HIGHWAYS AGENCY

Report on European Concrete Barrier Developments

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Summary

The report describes a survey carried out in 2002 on behalf of the Highways Agency and Britpave examining concrete barrier usage in Europe. The survey was undertaken as a desktop survey, primarily by e-mail questionnaire, and targeted in the main members of CEN Technical Committee 226, and in particular members of TG1, which is the committee responsible for EN1317, Road Restraint Systems.

The scope of the work included; utilization, standards and details, research and development, market penetration, whole life costing and general attitudes to the use of concrete barrier systems.

In all, useful responses to the questionnaire were received from 11 western European, including Scandinavian, countries. Approximately two thirds of the responses were from government sources and thus the results of the survey can be considered reasonably representative of the official view in Western Europe.

The survey indicated that concrete barrier systems are used in every country that responded and that the use of concrete is preferred to steel systems in central reservations particularly where traffic is heavy. It seems that at least 2 countries are close to excluding steel from use in central reservations. Reasons for this preference included safety, low maintenance, less risk of cross over accidents, and fewer interventions for repair.

The New Jersey type barrier was the most prevalent detail for concrete systems.

Regarding the use of EN1317, adoption is universal although responsibilities for certification and compliance is not entirely clear and seems will not be until EN1317-5: 'Product requirements, durability and evaluation of conformity', is issued and adopted. The responses indicated however that there is a definite leaning to a state body assuming responsibility for certification and compliance.

Data on current research and testing was sketchy and future responsibility for such work inconclusive.

Concerning market penetration, data was scarce but use seems to be increasing particularly in countries with densely trafficked roads. Where little used, and this tended to be in low population density countries with thus less densely trafficked roads, high first cost compared to steel was given as one of the reasons.

Whole life costing has been little adopted but where used, inputs such as concrete having twice the life of steel systems, and concrete having 20% of the time delays associated with repairs compared to steel, were cited.

Attitude to the use of concrete barrier systems was mixed but generally positive, particularly in those countries with densely trafficked roads.

1. Introduction

This report was carried out on behalf of Highways Agency and Britpave. The commission was jointly funded by both organizations and was undertaken during the early part of 2002.

2. Scope of report

The scope of the report was described in a letter from Britpave to the author dated 28th January 2002.

Essentially the letter detailed a survey to be undertaken of concrete barrier usage in Western Europe consisting of the following broad topics:

- Construction standards and details
- Position regarding EN1317
- Current research and testing
- Market penetration
- Whole life costing
- Attitudes to concrete barriers.

The letter indicated that the countries to be surveyed should include France, Germany, Belgium, Holland, Italy and Spain with specific contact to be made with contractors, governments, agencies and concrete/cement associations.

3. Survey

The survey was undertaken as a desktop survey, mainly by e-mail, supplemented by fax.

Communication was focused on the members of CEN TC226/WG1/TG1, the task group within TC226 responsible for the development of EN1317, which included researchers, government personnel, manufacturers and motorway operators. This allowed a wider area of contact than the scope required and included in addition to the countries already mentioned; Austria, Denmark, Sweden, Switzerland, Finland, and Norway.

In addition, contact was made with 'cement and concrete' contacts in France, Spain, Belgium and Germany.

First contact was made by e-mail to establish the relevant person who could provide the information required. Once this was established then a questionnaire was sent to the relevant contact.

A list of the contacts and personnel who helped with the survey is given in ANNEX A.

In order to generate and aid response, the questionnaire was restricted to one page in length consisting of 15 questions. The questions covered the following broad areas:

- Use/application
- Standards and details
- EN1317
- Research/testing
- Market penetration
- Whole life costing
- Attitude

The questionnaire is attached in ANNEX B.

4. Response

Replies were received from every country with the exception of Italy.

Overall the 'depth' of reply was good varying from 'a reasonable response to about 50% of the questions' to 'answers to all questions' even though, in the case of the latter, some of the responses were sometimes lacking in detail.

Putting the French motorway operator to one side, it should be noted that of the 11 countries that replied, 7 of the responses came from government/official sources, 2 from individuals, 1 from a Trade Association and 1 from a manufacturer. Overall therefore, because of the government 'bias' of the replies, the results of the survey can be considered reasonably representative of the official government view that prevails in Europe.

The responses are tabulated below separated into the broad areas detailed in 3 above.

4.1 Use/application

Table 1: Use/application of concrete barriers

COUNTRY	Q1. Are concrete barriers used? If yes, where and why?	Q2.Location where concrete barrier is preferred/ solely specified and why?
Austria	Yes. In central reserve because of high containment level. Also alongside roads and on bridges.	Often for central reserve because of containment level. Note level H3 is required and steel can't comply.
Belgium	Yes. Mostly in central reserve because it is an economical long-lasting solution.	Preferred but not solely specified for central reserve although it is likely that steel will be precluded soon.
Denmark	Yes. In central reserve and alongside roads	No location is specially preferred.
France (state)	Yes. Mainly in central reserve and particular points alongside roads to retain heavy vehicles	Preferred for central reserve for high traffic; to minimize the need and danger associated with maintenance and cross-over incidents. However there is no specific regulation.
France (auto-route operator)	Yes. Ditto	Ditto
Finland	Yes. At edges of roads as noise barriers in fill sections. Sometimes in middle of 4-lane roads but not often because they cause snowdrifts. On bridges.	No preferences or sole specifying
Germany	Yes, especially in central reserves, particularly when narrow, but also at road edges in potentially hazardous situations.	Preferred at road edges in potentially hazardous situations (e.g. next to railways), where major impact resistance is required, where groundwater quality is protected.
Holland	Yes. In central reserve for safety.	Preferred where central reserve space is limited.
Italy	-	-
Norway	Yes. In central reserve and alongside roads	No preferences or sole specifying
Spain	Yes. Typically for a semi-urban expressway where not much space is allocated to the central median and at edges of bridges	No preference
Sweden	Yes. Mainly in central reserve but also as temporary barrier alongside construction works	Preferred for high traffic urban motorways because of low maintenance costs and few interventions for repair
Switzerland	Yes. For urban central reserves and at edge of bridges where houses/traffic underneath.	Answer suggests that there is preferential specification at these locations.
UK	Mainly central reserve but some use in verge at structures and railways to provide increased levels of containment.	Not solely specified. Areas of hight accident risk. Areas where minimum deflection is needed.

4.2 Standards/details

Table 2: Standards/details

COUNTRY	Q3. General description and detail of barriers in use?
Austria	Delta Bloc precast system and where apparent that no strengthening will take place for 15/20 years, slip formed New Jersey type barriers are used.
Belgium	New Jersey type, mainly 80 cm
Denmark	New Jersey type and a local system of concrete post and panels
France (state)	New Jersey type
France (autoroute perator)	New Jersey type
Finland	US heavy vehicle median barrier, height 100 cms, width 60 cms
Germany	New Jersey type, 81 and 115 cms
Holland	Step-profile
Italy	-
Norway	Old are New Jersey type, new approved according to EN1317
Spain	Jersey and New Jersey types
Sweden	New Jersey type no longer used; replaced with vertical or convex sides
Switzerland	New Jersey type and single slope to Swiss standard SIA 160. When used in front of an obstacle or on a bridge, barrier must be capable of withstanding a horizontal load of 1000kN. In this case slip-formed concrete is used.
UK	VCB/HVCB/WCB/THVCB/TVCB

4.3 EN1317

Table 3: EN1317

COUNTRY	Q4. Has country adopted EN1317?	Q5. Who is responsible for EN1317 certification of new designs?	Q6. Who ensures compliance to EN1317?
Austria	Yes	Manufacturers	Ministry of Transport
Belgium	Yes (Part 1, 2 & 3)	To be decided	To be decided
Denmark	Yes in draft	Officially no-one since EN1317-5 is missing but until then contractor according to EN1317-1 & 2.	The test house used by the contractor
France (state)	Yes	ASQUER	ASQUER
France (autoroute operator)	France has yet to give a ruling on 'level' of implementation for motorways	-	SETRA
Finland	Yes	Road Administration at present but NOTIFIEF in future	
Germany	Yes	Bundesanstalt fur Strassenwesen (B.A.S.T) (Federal Office for Roads)	B.A.S.T
Holland	Yes	'AVV' (Advies-dienst Verkeer en Vervoer) part of the Ministry 'Bouwdienst Rijkswaterstaat'	
Italy	-	-	-
Norway	Yes	National Bridge Department	
Spain	Yes	At present no-one	-
Sweden	Yes for parts 1 & 2	National Road Administration	Uncertain
Switzerland	Yes but also SIA 160	Federal Highway Administration for state highways and the cantons for other highways	
UK	Yes - interim arrangement introduced	The Highways Agency now but will be the Notified Bodies in the future.	

4.4 Research/testing

Table 4: Research/testing

COUNTRY	Q7. Details of current research testing?	Q8. Who is responsible now for such testing?	Q9. Who will be responsible for such testing in the future?
Austria	Yes but not detailed	Manufacturers	Manufacturers
Belgium	No data provided		
Denmark	Yes but not detailed	Contractor	
France (state)	No current research	Left open	Left open
France (autoroute operator)	Companies involved with barrier work		
Finland	Unknown but stated that it is/will be carried out by manufacturers		
Germany	New developments with pre-fabricated units, resistance to H4b impact, and an ASI value less than 1.4	Manufacturer	Manufacturer
Holland	SWOW (Institute for Scientific Research and Road safety) and AVV	SWOW and AVV	SWOW and AVV
Italy	-	-	-
Norway	Unknown	Manufacturer	Manufacturer
Spain	Unknown	Laboratory ?	CEN ?
Sweden	Unknown since in the hands of the manufacturers	Possibly the Road and Traffic Research Institute in Linkoping	Any notified body according to EN1317, CEN mandate M111 and applicable guidance papers
Switzerland	On-going in accordance with EN1317 (apparently there is a 'slide' problem with TB11 above level B)	Uncertain but probably the 'Federal Institute of Technology'	
UK	None but will concider revised test to ascertain actual containment levels.	Industry.	

4.5 Market penetration

Table 5: Market penetration

COUNTRY	Q10. Length of concrete barrier built including comparison with other types of barrier?	Q11. Is use of concrete barrier increasing, by how much – in metres and %age market share?	Q12. If not increasing, give reason why?
Austria	600 km, 6/7% share of market	Yes. With regard to central reserve, estimated 40km in 1999, 80 km in 2000, 80km in 2001. In same period no steel systems were used.	N/A
Belgium	It is thought that about 60 to 70% of motorway central reserve has concrete barrier, exact length uncertain	Yes particularly since steel is being systematically replaced by concrete on existing roads	N/A
Denmark	Approx 210 km (c.f. steel 600 km)	No	Steel is taking more of the market
France (state)	10,000 km (c.f steel 80,000 km)	Stable at about 1000 km/year	Steel barriers are less aggressive to cars
France (autoroute operator)	No information		
Finland	20 to 30 km (c.f. 2000 km steel)	Concrete may be increasing in km but not in percentage	Price and snow drifting problems
Germany	Approx 1400 km, 5% share of market	Use is increasing by about 150 km/year and market share by about 0.5%/year	-
Holland	About 50% of per-manent market but overall length small	Yes but difficult to quantify	
Italy	-	-	-
Norway	1200 km	Unknown	
Spain	-	-	-
Sweden	No information given		
Switzerland	5% of market	No	Steel is safer and cheaper (20% of the cost of steel)
UK	<100km.	Yes, but slowly. Market share currently negligible.	Limited increase due to initial cost, but HA considering safety and maintenance implications which may increase market share.

4.6 Whole life costing

Table 6: Whole life costing

COUNTRY	Q13a. Is whole life costing used for evaluation of tenders?	Q13b. If yes, what maintenance assumptions are made?
Austria	No	N/A
Belgium	No	N/A
Denmark	No	N/A
France (state)	No	N/A
France (autoroute operator)	No	N/A
Finland	Yes	Maintenance is estimated; resistance to snow removal and small vehicle impact is also evaluated
Germany	Not in isolation but plays a role because no repairs are required after impact (c.f. steel which has to be repaired and causes traffic jams during repair)	Recent data suggests that costs due to time delays during repair work are 4/5 times higher for steel compared to concrete.
Holland	No	N/A
Italy	-	-
Norway	No	N/A
Spain	Yes	No detail
Sweden	Partially	Currently concrete is assumed to have twice the life of steel
Switzerland	No	N/A
UK	It is considered in major contracts. So far major contractors have not considered that there is an economic advantage in adopting concrete barriers.	N/A

4.7 Attitude

Table 7: Attitude

COUNTRY	Q14. What is the general attitude in the country to the use of concrete barriers?	Q15. What is the country's attitude to the adoption/use of systems in use in other countries?
Austria	Positive	Unknown
Belgium	Positive	Positive
Denmark	Positive but flexible systems preferred if space permits	Positive
France (state)	Positive particularly in high traffic situations	Neutral in that there are no preconceived ideas
France (autoroute operator)	Preferable because of lower maintenance costs	Ditto
Finland	Positive when used for noise reduction but in other applications there is a strong tradition for steel which looks better and is less expensive	Positive
Germany	Very positive particularly in road upgrading situations but it is the decision of each Federal State	-
Holland	Positive	Positive particularly for the step profile
Italy	-	-
Norway	No official view	Positive provided it meets requirements
Spain	No special attitude	No special attitude
Sweden	Generally less positive than steel because of greater cost, aesthetics, severe damage at high collision angles and problems with snow drift. However less maintenance costs	Positive provided they fulfill EN1317 requirements
Switzerland	Unfavourable because relative to steel more costly (x5) and less safe	Unfavourable
UK	Awareness is improving, but still only used when circumstances demand.	HA share knowledge and information through national and international committees.

5. Discussion

Since about two thirds of the responses came from government sources, the results of the survey can be considered reasonably representative of the official view in Europe, rather than representative of manufacturers and organizations with vested interests in concrete.

Table 1 (use and application) indicates that concrete barriers are used in every country that responded and that this use is mainly in the central reserve, particularly where space is limited and traffic is high. High trafficked urban/semi-urban dual carriageways were cited as a case in point. Many of the responses stated that concrete barriers were preferred for this situation although exclusive specification of concrete barriers for such situations is generally not the case although it seems that this may change soon in at least one country. It was apparent with at least one country that the containment level required by EN1317 for such situations precluded the use of steel. Reasons given for the preference for concrete compared to steel included:

- prevention of cross-over incidents,
- low maintenance costs,
- fewer interventions for repair compared to steel systems
- and thus overall less danger to road users and those carrying out repairs.

Other areas of use included edges of roads and bridges to retain heavy vehicles and, at least in one country, to minimize noise on fill sections of roads.

Finland pointed out that the use of concrete barriers in the central reserve caused snow drifts and thus concrete was avoided as far as possible.

Table 2 (standards/details) illustrated that the New Jersey type barrier was the most common detail used although some countries had developed their own systems;

- concrete post and panels,
- step-profile,
- single slope,
- vertical and convex sides.

Table 3 (EN1317) indicates that EN1317, in full or at least some parts, has been adopted by every country that responded. Responsibility for certification and compliance seems varied however and in some cases uncertain although there is a definite leaning to a state body taking/assuming responsibility for both certification and compliance. As was pointed out by one of the respondents, the position will remain uncertain until EN1317-5 is available and adopted.

The findings recorded in Table 4 (research/testing) are uncertain and inconclusive. It is apparent that some research work and testing is being carried out, mainly by manufacturers, but detail is scant and responsibility for research/testing, particularly in the future, is vague.

The major conclusion from Table 5 (market penetration), is that real hard data is scarce and that compared to steel, concrete systems have a lower use, significantly in many cases. Having said this, it is fair to say that in France, concrete enjoys a healthy use, as does, it is probable to say, steel because of the sheer magnitude of the motorway system, and that in Austria, with regard to central reserve, only concrete has been used for the last 3 years. The situation for concrete in Belgium is also interesting, since concrete barrier use seems both extensive in proportion to steel, and also because concrete is close to becoming the only permitted option for central reserve use with the reported systematic replacement of existing steel barriers with concrete. Overall however the responses suggest that the use of concrete barrier is increasing although difficult to quantify.

Table 5 reminds us that there are problems of initial cost and that one respondent is concerned about the aggressiveness of concrete to cars on impact compared to steel. Snow drifting is again cited as an issue with concrete but this presumably is only a problem where snow is a regular and lengthy hazard. It would be very useful if data could be collected that related just to central reserve use, particularly on high traffic roads and in urban/semi-urban situations, since I suspect that it is here that concrete is making significant inroads?

Table 6 (whole life costing) shows that with three exceptions, WLC is not used. The one country that apparently uses WLC fully is Finland but no real detail was provided except to say that maintenance was estimated and considered alongside the aspects of snow removal and small vehicle impact.

Two countries, Germany and Sweden, stated that they used WLC partially but again provided no real detail other than the facts that;

- concrete does not require repair after impact, and thus does not have the problem associated with steel systems of traffic jams during repair,
- concrete was assumed (in Sweden) to have twice the life of steel.

It should also be noted that one respondent (Austria) cited some German data that suggests that costs due to time delays during repair work are 4/5 times higher for steel compared to concrete.

Regarding attitude (Table 7), there was a mixed but generally positive response.

- Where the reply was positive there was sometimes (3 out of 8) a caveat such as 'flexible systems were preferred if space permits'; or 'although positive in the case of noise reduction, steel looks better and is less expensive'.
- Where the attitude was reported as less positive than steel or unfavourable (2 replies), reasons of greater cost, aesthetics, safety (?), severe damage to cars at high angle impact, were given.
- Generally the attitude to the adoptions of systems proven outside the country concerned were positive.

Even though about two thirds of the responses were from government sources, it was apparent to the author that some of the respondents were not entirely objective in their replies, some even gave personal opinions. In addition it seems to the author that the use of concrete and attitude towards it is a function of population and traffic density; the more densely populated the country and thus the more densely trafficked the roads, the more the use of concrete and the more positive the attitude. Where population and traffic density are low, there are obviously less accidents, and steel (or indeed nothing) is adequate. The replies, the discussion above, and the conclusions below, must be viewed in this light.

6. Conclusions

- Concrete barrier systems are used in every country
- The use of concrete is preferred in central reservations, particularly where traffic is heavy and space (width) restricted, and two countries seem close to excluding steel from central reserve use
- Reasons for use in the central reserve include safety, low maintenance, less risk of cross-over incidents, and fewer interventions for repair
- The New Jersey type barrier is the most prevalent detail for concrete barriers
- Adoption of EN1317 is universal although responsibilities for certification and compliance is not entirely clear and will not be until EN1317-5 is issued and adopted. There is however a definite leaning to a state body assuming responsibility for certification and compliance
- Data on research and testing is sketchy and responsibility for future research and testing inconclusive
- Market data is scarce but penetration seems to be increasing particularly in countries with densely trafficked roads
- High first cost compared to steel is often cited as a reason for the little use of concrete
- WLC has been little adopted
- Attitude to concrete systems is mixed but seems more positive in those countries where population and thus traffic is dense
- Attitude to the adoption of concrete systems proven in other countries was positive.

ANNEX A

This report would not have been possible without the greatly appreciated and valuable assistance of the following personnel and organizations who kindly completed the questionnaires.

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ANNEX B

CONCRETE ROAD RESTRAINT SYSTEMS

Questionnaire on European use, developments and trends

Country:	Organization:	Contact:

	QUESTION	ANSWER
1	Are concrete barriers used? If yes, where (e.g. alongside roads, in central reserve) and why?	
2	Locations where concrete barrier is preferred and (now) solely specified and why?	
3	General description and detail of barriers in use (e.g. Jersey).	
4	Has country adopted EN1317? If no, why not?	
5	Who is responsible for EN1317 certification of new designs?	
6	Who ensures compliance to EN1317?	
7	Details of current research testing e.g. profile, height	
8	Who is responsible now for such testing?	
9	Who will be responsible for such testing in the future?	
10	Length of concrete barrier built including comparison with other types of barrier?	
11	Is use of concrete barrier increasing? By how much - in metres and %age market share?	
12	If not increasing, give reason why?	
13	Is whole life costing used for evaluation of tenders? If yes, what maintenance assumptions are made?	
14	What is the general attitude in the country to the use of concrete barriers?	
15	What is the country's attitude to the adoption/ use of systems in use in other countries?	

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