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Climbing Flooring and Related Standards

Question: Does the climbing standard guarantee a good product?

Answer: No.

When we talk about flooring in the climbing industry, it is very often advertised that the flooring system complies with the climbing standard. To some customers, especially new to the business, this is a guarantee enough that the product is good. However, is that the case? To answer this question, we must first answer several other questions, such as:

- Boulder flooring or lead & top rope flooring?

- Which standard – European, French, Australian, etc.?

- What do those standards require and specify?

- Are those standards updated quickly enough to accommodate the rapid increase in climbing popularity and the rapid developments in the materials and technology used for production?

- How is testing done? What do the results represent?

- And others.

With this paper, we would like to provide information to our customers on the critical parameters and features of climbing flooring showing also what the climbing standards for flooring are and what they require. In general, there are good and bad things in each of those standards, and there are areas that are not mentioned at all. This is why at Climbmat, we are not only trying to pass the standard for a particular region but instead, we design our products using the best practices from all standards combined and even go beyond that. In our opinion, this yields a much better, much safer, and long-lasting product in the end. Not to mention, that in some cases it is lifesaving.

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Here is a shortlist of all standards, even remotely applicable to indoor climbing, with a short explanation of what the standard represents. A more detailed overview of what is or is not included in the standards will be given below when discussing the specifics.

- For Europe – EN 12572-1:2017. This European Standard specifies the safety requirements and test methods for artificial climbing structures (ACS), with protection points. In plain words, this standard is for indoor walls meant for Lead & Top rope climbing. The only two things remotely related to flooring are the "falling space" (the space on and around the ACS that can be occupied by the user during a fall), and "free space" (space around the ground projection of the ACS that can be occupied by a climbing, a lowering, spotting or belaying user) [1]. There is no actual mention of flooring or impact-absorbing material of any kind in this standard.

- For Europe – EN 12572-2:2017. This European Standard specifies the requirements and calculation methods for bouldering walls, including the safety zone [2]. In contrast to part 1 of this standard, this one does include safety requirements and calculation methods for impact absorbing flooring.

- For France specifically – NF P90-311:2009. This is a French national standard, which applies specifically to impact absorption equipment (mats, flooring), for their use underneath ACSs without anchor points (boulders), which comply with standard EN 12572-2: 2009. (The maximum height of the boulder wall, at the top of which it is not possible to stand, should be 4.5 m. It should be 4 m when it is possible to stand on it.) [3]. Simply put, this is a more detailed version of the previous iteration of the European Standard EN 12572-2:2008.

- For France specifically – NF P90-312:2007. This is a French national standard, which applies specifically for impact absorption equipment (mats, flooring), for their use underneath an ACSs with anchor points (lead & top rope), which comply with standard EN 12572-2: 2009. As stated in the standard it has been drafted upper the request of manufacturers and users, following accidents caused by the use of impact-absorbing equipment unsuitable for climbing or the total lack of such. The purpose of this equipment is to limit the risk of irreversible injury during landing, after a climber's fall from an ACS [4]. It is very important to note a fact, which

is also mentioned in the standard. Specified requirements and calculation methods for flooring in this specific case are to limit the consequences of a climber's fall from a height corresponding to its position in the snap hook of the first belay point. This is a height of less than 3.1 m. Meaning that this does not cover falls from a height greater than that – for example from the top of the wall – 15-17 m. Which we will argue is not sufficient. Even though those are the most common types of falls in this area of climbing, falls from greater heights are also possible, and unfortunately, have happened.

- For Australia – AS 2316.1-2009. This is an Australian Standard, based on the previous iteration of the European Standard EN 12572:2008 – Part 1, Part 2, and Part 3 [5]. It combines all three parts of the European standard, with small changes. For flooring specifically, this includes reduced sizes of the impact zones for bouldering and fixed ones for belayed ACSs, with a note that it might need to be increased depending on the inclination of the wall. It also offers a different testing method, when compared to the EN 12572-2, for the impact absorption capacity of the flooring for both bouldering and rope climbing. It is based on a playground safety standard EN 1177 [6], which is only concerned with the head of the user instead of the feet or the whole body.

- For the US and Canada specifically, there is no standard. As of the writing of this paper, there is no specific standard drafted for flooring for ACS of any kind. The best practice, which is followed, is to borrow from other standards, such as EN12572 and EN 1177.

- For the rest of the world – if there is no local standard specified, we recommend using a combination of the mentioned above standards. Which has been our practice in the past and will continue to be in the future.

Since the purpose of the flooring systems for climbing without a rope or other belaying devices (Boulder climbing) and with one (Lead & top rope climbing), are vastly different, we will split this paper into two parts, for each type.

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BOULDER FLOORING

In indoor boulder climbing it is generally accepted, and in most parts of the world mandatory, to put some impact-absorbing material underneath the artificial climbing structure – i.e. water, air cushion, shingle, or foam safety mat [2]. Being a foam safety mat manufacturer, we will mainly focus on our area of expertise. Those types of mats are by far the most popular choice for indoor climbing. Simply put, a foam safety mat is several layers of foam encapsulated together in a fabric bag (PVC coated, polyester fabric, carpet, ballistic nylon, etc.). They can offer very good protection for repetitive falls from various heights – from the top of the mat to the top of the boulder. When put in place, with proper cosmetic maintenance and cleanliness, they usually do not require changing for at least 3 to 5 years, and even more, depending on the types of materials used and the traffic.

In general, the purpose of the impact-absorbing flooring for bouldering is to be able to accommodate landings when falling from at least the top of the boulder. It should not be too firm, and not too soft – the impact force, experienced by the climber, needs to be within a certain range, as well as the energy absorption potential of the system. In all cases, the boulder flooring system should minimize the chances of common injuries. This, however, does not mean that a fall on a boulder mat is going to be comfortable (like in an airbag or a safety net), or that it guarantees that there is absolutely no possibility for injuries. For those reasons we strongly recommend to our customers, to educate their customers, especially new climbers, on proper falling techniques.

When designing and purchasing a boulder wall, and its foam safety mat, several things should be taken into account:

1. **Impact area.** This is the surface on which a user (climber) lands after falling from the boulder wall [2]. In the three standards for bouldering walls (European, French, and Australian), the size of this area is determined by extending the ground

Projection of the bouldering wall with certain dimensions, an example of which is shown in Fig. 1, below.

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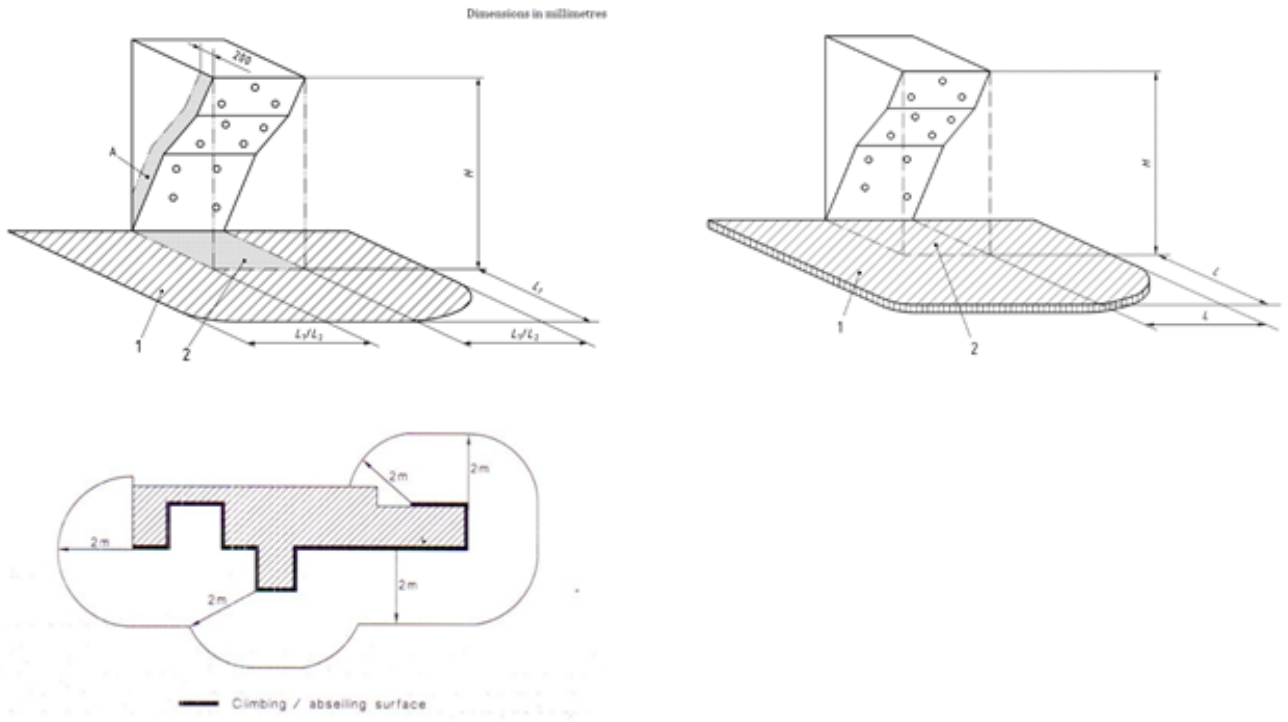

Fig. 1 Example of the impact areas at the base of the bouldering wall, a) EN 12572-2:2017 [2], b) NF P90-311:2009 [3], and c) AS2319.1-2009 [5].

In short, the difference between the French standard for the zone and the European is that in the French the size of the area in front of the boulder and on the side is the same. While in the European standard the size of the area on the side is reduced. For boulder walls with heights up to 3 m, those values are 2.0 m in front and ½ the height of the wall on the side (2.0 m for the French standard). For walls with heights between 3.0 m and 4.5 m, they are 2.5 m in front and 1.5 m on the side (2.5 m for the French standard). In the Australian standard, only the base of the wall is extended by 2 m, for walls up to 3.5 m. For higher walls or acutely over-hanged walls, it is stated that this zone may need to be revisited.

As stated in the standards, those are the minimum values, and those zones may need to be extended depending on the specific design of the bouldering wall – for example, acutely angled overhangs.

As most customers would say, the smaller the mat, the better, and as every manufacturer would prefer, the bigger, the mat, the better. Thus the biggest question here is, are those minimal values sufficient. Here we do not believe that there is an unambiguous answer. The most important thing that we always take into consideration is that there is matting covering at least the minimal impact area, and

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depending on other factors how can we extend that area. Those factors include, but are not limited to the design of the bouldering wall (shape and great angled overhangs), the surrounding structures (i.e. columns, walls, doors, emergency exits, etc.), route-setting (possibility for parkour bouldering problems or any other types of jumping at speed, or extension of the wall via big holds or volumes), and others.

We in Climbmat OOD, follow all those rules, and different design trends, and extend our mats above the minimal impact areas, according to them.

2. **Mat thickness.** How thick a foam safety mat should be? This specific parameter is not addressed in any of the standards.

Contrasting with the previous point there is no minimum value to be considered. One statement that can be found is from the European standard – "the impact-absorbing material shall be adapted to accept a fall from at least the maximum height of the bouldering wall at the bottom of which it is installed" [2]. This is a good guideline but is not very specific. The commonly accepted thicknesses in recent years are 300 mm and 400 mm (~12 inches and 16 inches). Climbmat offers standard mats, with both thicknesses. All of them have been optimized, following the above rule. However, to make a thinner mat able to accept a fall from a bigger height (up to 4.5 m) it is necessary to be stiffer, than a similar product that is thicker (400 mm for example). For this reason, we recommend that 300 mm mats are used for walls with a height up to 4 m.

A simple unwritten rule that is commonly accepted in gyms around the USA and Canada is to use 1 inch of matting for every 1 ft of the wall, thus approximately 400 mm mats for a 4.5 m wall.

This is a good simple rule to follow. However, we try to be more precise and scientific. For this reason, we base our recommendations on the total compression of a mat with a certain thickness, when tested according to the EN 12572-2 for its shock-absorbing capacity.

3. **Material of the cover.** The material, or combination of materials used for encapsulating the foam in a safety mat. This is usually the top surface, on which the climber walks, sits, and most importantly falls. Besides the mention that the top surface of a mat should be uniform, without huge gaps or sharp objects sticking out in the impact area, there are no other specific requirements for the types of materials that can be used.

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On one hand, this gives us as manufacturers the freedom to use different materials. On the other hand, it may lead to confusion, in customers, when comparing one product to another. For this reason, there is a brief overview of the most popular choices.

The three most popular choices that are used in the market right now are “Vinyl” (PVC, PVC Vinyl), “Carpet” and “Ballistic Nylon” as an alternative to the previous two. Historically “Vinyl” has been the most popular material of choice. This material’s elasticity and tensile strength make it a very good choice. However, its main drawbacks are that it is hard to clean, and does not hold the chalk – leading to greatly increased use of “Carpet” in recent years. It has been used in combination with “Vinyl”, as a standalone of laminated to closed-cell PE foam. To the best of our knowledge, the best quality and results are achieved when using “Vinyl” and “Carpet” together. But how to tell different materials apart?

When saying “Vinyl” or PVC, or PVC vinyl, the material in question is more precisely, a PVC coated polyester fabric. A variety of products with this description exists on the market. For our safety mat products, we only offer heavy-duty polyester fabric with double side PVC coating, with a total apparent weight of 900 g/m2. One-sided coating, or lower weight/strength materials (440 g/m2 or 650-680 g/m2), are sometimes offered on the market as well. Those however have proven to yield a lower lifespan of the product in general, and thus we have discarded it from our products.

For “Carpet” top material also a variety of products exist on the market – different types of carpets with PE or PP fibers, woven, needle felt or needle punched. The carpet on itself usually is not strong enough to accommodate falling climbers, when put on top of soft PU foam. This however does not mean that some manufacturers do not use this material on itself. To strengthen carpet material, some manufacturers have used a composite material, known as Carpet Bonded Foam (CBF). Simply put, it is carpet, laminated to one or more thin layers of closed-cell PE or XPE foam, usually no thicker than 3-5 cm. This type of composite material has its advantages, when used on its own, put over a hard surface, such as concrete, or when used over heavy and hard open-cell PU foams. When used over soft PU foams, however, which is the case for boulders safety mats, the CBF, has proven to be too brittle, and exhibit inelastic deformation under low stress, which leads to quick stretching and tearing of the composite material.

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Aiming to deliver the best possible quality, when using, we in Climbmat OOD, only offer a combination of "Vinyl", with "Carpet" laid on top of it. We only supply high-traffic optimized carpets, for our boulder mat products.

Here is a brief table of comparisons between "Vinyl" and "Carpet", when using on their own as a boulder mat top cover.

900 g (26 oz) Vinyl		Carpet	
Pros	**Cons**	**Pros**	**Cons**
Very durable and flexible material	Very hard to clean climbing shoe rubber marks	**Very easy cleaning**	Lower durability
Does not hold odors	Does not hold the chalk	**Comfortable to the touch**	**Non as flexible as vinyl, can cause warps and wrinkles over time**
Spill resistant – protects the foam.	No sound insulation	**Holds the chalk, which can be easily removed upon cleaning**	Holds stains and odors, if it's not cleaned very often
No seams		**High Sound/Noise reduction**	**Can have more seems**

Table 1. Comparison between Carpet and Vinyl. Bolded in blue are the pros and cons when the two materials are used in combination.

4. Mat stiffness. This is perhaps the most discussed topic when we talk about boulder mats.

A lot of factors can contribute to the stiffness of a mat, such as type of the cover material, type of construction, how tight the cover material is stretched over the foam, etc. The main factor of course is the type of foam used. In our products, we only use the highest quality foam, with different densities

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and types. A lot of climbers prefer a softer landing. However, a soft landing surface could contribute to more injuries like sprained or twisted ankles. Furthermore, the softer the foam is usually the shorter its lifespan is, thus from the gym owner's perspective, it can be more costly. On the other hand, harder mats (foam) do have a longer lifespan, but they could contribute to more severe injuries and long-term cumulative injuries. A compromise must be found here.

However, what does a hard or soft mat mean? How do we exactly measure that? Using the testing procedures described in the climbing standards and beyond, we at Climbmat OOD try to quantify that. All of our boulder mats are designed and tested to have sufficient impact attenuation in the event of a fall, even from the top of the wall. Even though we have precise deceleration measurements, it is our firm belief that no one ACS standard gives full and precise information on what happens to a climber in the event of a fall over an impact attenuating system of any kind. Nor do they qualify as to what is hard or what is soft, for a climber.

The EN 12572-2 and NF P90-311 standards use a 30 kg hemispherical indenter (160 mm in diameter), dropped on the top of the surface, to determine and record the deceleration during the impact, (subsequently from it the maximum deflection and resilience (rebound) of the boulder mat system). The AS2316.1 standard uses a 4.6 kg hemispherical “head form” (160 mm in diameter), dropped on the top of the surface, to determine and record the deceleration during the impact, as well as the head injury criteria (HIC), and the duration of the impact. Even though it is not specifically described, to the best of our knowledge the 30 kg indenter is a good representation of a climber falling on their feet, and thus focuses on that part of the body. The 4.6 kg “head form”, on the other hand, is an analog to the average human head, thus giving information about the potential head injuries, which even though much less frequent are more threatening.

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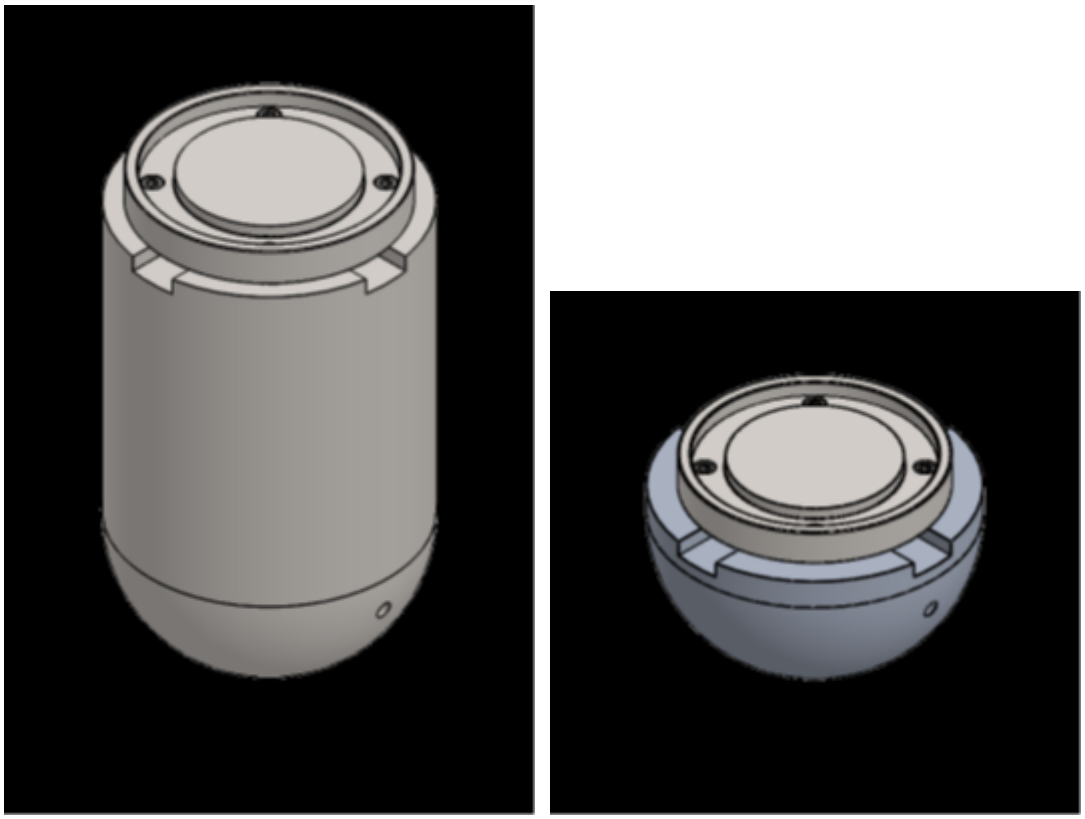

Fig.2 Depiction of the impactors used for testing, EN 12572-2:2017 [2], and NF P90-311:2009 [3] on the left, and AS2319.1-2009 [5] and EN 1177:2018 [6] on the right.

Thus to ensure that a boulder mat provides the best possible protection, in our design process, a combination of the best practices and test procedures from ACS standards all around the globe have been followed. In addition to those, borrowing from other industries, we use more precise human analogs to determine the effects a fall on a boulder mat has on a climber – Hybrid II crash test dummy – Fig.3. We believe that the combination of all those practices, and test procedures, provide the best possible protection for the climber on bouldering walls.

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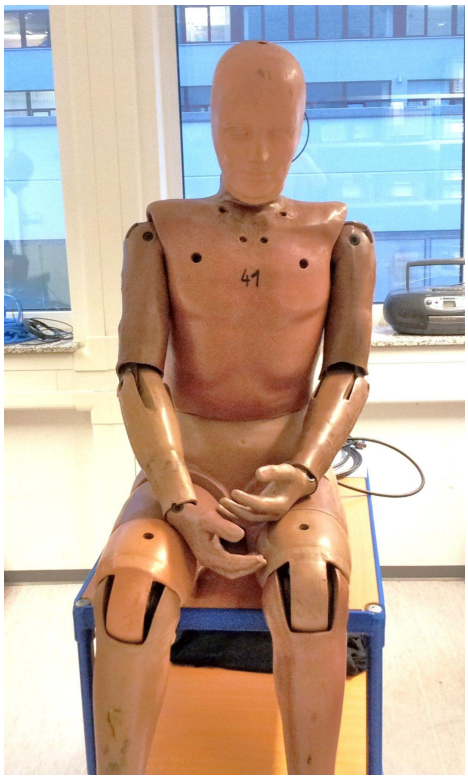

Fig. 3 Hybrid II 50th Percentile Male, crash tests dummy.

With all that being said and compiled together, hard or soft mat to climbers is still a relative expression. All of Climbmat OOD products are on the lower half of the deceleration (impact force) range, allowed by the European and Australian standards. However, to some climbers, even our softest mats could feel hard. Thus alongside quantifying the forces experienced by climbers and minimizing the possibility for injuries, we also advise our customers, to educate all climbers on proper ways of falling on boulder mats, to further minimize the chances for injury.

LEAD & TOP ROPE FLOORING

Broadly speaking the purpose of the impact-absorbing flooring for lead & top rope climbing is to …

Well judging by the current global state of flooring underneath rope walls, it is highly debatable what the main purpose should be. Unfortunately, a common practice in some places, in Europe and Asia is to not use any protection flooring whatsoever. Just as the indoor climbing walls emulate the experience of outdoor rock climbing, the concrete/wooden floor emulates the outdoor hard rock/ground

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experience. In short, you should not fall. As mentioned before, this is our humble opinion and is simply unacceptable, for modern indoor climbing. As we know all too well, accidents do happen.

In contrast to boulder climbing, where climbers fall/jump all the time, in rope climbing the falls from 1-2-3 meters should occur rarely, and falls from 5-10-15 meters should not occur. Yet the reality is different. Falls from up to 3 meters (up to the first clip), do occur very often. Climbers do not clip properly to the first clip, in lead climbing and they fall either on their feet or over the belayer. Those types of accidents have the potential for minor injuries, but they are not so frightening. Falls from above 3 meters however especially up to 15-17 meters are much more serious. They do not tend to happen very often, but unfortunately, they do occur occasionally. It might be a rare case of equipment failure, climber's or belayer's error, or something else. But the reality is that those accidents do occur. Even more so in recent years with the introduction of the auto-belay systems. Most of those devices are thoroughly tested, certified, and rarely fail, however climbers, both new and experienced, often forget to attach themselves to the device. Besides, even though accidents as such happen very rarely, they still do happen, and contrasting to boulder climbing, accidents here have a high chance for a severe, life-altering, or life-threatening injury.

With that being said the EN12572-1 standard does not mandate or even mention impact attenuating flooring for rope walls. Perhaps for that reason, many existing gyms around Europe, and other places around the globe don't have any flooring system. As mentioned countries like France and Australia, do mandate one, with the NF P90-312 and AS2316.1 standards, respectively, but they are optimized for accepting falls only up to the first belay point. Usually, thin (<10 cm) mats filled with closed-cell PE and/or open-cell PU foams are used. This type of flooring system has a good walking stiffness, which is desirable in rope climbing, and does offer reasonable protection for falls up to 2-3 meters, but extremely limited protection above that. It should go without saying that they are better than concrete or wooden floors (no impact attenuating flooring), but not by much, especially with the increase of fall height. In our opinion, this is not good enough.

It is our firm belief that impact attenuating flooring, under rope walls is not a luxury, but a necessity. Not only that, but that flooring should be sufficient enough to either accept falls from both up to the

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first anchor point and from the top of the wall, or at least up to 8-10 meters, where most of the accidents occur if not up to the top of the wall. Thus significantly minimizing the chances for life-altering or life-threatening injuries. Furthermore, this type of safety flooring should cover a much broader area than the current standards mandate as a minimum. Again for accommodating for falls up to the top of the wall. Another thing that needs to be considered is the walking stiffness of the mat. It should not be as soft as boulder mats (even though they would accept falls from up to 8-10 meters very nicely). It should be firm enough so that the belayer does not sink more than 25 mm. Furthermore, the surface should be as flat as possible, without any tripping hazards. Belayers have a very important job, so their focus should not be impeded – after all they hold the life of their partner in their hands.

When designing and purchasing a rope climbing wall, and its impact attenuation mat, several things should be taken into account:

1. **Impact area.** Since the mat in the related standards is only designed to limit the injuries in the event of a fall from a height, corresponding to the first anchor point [4]. An example of the French and Australian standard impact safety zones is shown below in Fig. 4.

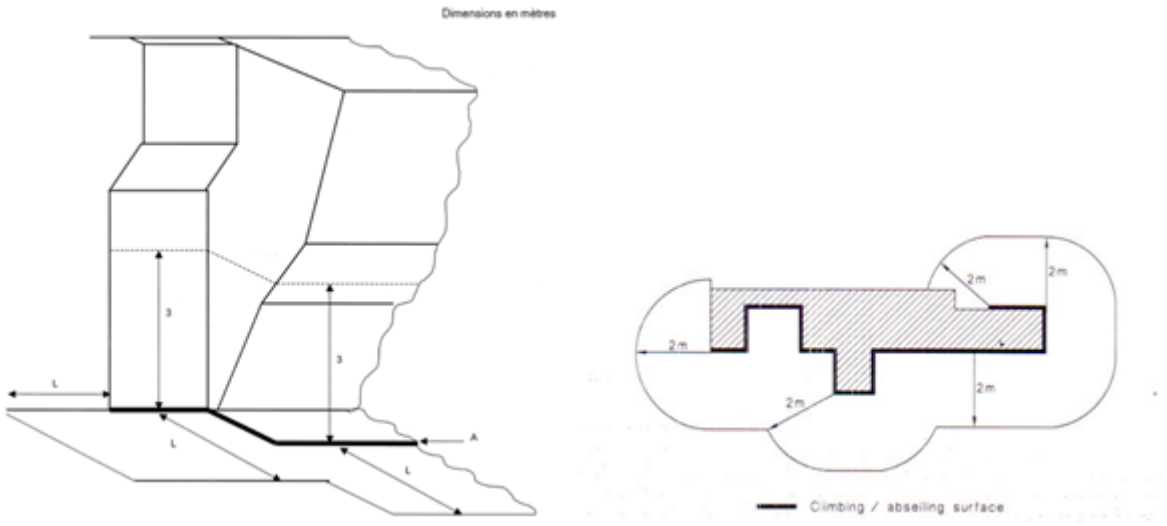

Fig. 4 Example of the impact areas at the base of the rope climbing wall, a) NF P90-312 [4], and b) AS2319.1-2009 [5].

In basic terms for the NF P90-312, the zone starts at the base of the wall and extends the ground projection of the ACS at the 3-meter point with a minimum of 2.5 m. The Australian standard simply

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states that only the base of the wall, bottom line, should be extended by 2 m. And for belayed areas with increased risks, such as off-wall anchors and inclined surfaces, this zone may need to be revisited.

We in Climbmat OOD, follow all those rules, and different design trends, and extend our mats above the minimal impact areas, according to them. However, we also believe that these zones as a base are too minimalistic. And as an extent, we propose and recommend to our customers an extended safety zone that can accommodate for falls from up to the maximum height of the ACS, instead of only up to the first anchor point. Borrowing from the boulder mat impact zones, starting from the base of the wall up to the extension of the ground projection of the top of the wall (or the top anchor point), with a minimum of 2.5 meters.

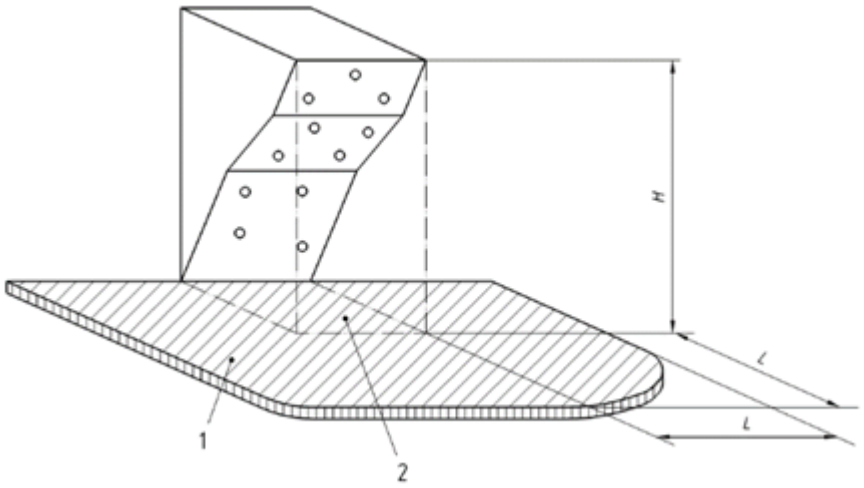

Fig. 5 Example of the Climbmat's proposed impact areas for rope climbing walls.

2. **Mat thickness.** It is not written explicitly in any of the standards, how thick a safety mat should be. The French NF P90-312, however, mentions an upper limit of no more than 10 cm [4]. The reasoning behind being to avoid too great a step, especially for the belayer. Even though it is good reasoning, it can be easily avoided by simply increasing the mat area, to avoid any steps.

A variety of products, with different thicknesses, exists. The main guideline for the mat thickness is to have a sufficient impact attenuation capacity. As we have mentioned the standards, only consider falls up to the first anchor point, if any. Thus typically very thin PVC fabric-covered, PU or PE foam mats, for rubber crumb tiles are offered and used here. As we will discuss in the next point we believe that

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those are not nearly sufficient in the event of a fall from a greater height, and thus we offer and recommend thicker mats.

It has to be mentioned that the 10 cm thickness significantly limits the impact-absorbing capacity of a safety flooring system.

3. **Static rigidity.** All the standards mention that the surface of the mat (boulder or rope alike), should be uniform, without any tripping hazards. The French NF P90-312, additionally specifies a certain static rigidity of the surface. The standard mentions that the surface of the mat should not deflect with more than 25 mm [4] when compressed with an 80 mm diameter, 50 kg testing object. It does not explain how this number was derived but the reasoning behind it is straightforward. If the belayer sinks too much in a too soft mat, they can potentially trip and fall, which can result in a serious accident for the climber. Making this an important guideline, which we follow for all of our products at Climbmat.

4. **Impact absorbing capacity or impact attenuation.** Simply put the impact attenuation is a property of the flooring system, which measures the dissipation of kinetic energy during an impact, by localized deflection, deformation, or displacement. Furthermore, this dissipation should have a controlled acceleration/time behavior experienced by the impacting object, during the impact [5] [6]. The impact absorbing capacity is strongly dependent on the thickness and stiffness of the material or the combination of materials used. As the popular saying goes “it is not the fall that kills you it is the sudden stop”. This essentially means that the more time you have to decelerate, the lower the impact force will be, thus fewer injuries will be sustained by the climber. More precisely the probability of an injury occurring and the severity of injuries is reduced.

With that being said, how exactly does one measure this and is the measuring accurate? The simple answer is by using sample test masses with integrated accelerometers, for the determination of the impact deceleration (force). We at Climbmat, follow the testing procedures in the aforementioned standards, and test all our products, according to them and beyond that. The NF P90-312 standard, for example, uses a small cylindrical impactor with only 60 mm diameter, and a mass of 8.0 kg (Fig. 6). As a contrast to the testing objects used for the European and French boulder standards, where the form and mass of the object were based-borrowed on testing standards for gymnastics and pole-vaulting [7], [8], here the standard, from which it was borrowed was for judo mats [9]. Even though the falls in gymnastics and pole-vaulting are not the same as those in boulder climbing they are

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much closer and relatable compared to those in judo and rope climbing. Granted as mentioned before this standard is optimized only for falls up to the first anchor point and it assumes that climbers fall on their feet only. To the best of our knowledge, the type of testing mass used in NF P90-313 is good enough for this specific purpose – simulating a person falling on their feet/heels from 1-2 meters over the testing object (mat). We have to mention that the specified height for those tests is 0.6 meters from the top of the mat. Again it could simulate a climber falling on their feet from ~3 m, but it does not give us more information than that.

Fig. 6 The NF P90-312 Impacator [4].

The other two standards that are applicable for flooring underneath rope walls are the Australian standard for ACSs – AS2316.1 and the EN1177, which is the European standard for "impact attenuating playground surfacing". They both use the same type of impactor. We believe that the AS2316.1 is based on the EN1177. The testing object used is the same as the one used in the Australian standard for boulder climbing. As the purpose of rope flooring is slightly different, higher limits are set for the maximum accepted deceleration (expressed in g's – 1 g = 9.807 m/s2) and the HIC criteria. The same 4.6 kg (160 mm diameter), hemispherical "headform" impactor, dropped from the same height of 1.5 meters is used here as well. However the limits here are a maximum accepted deceleration of less than 200 g (200 times the earth gravitational acceleration experienced for a very short period – 0.01-0.1 s), and HIC of less than 1000 (compared to 40 g and 200 HIC, for bouldering).

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Accidently those are the same values for determining the Critical Fall Height (CFH), in the EN1177 standard. Simply put this is the maximum free height of fall, for which an adequate level of impact attenuation is provided. The EN1177 Method 1 test is not limited to a certain drop height. Instead, the test mass is dropped from different heights increasing from zero, until the critical one is found. The newest version of the standard also specifies a second, simplified method, which limits the maximum drop height up to the maximum possible height in certain wall/attraction/playground equipment. The aim is for the flooring to provide sufficient impact attenuation from that height.

With all that being said, what does a deceleration of 200 g and head injury criteria of 1000, mean exactly? It means that if the average male human head experiences an impact like that, there will be a 3% chance for a critical head injury (MAIS 5), an 18% probability of a severe (MAIS 4) head injury, a 55% probability of a serious injury (MAIS 3), an 89 % of a moderate (MAIS 2) injury, and more than 99.5% of a minor (MAIS 1) head injury [6]. MAIS is the Maximum Abbreviated Injury Scale. It was first developed by the Association for the Advancement of Automotive Medicine [10], [11]. Currently both European and North American, agencies and car manufacturers wildly use it in the automotive industry as an indicator of the severity of head injuries. Lower values of impact deceleration and HIC, mean lower chances for head injuries and less severe injuries.

In Climbmat, we test and produce all of our products to be compliant with those standards. But we also ask ourselves if this is enough. The climbing standards are only interested in giving protection for falls up to 3 meters, and not above that. Furthermore, the only adequate injury assessment that they give, in combination with the playground surfacing standards, is for a head injury. Even though it is the worst-case scenario, this certainly is not the most common cause. On top of that, the tests involve dropping a very small, 4.6 kg test object. This does not accurately represent the energies involved during the impact of a person with safety flooring. It might be a good test for drops from 3-4 meters, but not above that. We in Climbmat aim that our flooring gives protection not only for fall up to the first anchor point but above that as well – even up to the top of the climbing wall. This is why when we developed our crushable safety flooring system “One More Life” we started using a more precise human analog – a Hybrid II crash test dummy. Given the fact that the dummy is anatomically correct, and has integrated 3-axial accelerometers both in the head and in the chest, it gives us much more data and represents a realistic fall scenario. Since this type of testing is not mentioned in the climbing standards, we have used the guideline set by the car manufacturing industries – regulated by the National Highway Traffic Safety Administration (NHTSA) for North America, and European

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Transport Safety Council (ETSC) for the European Union. We strongly believe that those procedures and standards are very applicable in the case of falls from great heights from ACSs since the velocities that reached ground level are comparable with average vehicle speeds. For example, if a person falls from 17 m / 56 ft, they will hit the ground at 65 km/h or 40 mph. Furthermore using this testing method, we can set quantifiable limits not only for the head injuries but also for chest injuries – in the form of maximum experienced chest deceleration.

Subsequently, we have used this testing method for all of our products to access the limits of the fall protection, which they offer. Using the crash test dummy in combination with the existing standards can give us a better picture of which type of flooring is safer. The safer the flooring is the less severe, life-altering or life-threatening injuries will be sustained by climbers. We hope that using the combination of all those tests we can help our customers to pick the best possible flooring system for their gyms.

We do believe that using a crash test dummy is the best way to test climbing flooring, for protection above the 3-rd meter. With that being said we do acknowledge that even though the EN1177 “headform”, CFH test, is not an accurate representation of a person falling from the top of the wall, it could be used to access the energy absorbing capacity of safety flooring. Thus comparing the different types to one another.

It has to be mentioned that all the tests point to the same conclusion – thicker and softer flooring means lower chances for injuries. Put in simple terms, the higher the CFH of a safety flooring system is the better. This of course needs to be combined with certain static rigidity, for the bilayer’s comfort (and thus climber’s safety), and other regular tasks, such as route-setting, to provide the best possible flooring solution.

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