1. OBJECTIVE

The objective of this guidance note is to provide post weld improvement techniques for dressing welds using angle grinders and die grinders fitted with rotary burrs or mounted stones. The techniques described can be applied to welds to improve their fatigue performance for welds meeting AS/NZS 1554.5 – 2004 “Structural-steel welding Part 5: Welding of steel structures subject to high levels of fatigue loading”. An increase in fatigue performance of 20%, for example, means that the allowable stress can be increased by 20%.

2. BUTT WELDS – WELD PARALLEL TO APPLIED LOADING

Post weld grinding of butt welds subject to loadings parallel to the direction of welding involves two steps. Rough grinding to remove all stop/starts and large weld solidification ripples and finish grinding in such a manner that the resultant finish grinding marks are parallel to the loadings that will be applied, Figure 1.

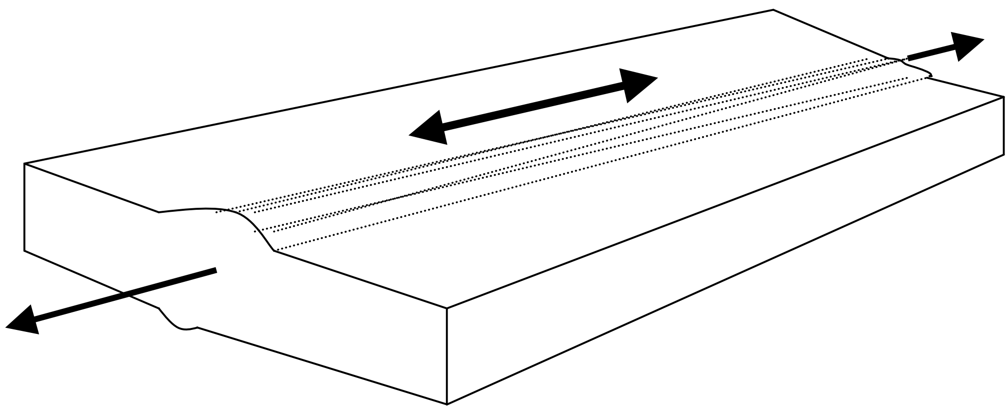

Figure 1. Grinding marks parallel to direction of cyclic loading – stop/starts and weld ripples removed.

3. BUTT WELDS – WELD TRANSVERSE TO APPLIED LOADING

Two methods are available to improve the fatigue performance of butt welds subject to loading transverse to the direction of welding. If the reinforcement on both sides is completely removed a 40% improvement in fatigue performance results. If the reinforcement is dressed such that there is a smooth transition between the reinforcement and parent metal with no undercut a 12 % improvement in performance will result.

Rough grinding with an angle grinder can be used to remove all excess metal but finish grinding must result in all grinding marks running parallel to the direction of applied load as shown in Figure 2. The grinding may extend 20 mm or so either side of the weld to ensure a smooth transition.

As an alternative to grinding which can be noisy, time consuming and laborious a rotary burr can be used to locally remove undercut and provide a smooth transition from parent metal to weld reinforcement. An exaggerated cross section is shown in Figure 3. Rotary burring will result in some local loss of wall thickness. Because the area of metal loss has a round profile, as opposed to a sharp notch like that produced by undercut or lack of fusion, it has improved fatigue performance. Wall thickness loss should not exceed 5% of the section thickness, or 0.8mm, whichever is the lesser.

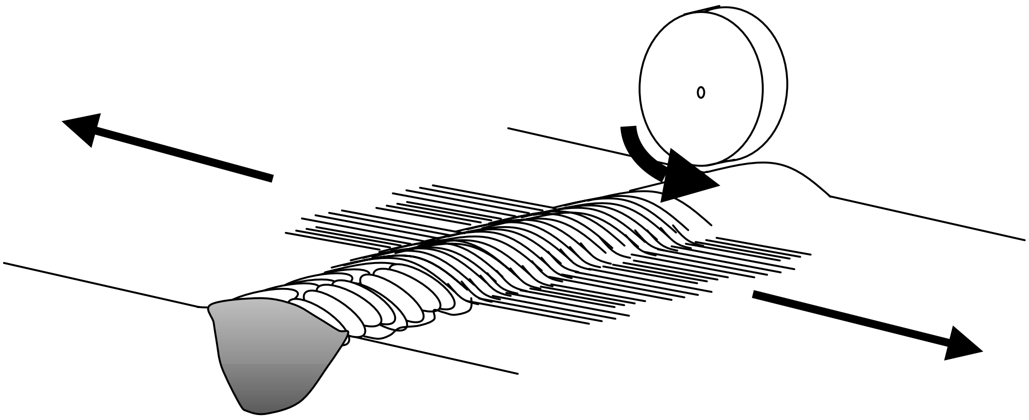

Figure 2a. Grinding Transverse Butt Welds can result in a 12% improvement in fatigue performance over the as-welded condition.

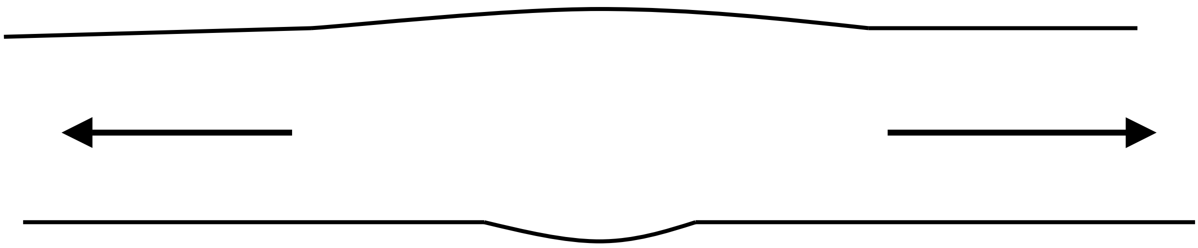

Figure 2b. Finished Cross-section of weld

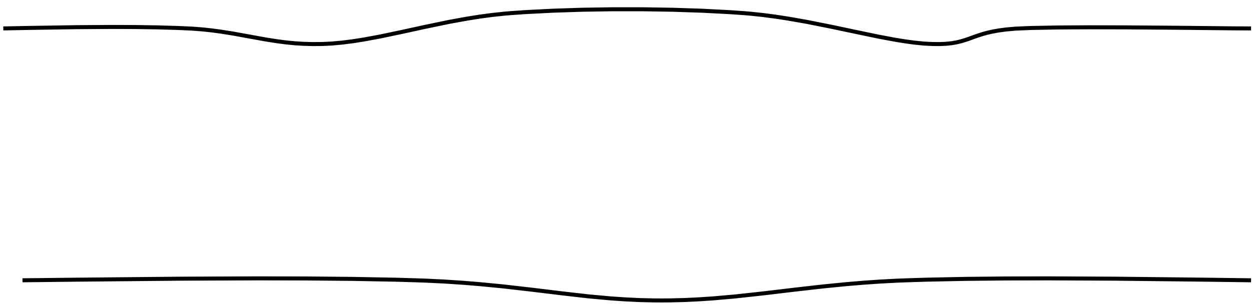

Figure 3. Rotary burring to improve fatigue performance will introduce small reductions in wall thickness that need to be kept to a minimum.

4. TEE BUTT WELDS OR TEE BUTT CORNER WELDS

The fatigue performance of fillet reinforced tee butt welds or tee butt corner welds can be improved by grinding to produce a smooth transition between the parent plate and the weld. The technique is shown in Figure 4.

Similar improvements can be made with a rotary burr concentrating on the removal of undercut and creating a smooth transition between weld and parent metal.

Again, with this technique the dressing must not introduce grooves transverse to the applied stress. Finish dressing needs to be carried out such that the resultant dressing marks are all parallel to the applied load. Such weld finishing techniques can improve the fatigue performance by about 13%.

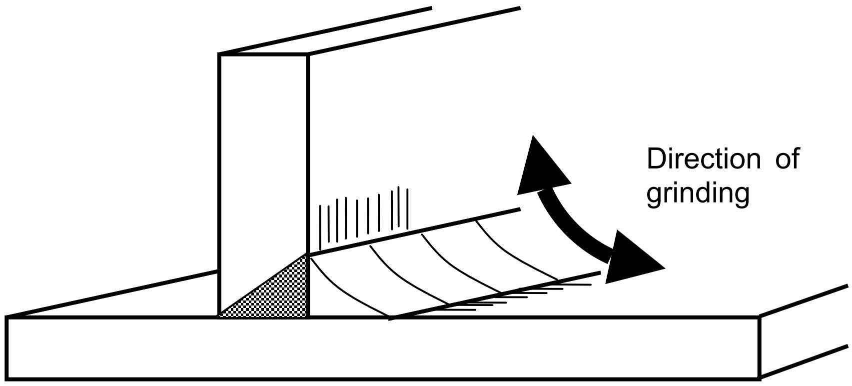

Figure 4. Improving performance of fillet reinforced Tee Butt welds by grinding or burring to remove undercut, stop-starts and establishment of a concave reinforcement profile.

5. FILLET WELDS AND PARTIAL PENETRATION BUTT WELDS

Transverse fillet welds and incomplete (partial) penetration butt welds have the worst fatigue performance of any type of weld. When subject to fatigue loadings, the root gaps of fillet and incomplete penetration butt welds should be no greater than 1 mm.

Switching from an incomplete penetration weld to a complete penetration weld made on a backing plate can result in a 97% improvement in fatigue performance.
Similarly adopting a fillet-reinforced butt weld instead of a fillet weld will result in a 97% improvement in fatigue performance.

6. STOP/STARTS

Weld stop/starts provide fatigue initiation sites so wherever possible all welds should be continuous and all weld craters fully filled. Where welds are not continuous the stop starts of welds that are unavoidably left exposed should be gradually tapered to an angle of not more than 45°. They should not be dressed concave or scalloped but should be in the shape of a *diamond point,* Figure 5. Stop starts should blend smoothly with each weld bead in multi-run welds and should blend smoothly with the previous bead. Stop starts should not be positioned at the end of sections such as stiffeners or gussets.

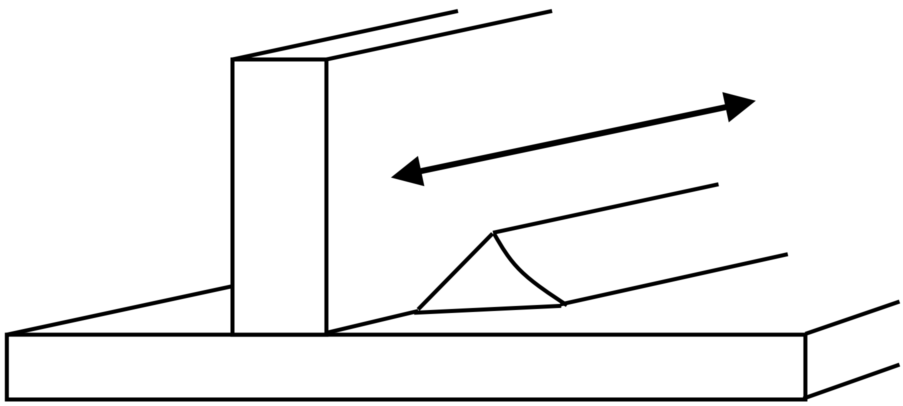

Figure 5. Blending the ends of non-continuous fillet welds parallel to fluctuating load

7. ATTACHMENTS

ATTACHMENTS SHALL NOT BE WELDED ONTO STRUCTURAL MEMBERS WITHOUT EXPRESS INSTRUCTIONS FROM THE DESIGN ENGINEER. Only when required by the design engineer shall attachments shall be welded in such a manner that the start and stop of the weld do not provide crack initiation sites at the corners of the attachment, Figure 6.

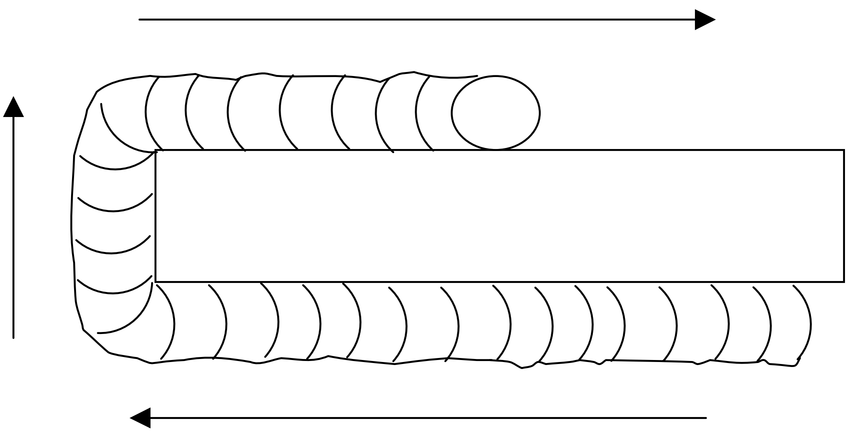

Figure 6. Attaching this stiffener to a structural member using a non-continuous fillet weld significantly reduces the fatigue performance of the component.

8. WELDING

The welding consumables and welding process should be selected to produce welds that result in weld beads that blend into the parent metal without excessive reinforcement and without a tendency to produce undercut. Automatic welding methods are preferable to manual or semi-automatic methods. Unduly course weld ripples and stop-starts are detrimental to fatigue performance and should be removed by dressing.

Run on and run off tabs should be used for all butt welds. The weld should extend into the run on run off tabs by a distance at least equal to that of the thickness of the parent material and joint should be completely filled. The run on and run off tabs should be removed and the ends of the weld dressed flush with the dressing marks parallel to the direction of loading.

9. DRESSING

Welds, or any section of weld, considered to have excessive reinforcement or unacceptable profile should be dressed in order to modify the surface profile and improve fatigue performance. Metal can be removed by grinding or burr dressing.

Rough grinding may be carried out using an angle grinder or a grinding stone .Care should be taken to ensure that deep score marks are avoided.

Rotary burring of weld toes generally provides the minimum amount of dressing necessary to obtain an acceptable weld. Rotary burrs are generally tungsten carbide tools that come in a variety of shapes and sizes. The type of rotary burr selected should be appropriate for the particular application. Local rotary burr dressing of the weld toes may be carried out but thinning of the parent material in any instance must not exceed 5% of the wall thickness.

Final dressing should be carried out using barrel grinders, flap wheels or rotary burrs. The method for final dressing should be selected to ensure that the diameters are appropriate for the size and profile of the weld.

Any dressing marks visible after completion of the work should be parallel to the loading direction.

10. NON-DESTRUCTIVE EXAMINATION

AS/NZS 1554.5 provides requirements for non-destructive examination which should be carried out after all dressing has been completed. Equally important is performing 100% visual inspection to ensure that no undercutting or gouge marks are evident after the dressing operations.

11. TRAINING

Examples of various types of welds showing the correct application of grinding and rotary burring are required to show acceptable surface finish. Personnel should be trained in dressing techniques and use the samples as benchmarks of acceptable workmanship. The samples should represent the types of welds being produced.

13. REFERENCES

TWI Fatigue of Welded Structures Course
The fatigue strength of welded joints improved by ultrasonic impact treatment
AS 4100 Design of Steel Structures
AS 5100.6-2004 Bridge Design Part 6: Steel and Composite Construction
AS/NZS 1554.5 “Structural Steel Welding Part 5: Welding of steel structures subject to high levels of fatigue loading”

PO Box 6165, Silverwater NSW 1811
Unit 50, 8 The Avenue of the Americas, Newington NSW 2127
Ph: +61 (0) 2 9748 4443 Fx: +61 (0) 2 9748 2858
Email: info@wtia.com.au Webpage: www.wtia.com.au

NDNP TECHNOLOGY DIFFUSION ACTIVITY # 27	WTIA Welding Technology Institute of Australia ABN 69 003 696 526 **NATIONAL DIFFUSION NETWORKS PROJECT** **TECHNOLOGY QUESTIONNAIRE** **Mining Industry Group** **Post Weld Fatigue Improvement Techniques - Dressing**	**Document No:** 9.4.6 - QR - 002 **Revision No:** Rev 0 **Page 1 of 2** **Date:** 21 Nov 2005

As part of the WTIA National Diffusion Networks Project the Mining Industry Sector has identified the need to improve the fatigue performance of welded components. The WTIA has prepared a technical guidance note "Post Weld Fatigue Improvement #1 Grinding" that explains how to improve the fatigue performance of welded components by grinding after welding. As a valued technology expert in this area we would like you to be part of the Technology Expert Group to review this document. Please complete this questionnaire so that we can gauge the success of meeting this need.

Objective 1: Identify the need for fatigue improvement in welded steel components

Component failure as a result of fatigue is common in the mining industry particularly for components that have been weld repaired. This document explains how post-weld improvement by grinding can be applied by the fabricator to improve fatigue performance. How well does the document achieve these aims?

poor ☐ average ☐ good ☐ very good ☐

Comments: ______________________________

Objective 2: Identify appropriate technology receptors

This document was written for Designers, Draughtsmen, Welders, Welding Coordinators and Maintenance Managers involved in fabrication and repairs for the mining Industry. Are these people the appropriate individuals we should be targeting?

yes ☐ no ☐

What other types of companies and/or personnel do you suggest we target? ______________________________

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Objective 3: Identify current best practice for improving fatigue performance

The document was written to reflect current best practice for improving fatigue performance by grinding. Do you envisage opportunities for the use of this practice in industry?

yes ☐ no ☐

If yes, what and where, if no why not? ______________________________

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Objective 4: Is the information provided clear, concise and accurate?

yes ☐ no ☐

If not, why? ______________________________

Objective 5: Broad dissemination of technology to the Mining Industry

Please indicate how best to disseminate this technical guidance note to the appropriate Industry Recipients

Free Website Download ☐ Poster ☐ Pocket Guide ☐ Pamphlet ☐

If poster, what size? A1 ☐ A2 ☐ A3 ☐ Laminated ☐ What selling price? $

Any other format for the information? ______________________________

Objective 6: Continuous Improvement

Please Identify areas where the document can be improved or return the document with your recommended additions/amendments. Alternatively, please use the area below to provide any additional comments.

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*Respondents Name:*________________*Company:* _________________*Phone:* ____________________

Fax: ____________________________*Email:* ___________________________*Date:* _______________

Please Fax (02 9748 2858) or E-mail (j.baker@wtia.com.au) your response.

Your prompt response is appreciated.