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What is the point of a non-fragile roof?

By Chris Pearce, CPA Board Representative, NARM.
An article prepared on behalf of the **Advisory Committee for Roofsafety (ACR)**

Statistics produced by the Health and Safety Executive (HSE) show that falling through a fragile roof accounts for 22% of 'falls from height' fatal injuries in the construction industry. Putting that into real terms, 7 people a year die from falling through a fragile roof and a substantial number of these will be through asbestos cement roofs or in-plane rooflights. In addition, many more will survive the fall but will be seriously injured for life.

It should be said in defence of the asbestos cement and rooflight industries that, prior to the early 1990s, these products were manufactured and sold as 'fragile materials' with clear instructions not to walk on them. During the 2nd half of the 20th century, the vast majority of non-domestic buildings built were clad with asbestos cement sheeting and a significant number of these buildings are still in use today, and as such due to weathering, such roofs are considerably more fragile today than they were when they were installed.

In the mid 1990s, matters came to a head with the HSE insisting that new roofs needed to be installed as non-fragile assemblies (the assembly being a combination of the roof sheets, the washers and fixings and the underlying roof structure). However the issue was that no one had defined the physical requirements necessary for a roof assembly to be defined as non-fragile. Out of this dilemma, the manufacturing sector of the roofing industry got together with the HSE and formed the Advisory Committee for Roofsafety (ACR). The result was that the ACR defined a specific drop test of a sand bag falling onto a roofing assembly fixed to a defined test rig (at ground level) that simulated the same effect as a heavy man walking then tripping and falling on to a roof surface. The conclusion of the work was written up in the first publication of the ACR called 'ACR(M)001 Test for Fragility of Roofing Assemblies'. (This can be downloaded free of charge from the ACR website - see footnote)

The conclusion of this test procedure is that roofing assemblies can be defined as Fragile or Non-fragile and if Non-fragile can be graded Class C, B, or A

Class C is defined that the roof assembly holds the sand bag on the roof after one drop of the bag.
Class B is defined that the assembly holds the sand bag after 2 drops of the bag in the same location.
Note that in both of the above cases it is likely that damage will be done to the assembly and, in practice, repairs will be required to maintain the integrity of the roof. However if the results are consistent from a series of tests , then the assembly is deemed to retain the weight of a person after tripping and falling onto the roof.

If it is deemed by a 'competent' person that no damage has been done to the assembly after 2 drops that will cause the assembly to advance it's rate of decay over time, then the competent person may classify the assembly as Class A

It is worth noting that the test is very severe on typical roof assemblies such that virtually all manufacturers of sheeted roofing assemblies will claim at best a Class B. Even if the roof sheet appears undamaged, close inspection may show that fixings have elongated their fixing holes, lap mastics may have broken their seal and surface protection of the sheet has been damaged - all of which could lead to an accelerated decay. It should also be borne in mind that accessories such as rooflights or ventilation units are tested as part of the roof assembly. Their inclusion can't improve the performance of the surrounding roof, so when installed in a Class B metal (say) roof, it is not possible for an assembly of the roof and accessory (eg rooflight) to achieve better than Class B.

The roofing manufacturers are continually being asked "how long will your product remain non-fragile ?" "Will you provide a non-fragility guarantee and if so, for how long ?"

It is important for designers, main contractors, roofing contractors and building owners to understand that the non-fragility test does not define the non-fragility of a roofsheet, it defines the non-fragility of the total assembly. When roof sheet manufacturers test their products, they define the number and type of fixings, the type of washers, recommended lap sealants and the structural assembly of the under roof. If some fixings are missed out, if fixings do not have the proper bearing on the purlins due to twisting purlins or built up rail systems, and if sub standard fixings are used to cheapen costs, these will all affect the classification of the fragility of the roof, and very importantly, the durability and longer term non-fragility of the assembly. The fixing process is critical to the non-fragility classification and long term life. It is vital that the specification of the assembly is clearly defined by the designer and that the main contractor takes full responsibility for ensuring that the specification is not reduced to save costs and that the work is completed with full appropriate inspection during construction. So realistically the manufacturer of a roof sheet is never in a position to guarantee that the assembly is safe to walk on, even when new.

There is a similar problem when considering performance over time, and addressing the vital question - "for how long will the roof be non fragile ?" Clearly if we are to reduce deaths and severe injuries from falling through fragile roofs, we need the roof to remain non-fragile for as long as possible. However, the reality is that once the building is handed over, no-one can ever be 100% sure that 100% of the roof is still non-fragile. Can we be sure that the specified components were all used and installed correctly? And that there are no factors which could affect interaction between components, or accelerate degradation? Whilst there are many factors which can affect non-fragile performance when new, there are many more which can have an effect on long term non-fragility, including both internal and external atmospheric conditions, which cannot be guaranteed in all circumstances.

Arising from this dilemma, roof sheet manufacturers are asked "how do I test for non-fragility on an existing roof ?" The ACR drop test is carried out at ground level on a prescribed frame and test procedure. It would not be practical to carry out this test at roof level and would inevitably do considerable damage to the existing roof which would be somewhat self defeating. If existing sheets are removed and taken to the test rig for testing, it would be exceedingly difficult to replicate the situation on the roof. Fixings will be decaying in the purlins, and lap mastic sealants will need to be damaged to remove the sheets . When refixing the old sheets to the test rig, old self drill fixings would most likely not self drill so new fixings will be needed. This together with new mastics will mean that

the old rebuilt assembly will now be far stronger than the remaining old roof still on the building and thus the results would be meaningless.

The conclusion is that it is exceedingly unlikely that a competent person could ever inspect an existing roof and determine that it is 'non-fragile'. Advice from the ACR and the HSE is that, in the absence of any clear documented evidence from when the roof was installed that the roof will remain non-fragile, any existing roof should always be treated as if it may be fragile and the appropriate safety procedures adopted whenever working at roof level.

Designers and building owners may therefore conclude - "why should I go to the expense of building a non-fragile roof if I still have to go to the expense of servicing and maintaining the roof as if it is fragile ?"

The answer is simple. It is vital, and a legal requirement, that risks are always minimised, and every reasonable precaution taken to do so. With regard to falls from height through roofs, the best way to do this in principle would be to avoid access to the roof. But this is not practical, access will always be required to roofs, for maintenance, for cleaning (eg of gutters and rooflights), for inspection (eg to assess storm damage) and to access any plant on the roof (eg air conditioning). It should be noted that it should never be a requirement that access is required just to fulfil the validity of a roofing products guarantee.

The best way to minimise the risk of falling through the roof when there is access to the roof, is to design the roof so that it can be expected to remain non-fragile in the long term, and to ensure it is installed accordingly, but then to also take additional safety precautions during access. By building to a high specification, damage will be minimal for years to come, maintenance cost will radically decline and the risk of falling through the roof because it has become fragile will be delayed for tens of years - lives will be saved.

Deliberately building to a lower specification, designing a roof to be fragile and relying solely on safety measures during access clearly presents a much greater risk and is not acceptable under current legislation, as well as leaving a poorer quality roof that is likely to decay quicker and lead to earlier failure

There is even greater risk if a roof is designed for long term non-fragility and then changes to the specification are allowed (perhaps for cost considerations) or quality of installation is uncontrolled; both could mean the roof is fragile when new, or that the non-fragile life is reduced. The Building's 'Health & Safety File' will incorrectly state the roof is non-fragile, and that if additional precautions have not been taken during access, there will be a very real risk to life.

The correct answer is to design a roof to be non-fragile in the long term, to ensure that specified systems and components are always used and installation is correctly controlled to create a roof that can be expected, but not guaranteed, to remain non-fragile in the long term – but then to complement this with safety precautions during access, as if the roof was fragile. Everyone who goes on to a roof should remember that all roofs will become fragile with time, it is just a matter of when, and no one, even the most competent, will be in a position to tell when that will be.