Reflections on the use of recycled plastic material in water mills

Ivor New

Following my work on the Hockley mill sluice gate I thought some details on the more general aspects of using recycled plastic in and around mills would be of interest. It is clear to me that this material has a lot to offer millers as long as it is used in a sensitive way within its physical capabilities. The case study in the last newsletter shows that the material is not suitable for significant load bearing duties as, by itself, it has limited strength and is too flexible to be useful in most load bearing situations – which will probably have many purists giving a sigh of relief!

Its properties can be best utilised in and around water, especially where there is a constant cycle of wetting and drying. The main beneficial attributes of recycled plastic are that it is easily workable and is not susceptible to fungal or insect attack. I understand that for some time it has been successfully used by the Environment Agency, Water Supply Companies, and other organisations with similar issues.

The material is available in a limited number of colours, sizes, and formats. The formats available can be divided into three classes – sheets, boards, and posts. Sheets are available in a variety of thicknesses; boards of various sizes are manufactured with differing surface textures some of which include steel reinforcing bars; and posts of differing sizes and characteristics are available and can include internal reinforcing steel cores.

The most obvious and common use in water-related environments is for decking (or other walkways) and bank support. Many examples can be found and reports indicate that the material has performed well. The main drawbacks seem to be an aesthetic one (it's plastic!) and that it is not cheap, certainly when compared with treated softwood. The manufacturers acknowledge this and provide tables to show the Cost of Ownership of recycled plastic is lower than standard wooden decking as the maintenance is virtually zero and it lasts several times longer.

In addition to these more conventional uses it seems to me that the milling environment has situations that would significantly benefit from utilising the properties of recycled plastic, especially in mills that are only operated occasionally and are subject to the accelerated levels of decay that this leads to. Examples that come to mind include flumes, sluices, small sluice gates or boards, float boards, and even starts in suitable water wheels.

From the evidence available it is clear that this material should perform well in most water channelling situations as long as its more flexible nature is taken into account and adequate support is provided. I think the most interesting area of use will be in more dynamic flow areas. Aspects of its use in the construction of sluice gates has been discussed elsewhere but this was in the context of rebuilding an existing gate. Building a new sluice and gate from scratch could well generate a different result.

Another use which I would like to see tested is its viability for starts and float boards in metal rimmed water wheels. This would require a trial to be set up that comprised a few float boards on a suitable wheel. The biggest single issue would probably be how a start is connected to the rim. The start will need a metal core to provide enough strength and the attachment to the rim must be some sort of fixing which does not damage or require modification of the rim, all at an acceptable cost. The float board itself should not be an issue as the loading on an individual board is not that high. The other constraint that may become critical is the availability of suitable standard profiles from the recycled plastic manufacturers – I am sure no one will be prepared to finance the tooling to make a special profile.

Clearly to take this forward a trial in a real environment is needed which would require the availability of a suitable water wheel. The first activity would be to develop an outline design for the starts which is economically viable. Following the completion of the design the real work of building a prototype would begin, assuming there is funding for the materials and any necessary tooling. The final activity would be to fit the parts into the target wheel and test the performance.

I would be interested to hear what others feel on this subject.

Editor: I would also be interested in your comments on this controversial subject. Below is a letter from Peter Mobbs, which coincided with Ivor sending me this article.

Letters

Recycled plastic boards *from Peter Mobbs*

Yet again I am greatly impressed by the interesting and varied content of the HMG Newsletter and its professional layout. Top marks to the editor, layout artist, columnists, proof reader, print manager and all concerned. The Newsletter really is a high quality document. A credit to you all!

Also I would like to thank Ivor New for his masterclass discourse on design philosophy for sluice gates. However I felt that he failed to fully explore the full potential for utilising the attractive durability characteristics of recycled plastic boards, RPB.

It would be possible to overcome the lack of bending stiffness of this material using "Sandwich Technology". This can be achieved by cladding the core material (in this case RPB) with thin stiff skins. A more detailed explanation of this technology is available at https://en.wikipedia.org/wiki/Sandwich-structured_composite . Since the RPB material is thermoplastic (melts when heated) it could be possible to hot melt a suitable surface reinforcement medium into the boards. Alternatively many builders merchants stock a variety of suitable 'off the shelf' galvanised steel strips. These could be used as a low cost surface reinforcement material secured in place using conventional fasteners.

Ivor also mentioned that the thrust of the water pressure is highest at the bottom of the gate and quoted a force of one third of a ton in magnitude. This would indeed generate a significant bending moment on the sluice gate. However at the water surface level the bending moment is negligible. So there would be some design merit in tapering the gate profile (similar to a dam): thick at the bottom and thinner at the top.

So it can be seen that there are indeed several novel solutions that could be used to overcome the perceived limitations of RPB. However, on the downside, turning workable design concepts into reality could have been a too advanced project for the team to undertake. Also this radical use of modern materials might not appeal to the more traditional mill enthusiast.

But I am pleased to know that the use of modern materials is being actively considered in mill maintenance projects. I feel this is more than ever essential in order to reduce maintenance costs to a sustainable level.