US government Fatal Accident Reporting System (FARS) indicate that the protective benefit of motorcycle helmets has improved over time. Anderson and Krause (Anderson and Kraus 1996) reported an apparent improvement in the reduction of fatality from 14% in 1976 to 49% in 1989. Deutermann (Deutermann 2004) reported that helmet effectiveness in reducing fatality improved from 29% in 1982 through 1987 to 37% over the years

1993 through 2002. Both these studies were based on accidents which involved a driver and a passenger and in which one or the other was fatally injured. The records included whether helmets were used but did not provide any specific information about the helmets themselves.

Lighter Helmets vs. Heavier

The COST 327 (Chinn, et al. 2001) Motorcycle Safety Helmet study included observations of head injury outcomes in motorcycle crashes along with the masses of the helmets worn by the injured riders. These were recorded in a table in the report but little was made of them. In fact, the report states that "[m]ass did not affect the injury outcome..." but when the table is converted to a chart there is a very strong suggestion that the heavier helmets were much more effective in preventing brain injury. It is possible that this suggestion evaporates when other observations are taken into consideration but the report, as it is now, invites the inference that heavier European motorcycle helmets are much more effective than lighter European helmets.

Energy Management

Each of these studies demonstrates that some helmets are more effective than others. The Florida data shows that thick walled, compliant helmets are better than thin walled non-compliant helmets. The FARS data shows that the in the United States, the more recent helmets in use are more effective than those previous. The COST 327 data indicates that in Europe the heavier helmets are more effective than the lighter ones. Taken together, they suggest that energy management, or energy absorption, is a critically important component of helmet protective capability.

The non-compliant helmets so popular in the US and which seem to provide no real reduction in crash fatality have virtually no impact energy management capability. In the FARS studies, Deutermann credits technological improvements for the increased effectiveness but Anderson and Krause also credit increased energy absorption. Both studies contend that the improvements noted in helmet effectiveness were due to less capable headgear being replaced over time.

If the performance of the heavier helmets in table 3.2 of the COST 327 report is due to the additional weight being a matter of thicker liners and more rigid shells, then the additional protective benefit implied in the chart is also a matter of increased energy management. Although the report states directly that mass did not affect the injury outcome, as strongly suggested in the table, the authors of that report did emphasize the importance of energy absorption and estimated the reductions that might be expected for increases in helmet energy absorptions of 24% and 30%.

Helmet Standards

The differences in the capabilities of the helmets in these studies may well be a matter of the differences in helmet standards. The dichotomy between the non-compliant and compliant helmets in Florida is largely a matter of the compliant helmets seeming to meet DOT requirements, the mandatory US minimum demands for street motorcycle headgear, while the non-compliant helmets were obviously incapable of satisfying any accepted motorcycle helmet standard.

Anderson and Krause credited the improvement they had noted in helmet effectiveness over the period of 1976 to 1989 to the gradual replacement of older headgear with helmets meeting appropriate standards. The improvement is striking, the older headgear must have been very poor or the newer headgear very much better to have had such an effect.

In fact, though, many of the helmets in use in 1976 may have already met DOT requirements. There are no records describing the helmets in the FARS data but a survey of motorcycle crashes in Los Angeles in 1976-77 may provide some insights. In 1981, Hurt, Ouellet and Thom (Hurt, Oullet and Thom 1981) published a survey of some 900 motorcycle incidents in the Los Angeles area during 1976 and '77 including assessments of involved helmets and other protective gear. Almost 50% of the helmets recovered from crash victims were made after 1974. 20% had DOT labels; DOT had taken effect in March of 1974 but only applied to helmets fitting the medium head form. Almost 42% were labeled to ANSI Z90.1-1971 (American National Standards Institute 1971) and 11% to the older ASA 1966 (American Standards Association 1966) requirement. 53% were labeled to SHCA, a certification program based first on ASA and ANSI and, later, DOT. Almost 23% were Snell labeled and 16% of these to Snell 1970. Since ASA, ANSI and Snell-68 called out the same test severities as DOT, by the mid 1970's most of the helmets in use in southern California already satisfied current US mandatory test severities.

Since the DOT severities remain unchanged to this day, it seems unlikely that the DOT requirements could have been the source of the increase in helmet effectiveness noted by Anderson and Krause and later by Deutermann. But even though DOT requirements were essentially static throughout these periods, Snell test severities advanced continually as well as the volume of Snell helmets being produced for sale in the US. Ouellet (Ouellet and Kasantikul 2006) noted that the impact liner thickness of helmets in the Los Angeles area in 1976-77 was about 20 to 25 mm but estimates that by 2005 these thicknesses were 25 to 35 mm. Snell certification almost certainly demands 35 mm or more.

The strong, negative correlation of head injury statistics with helmet weight evident in the table in the COST 327 report may also have had some relationship to helmet standards. The current ECE 22-05 requirement is frequently associated with lighter, thinner walled helmets but some of the national requirements preceding it could not be satisfied without thicker impact liners and much more rigid shells. BSI 6658-85 Type A for instance calls out requirements only slightly less demanding than Snell standards of the same period. Many of these helmets would still have been in use at the time of the COST 327 survey of motorcycle crashes.

Helmet Standards and Energy Management

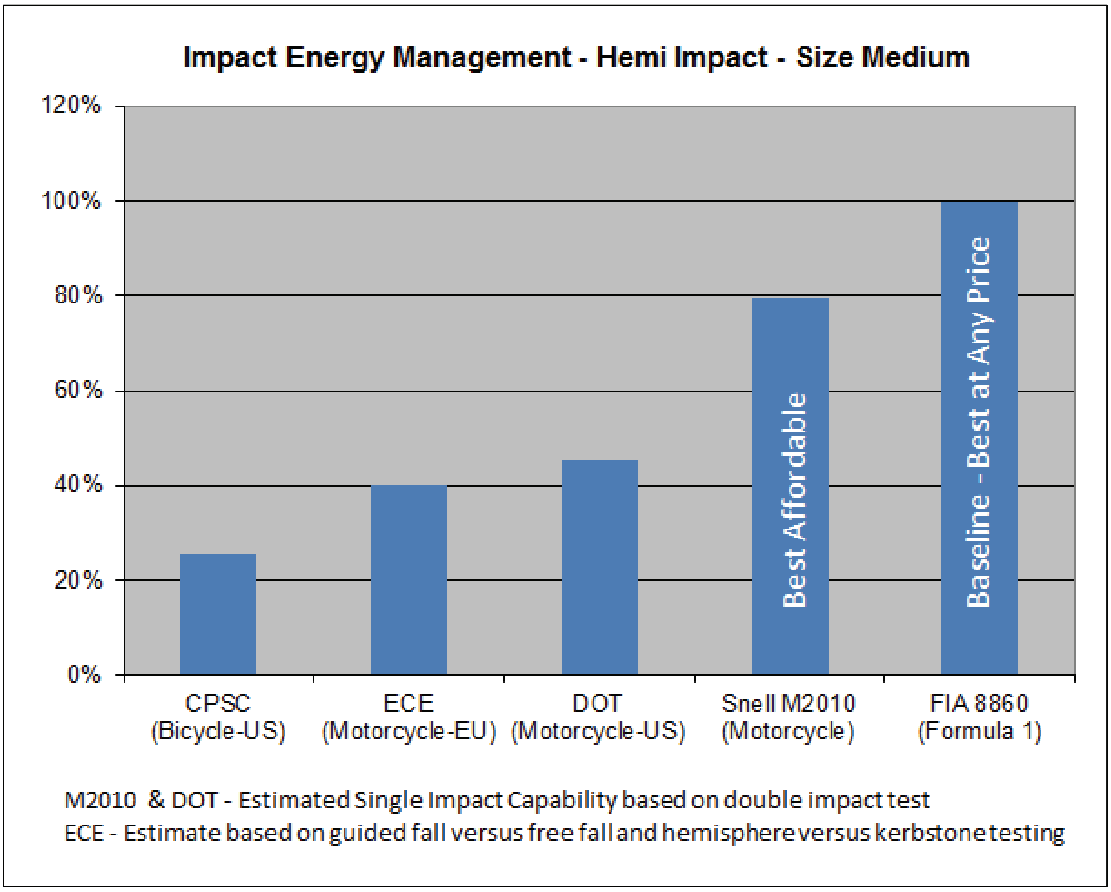
Helmet standards demand impact energy management by specifying impact tests. The essence of these is that a sample helmet containing a head form is dropped onto a rigid surface at a given velocity. Technicians measure the shock transmitted through the helmet wall and into the head form. If the helmet attenuates that shock sufficiently, it is deemed to have passed the test. There may be several different impact surfaces involved as well as different impact sites on the helmet shell and some standards call for more than one impact at a given site. When a helmet model is considered for certification, several samples must be tested in order to satisfy reasonable concerns that the model performs well in every test permitted in the standard.

There are two types of impact surface: flat which applies a distributed load across a broad area of the helmets surface, but most standards also call out at least one other convex surface which applies a concentrated load to a small area of the helmet. In ECE 22-05 (Economic Commission for Europe 2002) this convex surface resembles curbing and is called the kerbstone. Snell M2010 (Snell Memorial Foundation 2009), DOT and several other helmet standards call out an eight centimeter diameter hemisphere for their convex impact surface. There are also two types of failure seen in impact testing: one in which the helmet liner is too hard to attenuate the shock sufficiently and the other in which the liner is too thin and collapses completely before the impact event is over. Imagine jumping onto a thick, very hard mattress versus a soft, very thin mattress. In either case, the result is likely to be painful but the implications for the mattress engineers are very different. It's certainly no good making the hard mattress thicker or the thin mattress softer. The flat anvil amounts to a test for liner softness. If the liner is too hard, the distributed load applied in flat surface testing will pass too much shock through the helmet and into the head form. Of course, the helmet liner might also be too thin but, in that case, the concentrated loading in a test against a hemisphere or kerbstone would punch through the helmet wall well before a flat impact test would suggest any problem. However, if the liner is sufficiently thick, testing against the hemisphere and the kerbstone will never transmit as much shock as an impact against a flat surface. Effectively to meet impact test requirements, a helmet must be soft enough for testing on flat surfaces and thick enough for testing against the standard's convex surface.

There is one more consideration worth mentioning: a good, rigid helmet shell may also help a helmet to pass impacts against the hemisphere and kerbstone. A concentrated loading is less likely to punch through a good, rigid shell. Instead, the shell spreads that concentrated loading across a broader section of helmet liner in much the same way as impact against a flat surface. In Snell type testing, a perfectly rigid shell would yield the same impact result for either the flat or the hemisphere. However, no such shell exists; currently, even the best shells will flex somewhat so that the levels of transmitted shock will, at first, be lower but the helmet wall compression will be greater than for a comparable flat impact.

Since there’s no such thing as a perfectly rigid shell, it still holds that for helmets, flat impact requirements determine liner density and either the hemisphere or the kerbstone set liner thickness. And it’s also true that once the liner density is set, impact energy management depends on just how thick that liner has to be to survive the hemisphere or the kerbstone. A direct comparison can be had by looking at the kinetic energy of the test head form in these tests. The chart compares the size medium impact energy management requirement for five different helmet standards ranging from the United States CPSC bicycle helmet standard through to the FIA 8860-2010 advanced helmet specification (Federation Internationale de l'Automobile 2010) set for helmets used in Formula 1 auto racing. CPSC requirements represent the minimal demands thought consistent with bicycle safety but FIA 8860 demands all the crash impact protection considered feasible with current technology.

The chart shown below invokes several estimates. Since both Snell and DOT require two successive impacts, the single impact demand is estimated as the larger of either the first impact, or the sum of half the first impact plus all the second impact. An examination of test results from many Snell tests suggested that only half the energy management required for the first impact is lost due to helmet damage, the rest is recovered almost immediately after the test and is available to help manage the second impact. The ECE 22-05 estimate is based on the differences observed between ECE 22-05 type testing and the guided fall procedures used by FIA, Snell, DOT and CPSC. Guided fall aligns the head form center of gravity with the center of the impact surface assuring that almost all the impact energy must be managed by the helmet but in the ECE 22-05 procedure as much as 20% of the impact energy may be lost to rotation due to the misalignment of the head form center of gravity. The estimate also includes a consideration for the relative severity of the kerbstone versus the hemisphere. Guided fall tests of identical helmets showed that the kerbstone produces only 80% of the helmet wall crush seen in testing against the hemisphere. This difference seems plausible because the kerbstone concentrates the loading along a line while the hemisphere concentrates the loading about a point.



The chart indicates that ECE 22-05 demands more energy than the United States currently requires for bicycle headgear but slightly less than is required by DOT, a standard representing demands considered reasonable lower limits back in 1966. Snell M2010 demands almost twice as much and FIA 8860 demands as much as 150% more energy management than the ECE 22-05 requirement. However, FIA 8860 helmet technology is well beyond most riders' budgets. That extra margin of performance beyond Snell M2010 requires some very expensive shell technology.

M2010 Tests of ECE 22-05 Type Helmets

Previously, we had reported results for guided fall testing on helmets certified to Snell M2005 and comparable helmets made by the same manufacturer to ECE 22-05. At that time we had been investigating standards compatibility: whether it was feasible to make a single model which would meet both Snell and ECE 22-05 requirements. So we looked for the best possible helmets ECE 22-05 helmets we could find. For this study, we looked for something a little different: the minimum level of performance which could reasonably be expected of an ECE 22-05 homologated headgear. We purchased eight helmet units in medium sizes with established brand and model names and subjected them to Snell M2010 type testing.

All the helmets were full face and included face shields. The average weight of the helmets came in at 1368 grams, about 230 grams lighter than the average for comparable M2010 helmets. However, there is a considerable overlap in the weight ranges; the lightest of the Snell helmets is 1323 grams and two of the ECE 22-05 samples tested weigh more than 1500 grams.

None of the eight samples met M2010 impact requirements. Although they all easily passed requirements for flat impact, each failed one or more hemisphere impact tests. Still, the performance in many of these tests exceeded expectations. The Snell impact tests call for two impacts at each site tested, the first at 7.75 m/sec and the second at a velocity based on the size of the test head form. Three of the eight samples had no difficulty passing all the first impacts in tests against the hemisphere and there were a number of instances in which the samples also met requirements for the second of the two impacts. However, there were six instances in which samples failed the first of the two hemisphere impacts and one of these managed only about 77% of the energy estimated as a minimum for a compliant ECE 22-05 helmet.

All the samples were disassembled and inspected; there were no apparent defects in materials or workmanship. The test results were all self-consistent with no apparent anomalies. Still, it is quite possible that all the samples were ECE 22-05 compliant, in spite of the test results and particularly that result indicating only 77% of the impact energy management implied in ECE 22-05. Snell as well as DOT, FIA 8860 and a host of other helmet standards specifies broad areas of the helmet surface to which impacts may be directed. ECE 22-05 confines impact sites to specific points. The impact producing that 77% result was directed about 8 centimeters above and to the rear of the ECE 22-05 side impact site. Effectively, ECE 22-05 left a “hole” in the helmet’s coverage which might reasonably expose a wearer to a devastating injury.

Summary of Test Results – Part 1				
Sample		Snell Energy	ECE 22-05 Energy	Crush mm
2044	J head form			
	Flat Impact Left side 240° 240mm - Pass	100%		
	Hemi Impact Front 0° 260mm - 2nd Impact Failure	80%	168%	
	Hemi Impact Right 120° 140mm - 2nd Impact Failure	83%	175%	
	Hemi Impact Rear 180° 135mm - Pass	100%	211%	
2045	J head form			
	Flat Impact Left side 245° 220mm - Pass	100%		
	Hemi Impact Front 0° 260mm - 1st Impact Failure	72%	152%	40.2
	Hemi Impact Right 115° 135mm - 1st Impact Failure	69%	145%	38.1
	Hemi Impact Rear 180° 120mm - Pass	100%	211%	
2046	J head form			
	Flat Impact Left side 240° 210mm - Pass	100%		
	Hemi Impact Front 0° 255mm - 2nd Impact Failure	80%	168%	
	Hemi Impact Right 120° 135mm - Pass	100%	211%	
	Hemi Impact Rear 180° 120mm - Pass	100%	211%	
2047	J head form			
	Flat Impact Left side 237° 175mm - Pass	100%		
	Hemi Impact Front 315° 230mm - 1st Impact Failure	63%	133%	32.5
	Hemi Impact Right 125° 135mm - 2nd Impact Failure	79%	166%	
	Hemi Impact Rear 180° 100mm - 2nd Impact Failure	94%	198%	

The tables present a summary of the test results. Impact sites on the helmets are described in terms of the quadrant: Front, Right, Left and Rear; and also in terms of an angle and distance measurement. The helmet sample is placed on its lower edge on a table top and then impact site is located in terms of an angle measured clockwise from the front center line of the helmet and the vertical distance from the table top along the contour of the helmet to the impact site. The test outcome is given in terms of the percentage of energy management observed versus that expected. All the samples did well in flat impact and the samples met Snell requirements in nine of twenty four hemi impact test series. All the results except one exceeded the management implied in the ECE 22-05 requirements. That one was at a test site not exercised in ECE 22-05 requirements so the sample may still have been ECE 22-05 compliant. There were seven instances in which the samples did not meet requirements even for the first of the two Snell impacts. The helmet wall deformations calculated for these generally exceeded 30 mm and two appeared to be greater than 40 mm.

Summary of Test Results - Part 2				
Sample		Snell Energy	ECE 22-05 Energy	Crush mm
2048	J head form			
	Flat Impact Front 0° 263mm - Pass	100%		
	Hemi Impact Right 120° 130mm - Pass	100%	211%	
	Hemi Impact Left 240° 221mm - 2nd Impact Failure	97%	206%	
	Hemi Impact Rear 180° 150mm - Pass	100%	211%	
2049	J head form			
	Flat Impact Front 330° 225mm - Pass	100%		
	Hemi Impact Right 125° 125mm - 1st Impact Failure	74%	156%	42.7
	Hemi Impact Left 245° 205mm - 2nd Impact Failure	79%	167%	
	Hemi Impact Rear 180° 150mm - Pass	100%	211%	
2050	J head form			
	Flat Impact Left 220° 195mm - Pass	100%		
	Hemi Impact Front 305° 240mm - 1st Impact Failure	75%	158%	35.7
	Hemi Impact Right 118° 165mm - 1st Impact Failure	74%	156%	30.8
	Hemi Impact Rear 180° 140mm - Pass	100%	211%	
2051	M head form			
	Flat Impact Front 30° 250mm - Pass	100%		
	Hemi Impact Right 110° 145mm - 2nd Impact Failure	95%		
	Hemi Impact Left 220° 175mm - 1st Impact Failure	43%	76%	34.8
	Hemi Impact Rear 180° 150mm - Pass	100%	175%	

Discussion

Helmets provide impact protection by placing a deformable wall between the wearer's head and an impact surface. During an impact, this wall is crushed between the wearer's head and the surface. As it is crushed, the wall applies a controlled braking force to the head slowing it from its initial impact velocity. The wall must be sufficiently thick to avoid collapsing completely before the head slows to a stop and the wall must be sufficiently soft so that the braking forces do not exceed the head's injury tolerance.

Motorcycle helmet impact test procedures assess both these matters simultaneously. A sample helmet containing an instrumented head form falls onto an impact surface at a specified velocity. Any failure, whether the wall is too thin or the controlled braking forces too high, will cause the head form instrument readings to exceed the standard criteria.

Motorcycle helmets must also contend with a range of potential impact surfaces ranging from flat road surfaces which apply loads across a broad area of the helmet exterior to load concentrating surfaces such as curbing, barrier elements and sign posts which may punch through and collapse a small section of the helmet wall to reach the head inside. Helmet standards generally specify at least two impact surfaces, one flat and the other convex. Helmets which meet requirements for both these extremes are considered proof for any intermediate surface.

Helmets which fail because the braking forces are too high have trouble with flat impacts. Helmets which fail because the helmet wall has collapsed completely have trouble with convex impact surfaces. Effectively, flat impact tests may be seen as a limit on helmet braking force while convex surfaces demand a combination of at least a minimum wall thickness coupled with a rigid, load spreading shell.

DOT and ECE 22-05 apply different test criteria but, for flat impact, the effects are remarkably similar; the DOT time duration requirement and the ECE 22-05 HIC requirement both limit flat impact peak acceleration to about 250 G. Although Snell standards allow higher levels, Snell helmets sold for street motorcycling in the US must meet DOT and, in Europe, must meet ECE 22-05. However, Snell testing demands substantially more impact energy management than either ECE 22-05 or DOT. To meet Snell impact requirements, helmet shells must be more rigid or helmet walls thicker or some combination of the two. The effect is that Snell certified helmets will manage higher levels of head impact velocity than either ECE 22-05 or DOT.

At this time, there is no statistical proof that helmets meeting any particular standard reduce crash injury and fatality any more effectively than helmets meeting some other standard. However, there is evidence that DOT compliant helmets are more effective than non-compliant helmets, that DOT compliant helmets in use in the US from the late 1980's and going forward are much more effective than those worn in the mid 1970's and that the heavier helmets in the crash incidents considered in the COST 327 study of motorcycle injury were more effective than the lighter helmets. It is only a short step from there to ascribe these differences in protective capability to impact energy management. If that is truly the case, then helmets meeting Snell plus ECE 22-05 must certainly be more protective than helmets meeting ECE 22-05 only and similarly for Snell plus DOT.

Conclusion

Snell standards originated in 1959 and were intended, at first, for auto racing helmets. Motorcyclists began wearing them, almost from the beginning but the US mandatory DOT requirements did not take effect until 1974. Remarkably, motorcyclists continued to wear Snell certified helmets although, from 1974 on, these same helmets were required to meet DOT. Effectively Snell became a "value added" standard indicating crash impact performance exceeding DOT's mandatory minimums.

Snell exists because DOT demands much less than industry can provide and because more than a few DOT labeled helmets will not meet DOT requirements. ECE 22-05 also demands much less than industry can provide and, with no disparagement to European test technicians and standards authorities, the standard may be gamed leaving holes in the protection which might be expected of nominally compliant helmets.

Snell motorcycle helmet programs were able to continue because DOT demanded and assured much less than the industry could provide and American riders could afford. Throughout the 1980's and to this day, even while many American motorcyclists protest laws requiring them to wear helmets and choose instead to ride bareheaded, many other American riders choose to seek out, buy and wear Snell certified helmets rather than rely on the assurances of DOT.

I and my colleagues at Snell wish to offer this same choice to Europe; firstly to European riders who already have access to at least two helmet models meeting both Snell M2010 and ECE 22-05. But also to the European community in case they might consider revamping their standards and test procedures to demand levels of performance consistent with the best helmets riders can reasonably be expected to wear.

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