Rubber/Plastic Composite Rail Sleepers

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1. Summary

There is a large potential market for rubber-plastic composite rail sleepers in the UK and in Europe.

A US company, TieTek LLC of Houston, Texas has developed a railroad sleeper made of a rubber-plastic composite which it markets to America's railroads. In 2004, there were an estimated 141,509 miles of rail track in the USA, with between 2,640 and 3,000 sleepers per track mile. This amounts to a potential longer term market in the USA of between 373.5 million and 424.5 million sleepers if all wood and concrete sleepers were replaced.

In the UK there are an estimated 10,478 miles of rail track. If sleeper spacing is the same, a market exists in the UK for 27.7 million and 31.4 million composite sleepers if all of the concrete sleepers were to be replaced.

In terms of post-consumer waste passenger tyres, refitting all of the US sleepers would use about 1.5 Billion tyres-worth of granulated rubber, or 5 years of the USA's total tyre disposal. In the UK, this would amount to the use of about 115 million tyres-worth of granulated rubber, or over 1.5 years of the UK's tyre disposal with no tyres going to any other use. In short, the market potential is huge.

This report is about the composite sleeper product and the company which is developing the market.

2. The Potential for Composite Sleepers

Railroads, including the behemoth Union Pacific Railroad Company, which has 53,877 miles of track in 23 states covering about 2/3 of the USA, are using composite sleepers to replace creosote-soaked wood sleepers and less forgiving concrete sleepers.
The company has developed an innovative substitute for the common creosote-treated wood railroad sleeper. Applying a patented manufacturing process, it produces an alternative railroad sleeper that is superior in performance, environmentally responsible, and provides a significant value to its rail customers. Just as composite materials have revolutionised other industries including automotive, aerospace, sports, transportation and building materials, the company’s sleepers are having a profound impact on the rail industry in the USA.

By using composite sleepers, railroads can increase the profitability of their operations by reducing track maintenance costs, reducing downtime and improving performance.

Composite sleepers have proven to be viable replacements for traditional wood sleepers and have accumulated over 1 billion gross short tons of high tonnage load in a Class 1 rail environment.

Slippage on curves is a major problem with both wood & concrete sleepers. The company has designed non-slip texturing eliminating this problem. Photo by TieTek LLC.

The composite sleepers are responsible alternatives for both high tonnage, Class1 rail environments as well as low tonnage, commuter rail traffic.

Composite sleepers are impervious to insect and moisture damage, resistant to fungus, electrically non-conducive, resistant to chemical damage, and reduce vibration that can shorten the life span of other track material. Long after most comparable wood or concrete sleepers have been replaced, composite sleepers maintain their superior performance characteristics – up to 50 years, according to company estimates after extensive field testing.
To eliminate slippage on curves the company enhanced its product by adding a textured finish, increasing the friction with the ballast (crushed rock in the rail bed) and minimising lateral movement.

Composite sleepers are designed to be installed by the same equipment that installs wood & concrete sleepers. Photo by TieTek LLC.
Features of the composite sleeper, which are identical in size and weight to a wood sleeper, include:

- A composite sleeper lasts longer than a wood sleeper, reportedly with better performance.
- A composite sleeper can be used interchangeably with wood or concrete sleepers.
- A composite sleeper can be nailed or spiked just like wood without splitting and with greater spike retention; or can be pre-drilled like concrete. Either way, identical "hardware" can be used for the remainder of the sleeper to track system.
- A composite sleeper can be installed with traditional wood sleeper hardware and machinery.
- A composite sleeper experiences minimal deterioration due to climate – especially humidity or moisture.
- A composite sleeper is not susceptible to any insect damage.
- A composite sleeper has no future disposal costs (unlike creosote wood sleepers) and can be recycled into new composite sleepers.

A company employing showing that spikes can work free from wood sleepers over time. In composite sleepers, attaching spikes remain seated. Photo by TieTek LLC.
The composite sleeper is composed of a proprietary mixture of plastics (mainly shredded HDPE), rubber from whole post-consumer tyres, rubber buffings from retreaders, other waste materials, chemical additives and various fillers and reinforcement agents like fiberglass or vermiculite. The overall rubber content represents approximately 20% of the mixture. The company has created a five-stage manufacturing process that establishes efficiency and consistency in production. The stages of manufacturing are:

1. Raw Material Selection and Handling
2. Compounding and Mixing
3. Shaping, Forming and Cooling
4. Texturing
5. Quality Assurance

In addition to the melting raw materials, composite sleepers contain several components that do not melt in the manufacturing process. Therefore, the system simultaneously melts the plastics and completely mixes it with the non-melting components to achieve the
appropriate properties for the finished composite sleepers. In this stage of the manufacturing process, the ratios and sequence of the mixing process, as well as the introduction of chemical agents, have been empirically established and include several proprietary techniques necessary to achieve the desired product properties.

Stage one of the process involves accessing and feeding a consistent supply of raw materials for production. The company handles the raw materials to create a mixture matching its proprietary formula. According to the company's managers, the precision of this stage is critical to the efficiency of the operation and ultimately the overall performance of the finished product.

In stage two of the process, raw materials are mixed, melted and compounded to create a homogeneous material. The key to this stage is continuously mixing and melting together various components that have very different physical properties including weight, density, melting and mixing parameters, and flow characteristics.

The mixture from stage two is extruded into moulds that produce an attractive and "clean" sleeper that has a very close resemblance to a wood sleeper, and whose cross-section dimensions and profile are 7" (178mm) x 9" (229mm), with no unwanted curvature, twisting, or deviation from a perfect rectangular shape.

Once the moulds are filled, the cooling begins while still in the mould until the outer shell of the sleeper is hardened to a specific point. At the completion of the third stage the outcome is simple: Each sleeper identical - minimising warping, weak stress points and contains no creosote.

The company's third stage in the manufacturing process is actually the final stage of the production process. The company implemented an optimal moulding process that is feedstock tolerant, easily operated and controlled, and produces a product that is both dimensionally consistent and internally sound.

The company's fourth stage in the manufacturing process is a unique texturing process that presses a cross-hatched pattern onto the bottom and two vertical sides of the sleeper. This feature enables composite sleepers to grip the rock bed ballast and dramatically improve lateral resistance over smooth sided wooden sleepers. This feature improves rail stability and protects against derailment.

Once the actual production is complete, each sleeper is tested by a non-destructive inspection method to assure the highest quality and adherence to the strict product guidelines, and especially to assure that there are no structural voids within the sleeper. This stage is critical for manufacturing process feedback and control, as well as complete product quality assurance.
4. **Composite sleepers are environmentally friendly**

The company has an environmentally friendly business in three ways:

- **First,** recycled raw materials are used in manufacturing composite sleepers, diverting tonnes of would-be wastes from landfills to a productive, "clean" use.

- **Second,** composite sleepers replace wood sleepers, which have a negative impact on the environment. More than three million mature trees are harvested each year to provide wood sleepers for rail use in the USA. Wood sleepers are treated with creosote, a toxic chemical that poses manufacturing and pollution exposure. Each mile of track that utilises wood sleepers uses 810 mature oak trees while, in comparison, a mile of track using composite sleepers consumes 2 million plastic bottles, 8.9 million plastic bags, and 10,800 post consumer passenger tyres.

- **Third,** composite sleepers are manufactured from recyclable materials and are 100% recyclable after production. Since composite sleepers incorporate readily available waste materials in the manufacturing process, they have no harmful impact on the environment. Because composite sleepers are recyclable themselves, there are no disposal issues.

5. **Contribution to Recycling**

At about 260 lbs each (118 kG) and a 20-60-20 split of ingredients, the company has used about 1.2 million whole post-consumer tyres-worth of recycled rubber granulate, using about 4 tyres-worth for each sleeper. Additionally, the company has used about 22,000 tonnes of recycled HDPE, using about 70 kG per sleeper.

6. **Why a Best Practice?**

6.1 **Establishing a market and a product**

TieTek established a reliable, consistent and long-term market for its rubber-plastic composite product, which is wholly recyclable. This required many years of work. The rail industry is not known for its innovation, making it a difficult target consumer.

6.2 **Responding to a product problem which competing sleeper products cannot solve**

When "slippage" became an issue with wood, concrete and composite sleepers, the company designed a non-slip surface that is now incorporated into its product. In addition to its environmental benefits from recycling, this distinguishes composite sleepers from its conventional competitors, which have been unable to solve the slippage problem.

6.3 **Joining with customers in testing**

The company has financed much of the medium-term research, testing the miles of track that have been installed. It has participated with its customers in testing opportunities, adding trust in its abilities and confidence in its product.

6.4 **Product replaces ones using virgin materials**

The composite sleeper is a Best Practice product, replacing competing products using mature oaks or thousands of tonnes of concrete and steel.
The composite sleeper is superior to the products using virgin materials it replaces:

- It performs as long or longer than wood or concrete sleepers, needing replacement less frequently; and
- It slips less on curves than wood or concrete sleepers, making the rail track safer.

6.5 Manufacturing quality assurance

The company’s methods of production qualify as a Best Practice, especially the routine non-destructive testing of all finished products. Composite sleepers which do not meet the required standard are shredded and returned to the mixer for incorporation into new sleepers.

6.6 Technology can be licenced

The composite sleeper process and formulation can be licenced; hence it can be replicated.

7. Additional information:-

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