Sustainable Artificial Badger Sett Design - Case Study

Background and industry context
To mitigate for the loss of badger setts, closed due to construction of HS2, over 30 artificial badger setts (ABS) have been constructed across Phase One of the Scheme, under a licence from Natural England.

Standard ABS design often uses plastic[1] piping for tunnels with a range of materials used for chambers. To reduce plastic and employ more sustainable materials, Fusion, one of the HS2 Enabling Works Contractors, working with Southern Ecological Solutions (SES) and another consultant looked at alternative materials.

Approach
A simple option appraisal of materials was carried out and is summarised in Table 1. Key considerations for alternative materials included the availability of the correct diameter tube for badger tunnels, a round cross section rather than square/rectangle as this provides a stronger cross section, and material longevity of at least 12 months; within this timeframe badgers could create their own entrances and tunnels within the sett.

Table 1: Option appraisal of materials for use in ABS tunnel construction.

Material	Pros	Cons
Plastic (single wall pipe rather than twin wall pipe)	Widely manufactured and obtainable	• Uses non-renewable material. • Single wall pipe not widely available in the UK (manufactured in EU countries like France). • Cost/carbon of transport higher (would need to order in bulk to balance cost/benefit).
Forest Stewardship Council UK (FSC) certified ply board	• Cheap • Easy to obtain • Fairly easy to work with	• Extra labour to construct tunnel shapes and would need screws/nails adding extra materials. • shape: ply tunnels would inevitably be square profile which is less 'naturalistic' and less strong. • Reduced longevity - plyboard would rot more quickly than a standard sheet of ply due to cut edges and drilling holes and may have to be strengthened to withstand the weight of overlying soil. • Not as much flexibility for altering ABS layout in the field and difficult to transport.
Concrete pipes	Widely manufactured and obtainable	• Difficulty of getting the right diameter. • High carbon content. • Heavy, non-flexible and harder to handle on site. • High cost.
Ceramic	Manufactured and obtainable	• Not renewable. • Heavy, non-flexible and harder to handle on site. • High cost.
Strengthened recycled cardboard	• Sustainable source • Light and easy to transport • Can be cut to size on site	• Might not be manufactured currently to the right specification, would need developing with a supplier. • Low strength and moisture resistance (may need additional use of clay to pack around the pipe adding cost and labour).
Biodegradable material (such as cellulose)	• Sustainable source	• Might not be manufactured currently to the right specification, would need developing with a supplier.

[1] High Density Polyethylene (HDPE)

Material	Pros	Cons
	• Light and easy to transport • Can be cut to size on site	• Low strength and moisture resistance (may need additional use of clay to pack around the pipe adding cost and labour)
Use of brushwood faggots and mattresses.	• Could use brash material from vegetation clearance • Potentially renewable resource	• Likely to make footprint/area of sett larger as the bundles would have to form the walls of tunnels and chambers. • Probably only a partial solution in combination with other materials • Stacking bundles like cribbing[2] would be labour intensive. • Might need tighter bundles than usual to prevent ingress of water and soil into the ABS.
Use of 'off-cuts' from construction site; such as plastic twin wall pipe used for drainage.	• Uses materials that would otherwise be 'waste' • Low cost as already being ordered/used elsewhere on site • Could be used in conjunction with other materials above.	• Timing of availability and not enough of the right materials being available to construct a sett when needed. • Cost of transport of materials to ABS location (especially if coming from more than one construction site).

In 2020, the Contractors trialled six ABS using strengthened recycled cardboard (fibreboard) to create sett entrances and internal tunnels. A comparison of the fibreboard and traditional plastic is provided in Table 2. The Contractors worked with Ezee Tree, a manufacturer of sustainable tree guards, on the tunnel design.

Table 2: Comparison of ABS construction using plastic vs recycled fibreboard

	Plastic	Recycled Fibreboard
Material	HDPE Pipe	Recycled Fibreboard
Amount Recycled Material	Mixture virgin and recycled	100% recycled material
Source	China/Europe	Spain
Durability	50 years in the ground, becomes brittle, breaks up and enters the environment	Was strengthened to try and give a longevity of 12 months in the ground, although there was no materials field testing carried out prior to deployment. Would eventually compost into the ground.
Waste	Difficult to recycle, often goes to landfill	Compostable
Aftercare	Stays in ground and breaks down into harmful microplastics	Composts into the soil
Energy Requirement	High	Low
Cost to Purchase (2020) -	£419 plus VAT	£355 plus VAT

[2] Cribbing is a temporary work structure commonly used in construction. It is used to support aerial lifts and other heavy equipment. Wood is often used for cribbing, since it provides strength and durability.

Total per sett for materials only (assuming a standard size 2 chambers, 6 entrances)		

Outcomes
A total of six sustainable ABS were constructed in 2020 and were monitored following construction. Evidence of badger use was recorded, although the durability of the ABS varied depending on location, with five requiring some degree of remediation.

Of the six ABS created one had to be completely replaced and one had to have the tunnel entrances replaced, due to water logging resulting in the tubes sitting in water (see Figure 2). This was exacerbated by livestock trampling following a gate being breached by the local farmer.

Table 3: Sustainable sett outcomes

Sett location	Date constructed	Monitoring data showing evidence of badger use
Buckinghamshire	September 2020	Water logging of tunnels recorded in November 2020; video recording from same month showed escaped cattle trampling top of sett. Video monitoring from April 2021 shows badgers entering tunnels and photo of badger footprints inside tunnel. Main sett was closed in November 2021. ABS condition in summer 2022 recorded as good where the ground was dry and hard with 2 of 6 entrances active. The condition was reevaluated as fair in November where the ground had become boggy and camera recording showed no active entrances and no signs of badgers.
Buckinghamshire	August 2020	Video footage from October 2020 shows one badger outside sett entrance. Video footage from November 2020 showing badgers exiting and re-entering tunnels. However, tunnels also recorded as in a poor state and collapsing due to water logging. ABS was remediated in April 2021 replacing fibreboard tunnels with plastic tunnels.
Buckinghamshire	October 2020	Waterlogging was recorded over the winter of 2020/21 with no use by badger. Remedial works to mitigate waterlogged and collapsed tunnels was carried out in Spring 2021, by adding an 'upper tier' of entrance tunnels using plastic pipes and chambers.
Northamptonshire	October 2020	The ABS was destroyed following flooding and collapse of entrances over winter 2020/21. Sett was replaced in 2021 using plastic pipes.
Northamptonshire	October 2020	Evidence of use of the ABS was identified in January, April, and May 2021. Existing main sett was closed in November 2021. Monitoring in 2022 recorded ABS in good condition and suitable for use by badgers. The fibreboard tunnels had degraded but badgers had created new entrances with evidence of badger use and badger paths present in the area.
Buckinghamshire	October 2020	Although initial indications were that this ABS was successful, the existing badger sett was never closed due to changes in work scope and design by Contractors after the ABS was built. Therefore, ABS did not require monitoring.

The conclusions of the trial are:

- A sustainable artificial sett can be cost effective.
- Badgers will use a sustainable artificial sett.

- Location and local site conditions are important to the longevity of the ABS if using fibreboard.
- Although the material used for tunnels doesn't need to have a very long longevity, it does need to be robust and last for as long as possible, so badgers have a chance to create their own entrances to the sett chambers.
- ABS using fibreboard need to be raised off the ground with an underlying base of granular material to aid drainage, especially in areas of clay rich soils.

SES are currently looking at a new design for ABS entrances, constructing new setts above ground and discussing with the manufacturer whether they can provide a product that is of a higher tolerance.

Figure 1: Sustainable ABS during construction. Sett showing fibreboard tunnels and plyboard chambers in place (left), and sett following coverage with topsoil (right).

Figure 2: Issues with fibreboard tunnels. Entrances to setts waterlogged (top left) due to heavy rain and standing water on heavy clay soils (top right). Exacerbated on one sett by escaped cattle trampling the sett (bottom).

Figure 3: ABS remediation. New sett replacing failed ABS which used plastic pipes but retained use of FSC plyboard for chambers (left). Test design for ABS entrances on non-HS2 sites, as part of the on-going process of improving the sustainbility of ABS design (right). Photos courtesy of SES.

Figure 4: Still from video footage of a badger exiting the tunnel of a successful sustainable ABS