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Aim of Work:

Consider relevance of freeze thaw and water adsorption testing. With reference to British Standard BS EN 1340 (Concrete Kerb Units), when testing HDPE kerb units.

Background:

Durakerb are a company involved in Research and development of HDPE/RPE kerb units as a replacement to concrete kerbstone units, which have been traditionally been used. Concrete kerbstones, although proven in application, have a distinct drawback due to their weight and the subsequent difficulty in manoeuvring and laying. As Manual handling regulations have become increasingly stringent the laying of kerbstones weighing up to 70kg has become increasingly difficult within health and safety law. As such the industry has had to shift to mechanical or machine assisted laying or smaller kerb units in order to not breach the upper lifting limit imposed by manual handling regulations [1].

Several solutions to this problem have been proposed including slip formed/extruded kerbs, plastic kerbs (Durakerb), rubber kerbs and combined drain kerbs. To date none of these alternatives have achieved widespread use [2].

As Polyethylene are fundamentally different materials it is proposed that some of the testing required for concrete kerbstones [3] is not relevant to Durakerb products, particularly some of the weathering tests. In particular Durakerb believe that freeze thaw behaviour and water adsorption behaviour will have little relevance to plastic kerb units.

Freeze - thaw testing

Freeze thaw testing as defined in the relevant standard [3] involves the determination of the quantity of material (i.e. concrete) removed from the test surface over the required number of freeze – thaw cycles. The quantity should be less than 1kg/m² over the surface area of the sample. For concrete test specimens it would be expected that some water would adsorb into the pores present in the concrete. Continual freeze thaw cycles would see cyclic expansion and contraction of the water residing in the pores that could place stress on the concrete resulting in some material breaking off the surface. In the case of Polyethylene, adsorption of water is on a sub micron scale and as such the stresses generated by freeze thaw action will not cause failure and the removal of material from the sample surface.



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The potential for polymeric materials to undergo major thermal transitions such as the glass transition (T_g) and crystal transition (T_m) must also be considered. If such transitions occur within the conditions of test there is the possibility that the material properties will change considerably. In the case of Polyethylene the T_m is at approximately 120°C (+/- 10°C depending on morphology and % crystallinity), which is well above the temperature expected for the test. The situation regarding the T_g of Polyethylene is much less clear and there is considerable disagreement over the actual value [4]. Several transitions have been identified at temperatures of -30°C (+/- 15°C), -80 (+/- 10°C) and -128°C (+/- 15°C) [5]. These temperatures are outside those used for the test and in terms of the application outside conditions generally seen in the UK. If the product were to be used in colder climates (e.g. Scandinavia) then further consideration and testing would be required.

A final consideration would be the potential for volume change over the temperature range described. Upon investigation it was found that the specific volume ratio was found to change by only 0.022 over the temperature range -20°C to $+20^{\circ}\text{C}$ [5], which is insignificant for this application.

Water adsorption

PE is considered to be a hydrophobic polymer and as such would not be expected to adsorb large quantities of water. The maximum allowed water adsorption for concrete kerb units is 6% [3]. It is known that hydrophilic polymers such as Nylon 6 can adsorb up to 10% water [6]. No figures for the adsorption of water by Polyethylene were found, most likely due to it being unimportant in most applications of this polymer. Some data is available though, on Polyethylene/natural fibre composites such as those described by Wang et al [7] and Pascal-Kamdem et al [8]. Both studies indicate that the water adsorption of these composites was significantly lower than the figure of 6% maximum quoted in the relevant standard.



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