DETR PROJECT REFERENCE 39/3/487, CC1553
DEFINING & IMPROVING ENVIRONMENTAL PERFORMANCE IN THE CONCRETE INDUSTRY

R FERRY & L PARROTT, DECEMBER 1999

The UK Concrete Industry Alliance initiated a project in April 1998, with DETR support, to define and improve environmental performance in the concrete industry. This fact sheet, on the environmental impacts associated with glassfibre reinforced concrete is one of the project outputs.

CIA
Concrete Industry Alliance

DETR
Department of the Environment, Transport and the Regions

CIA Concrete Industry Alliance

Environment factsheet

Environmental impacts of two glassfibre reinforced concrete products

The UK Concrete Industry Alliance initiated a project in April 1998, with DETR support, to define and improve environmental performance in the concrete industry. This fact sheet is one of the project outputs. Further details of the project can be obtained from www.bca.org.uk

The main purpose of this fact sheet is to illustrate the environmental impacts of glassfibre reinforced concrete drainage channels and cable ducts supplied to a construction site with regard to:

- Glassfibre content
- Alternative precast concrete products.

The glassfibre reinforced and precast concrete products have comparable internal dimensions and perform the same function. Furthermore the service life and maintenance requirements will be essentially the same.

The lightweight glassfibre reinforced drainage channel is designed and tested in accordance with the 1998 Highways Agency specification for class D integral drainage systems. They are made using vibration casting in the same manner as normal precast concrete products. The lightweight glassfibre reinforced ground cable duct is a 2 metre long u-section with a flat lid. The duct is made using a mechanised spray process in combination with folding moulds; the flat sheets are folded into shape while still “green”. The environmental impacts arising from the moulds are small and assumed, for analysis, to be the same for the glassfibre reinforced and normal precast concrete products.

Table 1. Input data for 1 metre length of product

Product	Cement (kg)	Sand (kg)	Gravel (kg)	Glassfibre (kg)	Rebar (kg)	Truck (t.km)
Drainage channel 3% glassfibre	32	36	24	1.68	6.65	8
Drainage channel 2% glassfibre	32	36	24	1.12	6.65	8
Drainage channel 1% glassfibre	32	36	24	0.56	6.65	8
Drainage channel Precast concrete	56	85	169	0	6.72	31
Cable duct 3.8% glassfibre	10.7	4.74	0	0.7	0	0.99
Cable duct Precast concrete	14.7	21.9	43.9	0	2.0	4.5

The amounts of cement, aggregate, glassfibre, steel and transport required for producing and delivering cable ducts and drainage channels were estimated on the basis of information received from members of the Glassfibre Reinforced Concrete Association. The main assumptions were:

1. Delivery of products from works to construction site involved a 50 Km truck journey with a full load; the return journey was with no load,
2. The glassfibre reinforced and precast concrete drainage channels, both with reinforced concrete lids, require the inputs given in rows 2 to 5 in Table 1
3. The glassfibre reinforced and precast concrete cable ducts and lids require the inputs given in rows 6 and 7 in Table 1

SimaPro software [1] was used to compare the environmental impacts of the alternative products and to elucidate the effects of glassfibre content for the drainage channel.

Environmental effects of drainage channels

The environmental effects of the drainage channels are shown in Table 2, Figure 1 and Figure 2. Table 2 indicates that the decreases in environmental effects due to reductions of glassfibre content, from a 3% baseline, were small and dependent upon the particular environmental indicator.

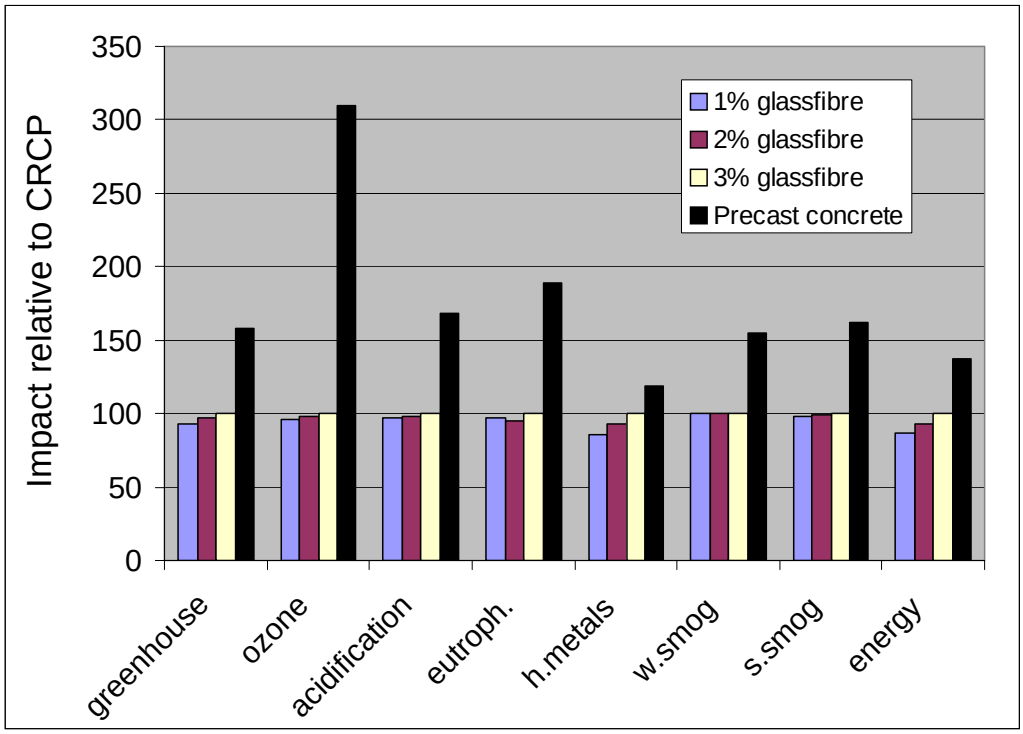

Fig 1 Environmental impacts of drainage channels relative to that with 3% glassfibre

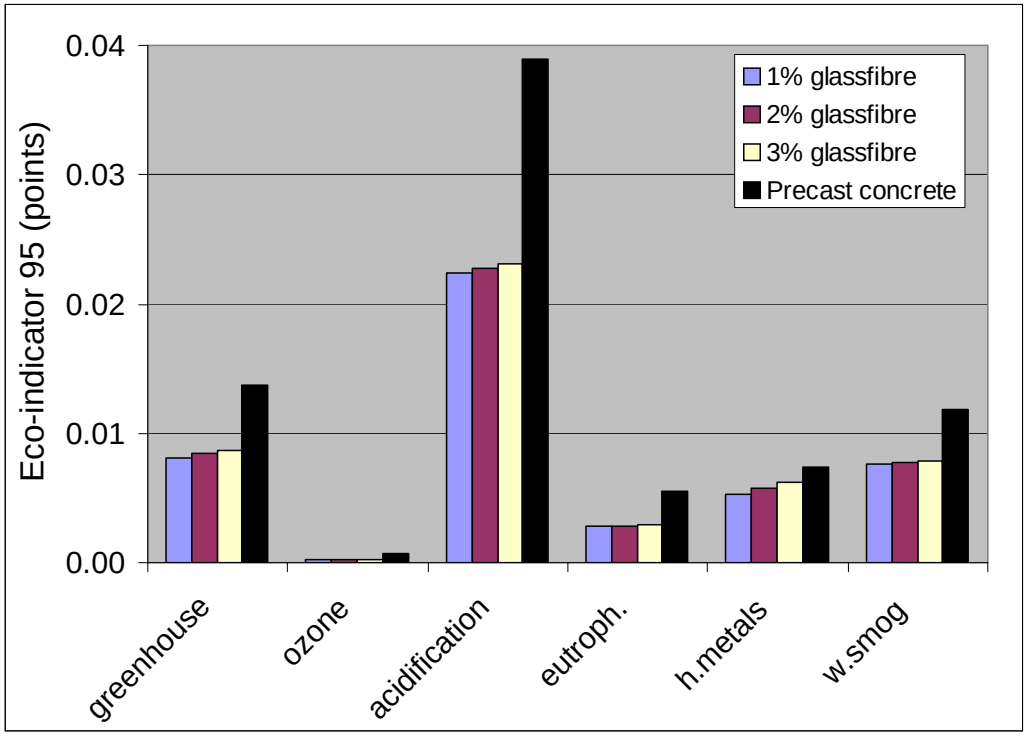

Fig 2 Environmental impacts of drainage channels using Eco-indicator 95 weighting factors

Table 2. Environmental effects of drainage channels. Figures in brackets use 3% glassfibre as a baseline

Environmental impact class	Units	1% glassfibre	2% glassfibre	3% glassfibre	Precast concrete
Greenhouse gas equivalent	kg CO2	42.5 (93)	44.0 (97)	45.5 (100)	71.7 (158)
Ozone depletion equivalent	mg CFC11	1.92 (96)	1.96 (98)	2.00 (100)	6.19 (310)
Acidification equivalent	g SO4	253 (97)	256 (98)	260 (100)	438 (168)
Eutrophication equivalent	g PO4	21.6 (97)	21.9 (99)	22.2 (100)	41.9 (189)
Heavy metal equivalent	mg Pb	58 (85)	63 (93)	68 (100)	81 (119)
Winter smog equivalent	g SPM	123 (100)	123 (100)	123 (100)	191 (155)
Summer smog equivalent	g C2H4	18.6 (98)	18.8 (99)	18.9 (100)	30.6 (162)
Primary energy use	MJ	340 (87)	366 (93)	393 (100)	541 (138)
Unweighted average impact	%	94	97	100	175
Eco-95 weighted average impact	%	94	97	100	157

Figure 1 compares the individual environmental impacts using the 3% glassfibre results from Table 2 as a baseline. As shown in the penultimate row of Table 2 the average decreases were 6 and 3% for glassfibre contents of 1 and 2%, respectively. The precast concrete drainage channel had a significantly higher impact in each class than the 3% glassfibre product: on average the impact was 75% higher.

Table 2 shows that when account is taken of the importance of environmental issues, using Eco-indicator 95 weighting factors [1], the respective aggregated environmental impacts for 1 and 2% glassfibre content and for precast concrete are 94, 97 and 157% of those for the drainage channel made with 3% glassfibre. As shown at the foot of the table, these figures are of a similar magnitude to those for the unweighted environmental impacts. Figure 2 shows that the most important impacts were acidification, greenhouse gas emissions, winter smog and heavy metal emissions.

Additionally there are non-quantified advantages of glassfibre reinforced concrete drainage channels over their precast concrete counterparts:

- Precast concrete channels are more prone to cracking during installation. Replacement units would then represent additional environmental impacts in both manufacture and disposal.
- Mechanical handling equipment is not required.
- Installation cost is lower and delivered cost is competitive.

Environmental effects of cable ducts

The environmental effects of the cable ducts are shown in Table 3. The table indicates that the precast concrete drainage channel had a significantly higher impact in each class than the 3.8% glassfibre product: the average increase was 123%. When account is taken of the importance of each environmental issue, using Eco-indicator 95 weighting factors [1], the aggregated environmental impact for the precast concrete product is 61% greater than that for the cable duct made with 3.8% glassfibre. Figure 3 shows that the most important impacts were acidification, greenhouse gas emissions, winter smog and heavy metal emissions.

Additionally there are non-quantified advantages of glassfibre reinforced concrete cable ducts over their precast concrete counterparts:

- Installation is quicker and mechanical handling equipment is not required.
- In the case of in-ground track-side ducts a smaller amount of material is excavated, installation damage is reduced and track occupancy times are reduced.
- The ex-works cost is greater but this is offset by lower transport and installation costs.

Table 3. Environmental effects of cable ducts

Environmental impact class	Units	3.8% glassfibre	Precast concrete
Greenhouse gas equivalent	Kg CO2	13.8 (100)	18.4 (133)
Ozone depletion equivalent	mg CFC11	0.32 (100)	0.99 (309)
Acidification equivalent	g SO4	66 (100)	109 (165)
Eutrophication equivalent	g PO4	5.9 (100)	9.8 (166)
Heavy metal equivalent	mg Pb	14.9 (100)	21.3 (143)
Winter smog equivalent	g SPM	34.4 (100)	59.0 (171)
Summer smog equivalent	g C2H4	1.23 (100)	7.04 (572)
Primary energy use	MJ	110 (100)	137 (125)
Unweighted average impact	%	100	223
Eco-95 weighted average impact	%	100	161

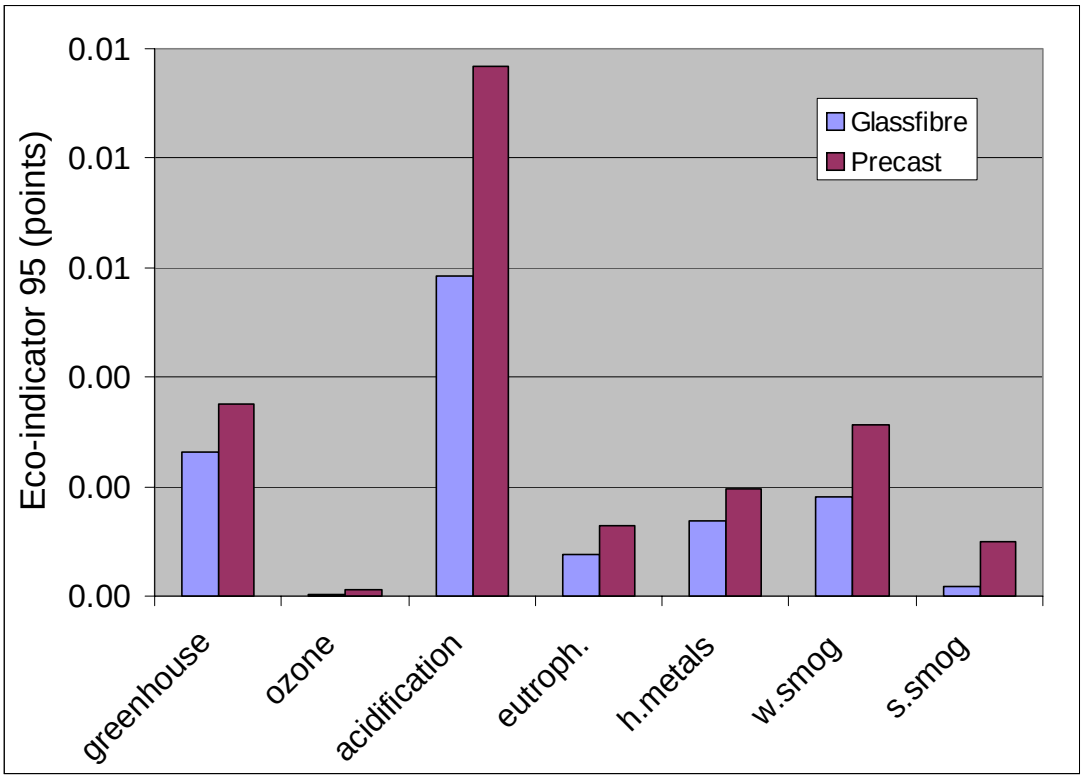

Fig 3 Environmental impacts of cable ducts using Eco-indicator 95 weighting factors

Concluding remarks

The average environmental impacts of glassfibre reinforced cement drainage channels supplied to a construction site were decreased by about 6 and 3% by reducing the glassfibre content from 3 down to 1 and 2 % respectively. These decreases were estimates that take account of the weighted and unweighted environmental impacts. The weighted and unweighted impacts of an alternative precast concrete product were 57 and 75% greater, respectively.

The average weighted and unweighted environmental impacts of a precast concrete cable duct supplied to a construcion site were 61 and 123% greater, respectively, than the corresponding impacts of an alternative glassfibre reinforced cement product with 3.8% glassfibre.

Although the cement content per unit volume of glassfibre reinforced concrete was higher than that of normal precast concrete, the reduced weights of the comparable glassfibre reinforced products, together with the reduced transport impacts led to a lower overall environmental impact. Also there were secondary benefits of glassfibre reinforced products with regard to reduced breakage, reduced site-work and ease of handling.

Reference

1. Pre Consultants, SimaPro User Manual and Database Manual, November 1998.