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Ref No: 08-08-11-015

New Equipment & Systems Approval - (1) 16 mm lockspikes and (2) Spikefast for use with Timber Sleeper

1. Determination of Need.

In NSW there is considerable timber sleepered track. Much has double shouldered sleeper plates which have provision for only 2 x 16 mm lock spikes per plate, plus 4 locations for 19 mm round dogspikes to hold rail to sleeper. These dogs are removed for retrofitting any of the resilient fastening systems leaving only the 2 x 16 mm lock spikes to carry forces - shear, uplift, lateral, etc.

The NSW system uses 16 mm lockspikes, while most other systems use 19 mm lockspikes.

In April 2005, the Engineering Compliance Manager from Wagga requested approval to use 16 mm lockspikes for use on any "retrofit" resilient fastening systems in double shoulder baseplates in NSW.

Both PP-122 and TEP-01 require testing or prior usage as a basis for approval. This paper is based upon technical analysis completed by GHD's Alan Bohn. Note: GHD has previously completed considerable analytical work for ARTC on similar fastening systems in Vic. So they have an extremely good background on the theory and field performance of this type of assembly.

At around the same time, ARTC learnt of a new product (for Australia) called Spikefast. This was very timely and the reasons for this are outlined below.

This paper outlines the conditions under which approval for this system can be granted.

It is considered that this conditional approval should be for all timber sleepered tracks in ARTC.

2. Significant Change or Not

This change in equipment is assessed as MINOR

3. Review Panel



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- John Cowie - Manager, ISP, Standards and Systems
- Tim Calver - Standards and Technical Services Engineer
- Alan Bohn/GHD – Senior Engineering Consultants.

4. Suitability

The draft GHD report is attached as Appendix A. and the Bodycote report on Spikefast as Appendix B.

SUMMARY of GHD RECOMMENDATIONS

1. N.S.W. baseplates and 16mm lockspikes can be used with retrofit resilient fastenings up to 25 tonne axle load and above 500 metre radius curves, provided the sleepers are in serviceable condition. In all cases 4 No. lockspikes should be used, with the gauge hole shimmed in all cases. The outer hole may need shimming depending on sleeper condition

2. Below 500m radius with serviceable sleepers or a mixture of new and serviceable 19mm lockspikes and new or repunched plates should be used.

3. With 100% new sleepers 19mm lockspikes, 4 No per plate should be used below 400m radius.

4. In all cases where the gauge hole is used for a lockspike a shim should also be used.

Other Requirements.

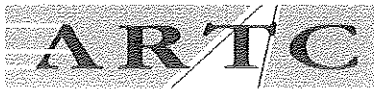
In lieu of shimming, ARTC has also been advised of a product called Spikefast which is essentially a glue that fills the dog hole in timber sleepers. A hole is then drilled in this "restored" timber to accommodate either a dog spike or a lock screw. This is particularly useful, where round dogs can be used in slotted, worn, "D" shaped or square lockspike holes. Spike fast can also be drilled out to make "new" holes without further boring of aged timber sleepers.

While ARTC has no prior experience with this product, it has received an independent report from the Willamette Valley Company regarding testing of this product in Canada by an internationally accredited company called Bodycote and the results for tests of 1,000,000 cycles are good. See Attached summary of report – Appendix B.

Note: Bodycote is accredited to ISO 17025.

While 1 million cycles is less than our desirable minimum of 3 million cycles, it is felt that for a 18 month trial this is adequate.

5. Conditions of Approval – 18 month trial



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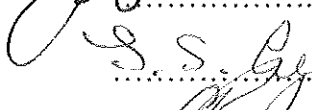
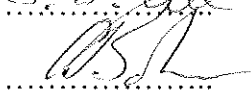
- Approval is conditional on the satisfactory completion of field trails of Spikefast near Wagga in July 2005. Note: these trails are to check general handling, application and suitability, NOT longevity/fatigue life of the product.
- If Spikefast proves to be unsuitable, the shim options recommended by GHD will have to be reconsidered.
- The suitability of Spikefast and the 19 mm dogspikes or alternatively Spikefast and 19 mm lock screws, is to be assessed after 18 months and further type approval obtained in accordance with PP-122.
- Appropriate standards, specification, procedures will then be revised to match this option in due course.
- That Corridor/Delivery/Asset/Procurement Managers must:
 - Assess each site to determine suitability for this product. This is particularly relevant in this application, where timber condition can vary considerably.
 - Assess cost/benefit of this process at locations chosen.
 - Ensure that the installation is in accordance with the manufacturers instructions.
- That the suppliers remain accredited to ISO 9001 and ARTC is advised on a 18 monthly basis that accreditation is current. ARTC reserves the right to conduct its own audits of the manufacture and supply of these components – subject to Australian Standards and normal audit procedures.

6. Recommendation

The usage of 2 x 16 mm lockspikes be in accordance with GHD recommendations above, with the exception that Spikefast can be used in lieu of or in addition to shims – as determined by sleeper condition in the field. In addition the 16 mm lockspikes are to be supported by Spikefast and either 19 mm lockscrews or 19 mm round dogspikes in the old dog holes.

7. Interim sign off

Review Panel:

John Cowie		Date	27/6/05
Tim Calver		Date	27/6/05
Alan Bohn		Date	28/6/05

APPENDIX A



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DRAFT

Comments on Peter's query about the use of 16mm lockspikes with retrofitted resilient fasteners on N.S.W. baseplates with 2No outer 16mm holes and using 19mm round gauge spikes and some recommendations . This information is based on a previous report to A.R.T.C of October 2002 "Lockspikes - Resistance to Gauge Widening " and additional information from a paper by Heiner Moehner titled "The mechanics of Long Term Gage Holding" presented at a Symposium on Elastic Track Fastenings ,Omaha, June 3, 1992.

Retrofitted resilient fastenings will be either Pandrol or RexLok and while there is a difference in their performance in terms of toe load ,resistance to rollover and other factors which influence rail creep, rail uplift and behaviour under extreme conditions this difference will not significantly affect gauge holding or other plate behaviour under normal conditions.

The following comments apply to both systems.

- 1. The action of a lockspike is simple but it is part of a system that influences its behaviour under various traffic conditions.e.g.speed,axle load ,rail weight track geometry track stiffness, baseplate friction, sleeper condition and lockspike dimensions. The imposed loads on the lockspike i.e.

- longitudinal forces from traffic and thermal effects.
- lateral forces from traffic , geometry
-gauge widening forces
- pullout forces from uplift effects are resisted by friction forces and shear between the lockspike and timber.

The major loads are from lateral forces which are resisted by bearing of the lockspike along the timber grain and frictional forces between plate and sleeper. Cross grain bearing failure will generally not occur and can be ignored as can gauge widening forces. Uplift of the lockspikes under traffic reduces the frictional component of lateral resistance and allows working of the lockspike in the sleeper leading to accelerated degeneration. Strength of the lockspike is not an issue as the timber will always fail first.

- 2. Chapter 5 and 6 of the Oct. 2002 Report examine the above in some detail with tables V and VI giving recommended lockspike patterns for 23tal and Tables VII and VIII giving recommendations for 25tal.Table IX on P18 gives a summary for both 16mm and 19mm lockspikes and this is shown below.

Table with 5 columns: Tangent to, 23tal (19mm, 16mm), 25tal (19mm, 16mm). Values: Tangent to 2, 3, 2, 3



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800m R

800m R to
500m R

2

3

3

4

500m R to
300m R

3

4

4

4

Below 300m R

4

4

4

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The following assumptions were made in developing the above

1. New or good serviceable sleepers used.
2. Full frictional resistance is achieved and lockspikes are correctly seated.
3. Track is in good condition.
4. Lockspikes are driven into outer plate holes into good timber.

As the track conditions are likely to be less than ideal and the N.S.W. sleeper plate is punched for 16mm spikes with one outer hole the following conditions are recommended to allow existing plates and 16mm lockspikes to be used.

1. Two 16mm lockspikes and 2No PC3 type lockspikes per plate be used at all times.
2. The minimum radius curve for the installation of 16mm lockspikes be 500m.
3. PC3 or equivalent lockspikes to be used in the gauge holes with shims. In the outer plate holes L16 or equivalent lockspikes are required. Shims may be needed depending on sleeper condition at the outer holes.
4. Below 500m radius it is recommended that 19mm lockspikes be used in the outer holes either by replacing the existing plates or repunching the existing plates. Repunching is a relatively economical operation, the major cost being in plate removal and replacement and for transport.

The comments by Graeme Templer in his email of 8April 2005 outlining maintenance strategies is relevant to the above. It is recommended that even with 100% new sleepers that 19mm lockspikes be used below 400m radius.

NOTE:

1. Shims are available commercially and used regularly in W.A. made from flat steel strip and cost about 50c each ex factory. A spring steel shim is also available and this type may be more suitable where the timber is degraded. Cost is about \$1.50 in quantity. It is recommended that field staff conduct some trials of both types to determine suitability.
2. A dimensional check is needed to ensure that Pandrol and RexLok will clear the lockspike heads. From drawings the RexLok system will clear but the Pandrol system may not.

SUMMARY of RECOMMENDATIONS

1. N.S.W baseplates and 16mm lockspikes can be used with retrofit resilient fastenings up to 25tal and above 500m radius curves provided the sleepers are in serviceable condition. In all cases 4No. lockspikes should be used, with the gauge hole shimmed in all cases. The outer hole may need shimming depending on sleeper condition



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2. Below 500m R. with serviceable sleepers or a mixture of new and serviceable 19mm lockspikes and new or repunched plates should be used.
3. With 100% new sleepers 19mm lockspikes ,4No per plate should be used below 400m radius.
4. In all cases where the gauge hole is used for a lockspike a shim should also be used.

Alan Bohn



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APPENDIX B



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**Willamette Valley Company
Spike Fast Hole Plugging
Static and Fatigue Testing**

June 2002

Presented to :



**Willamette Valley Company
660 McKinley Street
Eugene, Oregon 97402**

Bodycote Project # 02-130507

Prepared by:

**Tim Johns
Mgr., Rail Products**

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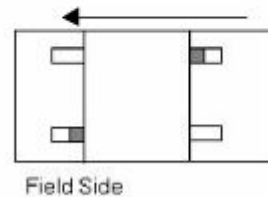
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General

In accordance with the Bodycote Offer of Service # MAT 0096 dated 25 January 2002 and discussions with Willamette Valley Company, the first stage of the test program to evaluate two different tie plugging materials, trademark Spikefast, has been completed. This first stage included spike insertion/extraction tests and full tie fatigue testing. The final stage of the testing, involving individual spike fatigue testing, will be completed at a later date.

The two ties used for the tests were supplied by Willamette Valley Company and were prepared for testing by them. This preparation included placement and cutting of slotted holes, which were aligned to accept a 14" flat bottom tie plate using standard North American track gauge. The slots measured 3/4" x 1.5". Each tie was filled with a separate material, identified as ES-25 for the red material and ES-50 for the yellow material. It was noted that the tie plates aligned in such a way that the gauge side spike would bear on a very thin section of repair material, where the field side spike would bear on the full slot of material. (See the figure at right; shaded squares represent spike locations) While this configuration lends a slight bias to the test, the load is concentrated on two spikes only and sufficient comparison is possible between materials, since both ties are configured the same way.



Before applying the plates, the test material had to be ground flush with the tie surface to prevent interference with tie plate leveling.

Pictures of the test setup as well as pictures of the spike holes can be found in Appendix #2 of this report. Charts and work tables are in Appendix 1.

Test Procedures

Two diagonally opposite spike holes were selected for spike extraction testing. This involved driving a spike into the prepared spike hole to a depth equal to the correct position in track when a tie plate is in place. The insertion force was recorded. The spikes were then extracted and the extraction force was recorded. This procedure was repeated 10 times to produce the spike insertion/extraction curves in Appendix 1.

The remaining diagonally opposite spike holes were used for the fatigue test. This involved spiking a standard 14" cut spike tie plate to the tie at both ends using the treated spike holes. A two spike pattern was used to spike the ties. A cycling load was applied simultaneously to both rail heads using a dynamic loading as follows:

Inclined Load "Tangent Loading" Fatigue Test		
Load per rail, Lateral	= 13,000 lbs max.	260 lbs min.
Vertical	= 25,000 lbs max.	500 lbs min.
Load Ratio L/V	= 0.52 constant	
Test angle	= 27.5° per arm	



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Deflection measurements were taken on the plate gauge side using an LVDT transducer connected to a brush recorder to monitor plate movement throughout the test. Static measurements were also taken on the rail head at each end before and after the test to measure total gauge widening.

After the fatigue test, the spikes were extracted and the extraction forces were recorded. The extraction forces before and after the fatigue test combined with the amount of plate movement after 1,000,000 cycles were used to compare the working characteristics of the two materials. The comparative data and graphic representations of the various comparisons are found in the Appendix #1 of this report.

Test Results

Spike Insertion/Extraction

During the insertion of the spikes, it was noted that the Spikefast material filler plug was pressed into the hole to a depth of 3/16" under the force of the insertion. The spike holes may not have been filled to the bottom of the hole, perhaps due to trapped air. This did not appear to have a detrimental affect on the test results. Both materials produced flakes when the spikes were removed during the 10 insert/extract cycle sequence but not after the fatigue cycling.

When compared to cedar tie plugs, the spike extraction forces and plate movement for both Spikefast materials were considerably better statically and dynamically, both before and after cyclic load testing. (Charts #4 & 8).

Comparing the two Spikefast materials, the red material (ES-25) appears to be harder than the yellow (ES-50). Test results for all tests are in accord with this. The results for the spike insertion/extraction show higher forces required to insert the spike but slightly lower forces measured on extraction. Extraction force after 1,000,000 was lower on the red but with 6% less loss of holding power. There was less plate deflection during both static and dynamic load deflection measurements on the red material.

Cyclic Load Test

The results of the cyclic load test indicate that both materials resist lateral loading better than the cedar plug. The red material (ES-25) appeared to have a slight advantage over the yellow (ES-50) for resistance to plate movement after 1,000,000 cycles (See Table 4). Extraction forces after cyclic loading were slightly lower for the red material.

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APPENDIX 2

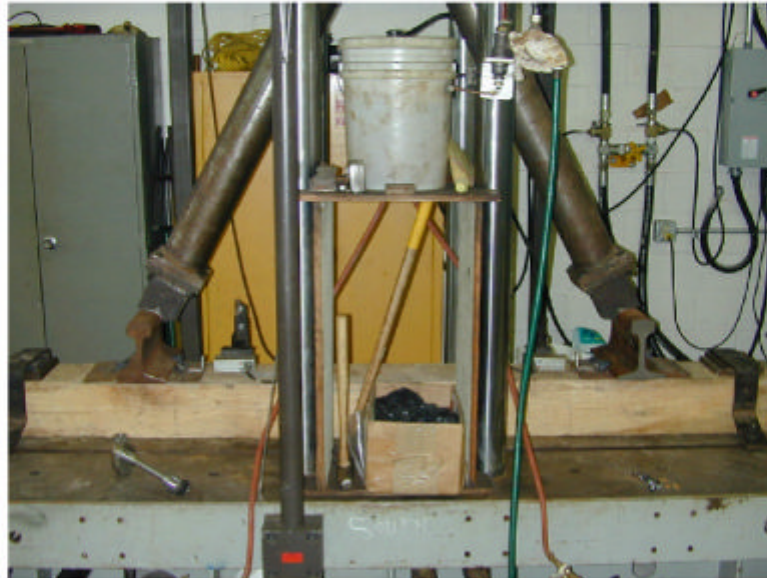


Figure 1 – General Setup of fatigue test.



Figure 2 – Close-up showing one end of setup with plate bracket and LVDT transducer visible.

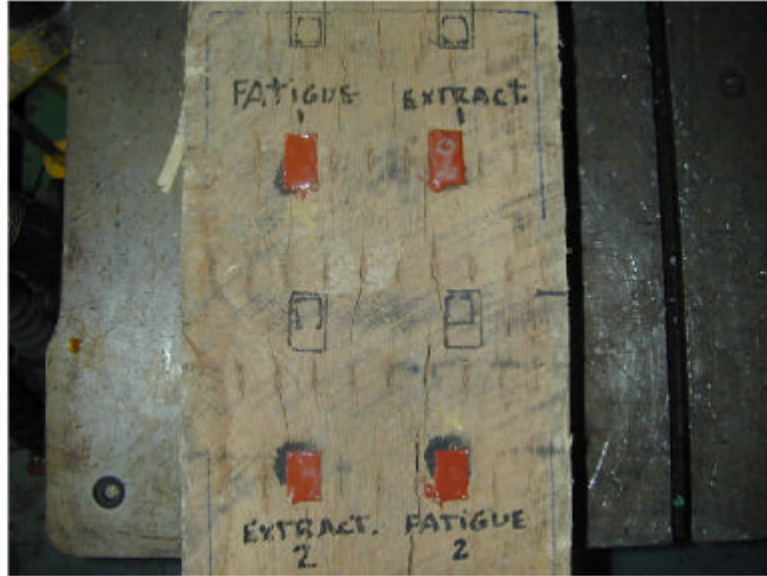


Figure 3 – Red ES-25 material in tie before testing.

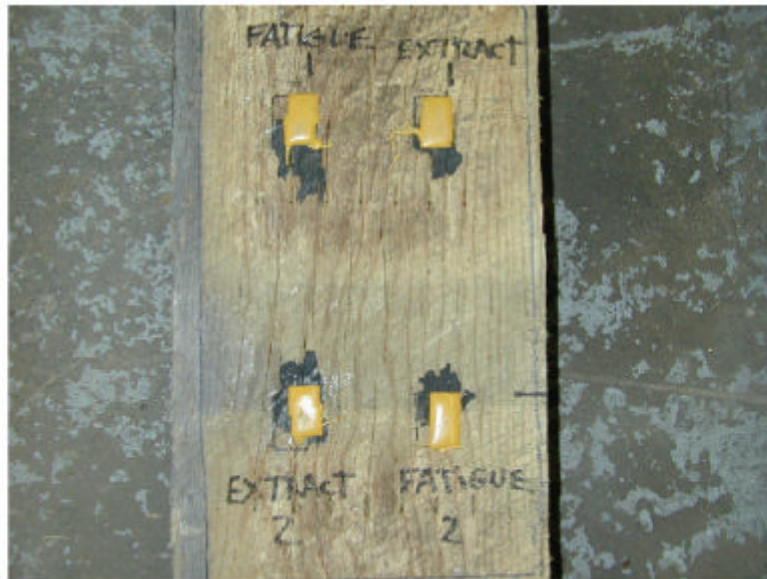


Figure 4 – Yellow ES-50 material in tie before testing. Note raised profile of material, which was smoothed off before fastening tie plates.



Figure 5 – Start of insert/extract tests. Note filler plug pressed into the hole.



Figure 6 – Example of spike holes after 10 extraction cycles showing red ES-25 (left) and yellow ES-50 (right). Same flaking occurred in both materials during extraction (yellow ES-50 right, cleaned before photo was taken). Note slight depression around yellow material also.

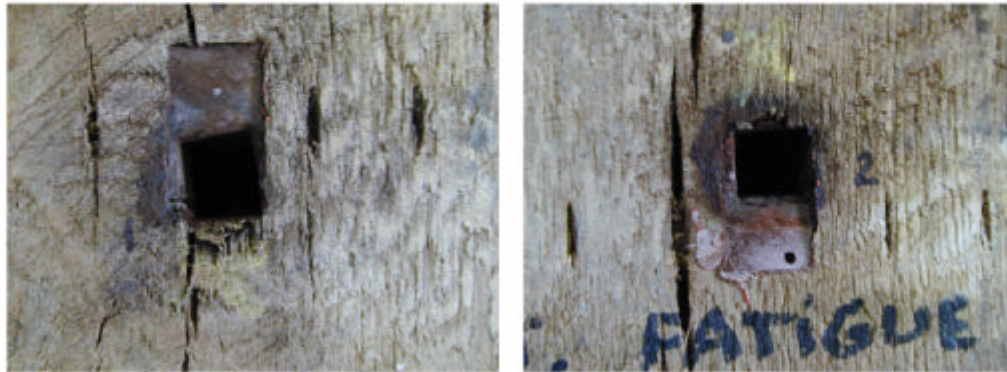


Figure 7 – Spike holes from red ES-25 (field left, gauge right) after 1,000,000 cycles.



Figure 8 – Spike holes from yellow ES-30 (field left, gauge right) after 1,000,000 cycles..