GUIDE TECHNOLOGY TO MAXIMIZE MILL PRODUCTIVITY[1]
A FOCUS ON THE X-CLAMP® FINISHING BLOCK GUIDING SYSTEM

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Abstract
As rolling mill operators, and in turn rolling mill suppliers, are forced to produce their products more efficiently with increased rolling speeds and better tolerance control Morgan guides has developed designs to keep pace with the demands of the rolling mill. Morgan has since made significant improvements over the last twenty five years, raising finishing speeds from 75m/s to 120m/s as well as improving the dimensional and metallurgical aspects of the finished product. Morgan's focus on guide development and continual innovation has insured that Morgan guide equipment meets the highest levels of performance, quality and reliability.
Key words: Mill productivity; Guides; Mill guiding systems.

TECNOLOGIAS DE GUIAS PARA MAXIMIZAR PRODUTIVIDADE FOCADO NO SISTEMA X-CLAMP® NO BLOCO ACABADOR

Resumo
Como a tendência dos laminadores e provedores de laminadores atenderem níveis de produtividade e melhor controle dimensional Morgan desenvolveu um projeto adequado às demandas dos laminadores. Morgan vem desenvolvendo tecnologia nos últimos vinte e cinco anos , aumentando velocidades de laminação de 75 m/s aos atuais 120m/s aliada às melhorias dimensionais e metalúrgicas do produto final. O foco da Morgan desenvolvendo equipamentos de guiagem com contínua inovação assegura que estes equipamentos encontram os mais altos níveis de performance, qualidade e confiabilidade.
Palavras-chave: Laminador; Guias; Produtividade.

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Introduction

Morgan Construction Company is well known as being the world's leading supplier of rolling mill equipment for the long products industry. More than one hundred and eighteen years experience has resulted in an extensive list of world class references of the most productive rolling mills in the world.
As rolling mill operators, and in turn rolling mill suppliers, are forced to produce their products more efficiently with increased rolling speeds and better tolerance control Morgan guides has developed designs to keep pace with the demands of the rolling mill. Morgan has since made significant improvements over the last twenty five years, raising finishing speeds from 75m/s to 120m/s as well as improving the dimensional and metallurgical aspects of the finished product. Morgan's focus on guide development and continual innovation has insured that Morgan guide equipment meets the highest levels of performance, quality and reliability.
Not only does Morgan provide designs and equipment for high-speed rod production but a wide array of the long products market for a wide array of rolled products including but not limited to:

- Rounds: ø4mm – ø190mm
- Rebars: 10mm - 52mm (#3 - #18) Slit and single strand rolling
- Flats: 30mm – 150mm wide 3mm – 30mm thickness
- Squares: 10mm – 76mm (3/8" – 3")
- Hexagons: 16mm – 64mm (5/8" – 2 ½")
- Angles: 25mm – 90mm (1" – 3 ½") Equal and Un-equal leg

The guide offered include roller entry guides, roller twist delivery guides, slitting delivery guides, static entry and delivery guides as well as all types of guide mountings, roll cooling headers, inter-stand equipment etc. necessary for optimum performance of the long products rolling mill.
In addition to standard products, Morgan has the flexibility and capability to customize designs to solve the most demanding applications demanded by our customers. Utilizing the latest technology computer aided engineering and manufacturing insures Morgan Guides meet and exceed the demanding rolling mill conditions providing exceptional reliability and long service life.
Morgan's focus on guide technology insures that our equipment continues to exceed the increasing demands for maximum productivity and quality to maximize the profitability of today's premier rolling mills.
The development of the X-clamp guide mounting system, including guides, guide mountings, and precision optical alignment equipment has allowed Morgan to achieve the World class production, tolerance, and utilization levels that is synonymous with the Morgan name in the rolling industry for over 100 years.

Morgan Specializes in High Speed, High Quality, Precision Rolling

The Morgan RE-20 USX-2 roller entry guide is currently acknowledged to be in operation at the world's fastest speed, this has been consistently proven when rolling long commercial runs of 5,5mm diameter finished product at speeds approaching 120m/s.
The RE-20 USX-2 roller entry guide is robustly constructed for rolling mill conditions using high strength stainless steel components providing exceptional reliability and long operational service life.

Major components such as the guide box, roller holders and inserts are manufactured from high quality stainless steel investment castings, resisting wear and corrosion.
Additionally the pivot and roller shafts are manufactured from heat treated, high strength stainless steel for wear and corrosion resistance.

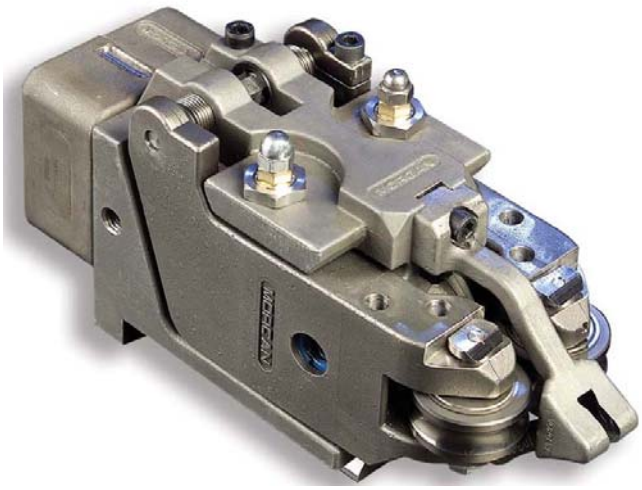

Figure 1: RE-20 USX-2 Guide Assembly

Low inertia, low profile titanium carbide rollers are offered as standard. These are furnished with contoured profiles, accurately matching the incoming section for optimum guiding and exceptional service life.
The rollers are furnished with two internally mounted, special high speed, anti-friction deep-groove ball bearings with precision bearing spacers.
Lubrication of the bearings is by air/oil, supplied to a fitting at the top of the roller holder. Cross drillings in each roller holder and roller shaft enables the lubrication to be precisely delivered to both bearings via slots in the precision bearing spacer that also prevent any bearing preload.
High stiffness compression springs are fitted between the roller holders and the guide box in order to remove any potential clearances at the pivot points. The roller holders are height adjustable, insuring precise alignment of each roller to the section and centerline of pass. This adjustment feature enables the guides to remain in service for many years, without refurbishment of the contact faces of the guide box and roller holders.
Direct water cooling is an essential factor for long roller life and is provided to both rollers via cross drillings in the roller holders.
The guide is designed to enable the most precise setting, for the highest levels of accuracy associated with high speed rolling. Adjustment is both quick and simple yet allowing the rollers to be accurately positioned to match the contour of the incoming section, providing precise guiding and firm holding of the section directly in front of the roll bite.
Precise adjustment of the roller gap is facilitated by single point adjustment located at the rear of the guide box.
Close attention to detail is given to the design and manufacture of the critical components to achieve excellent bearing life. Recent recorded data indicates that this is now in excess of 17 hours when rolling 5.5mm finished product at a speed of 117m/s. This is more than double the typical eight hours achieved by most

competitors' guides. Increasing the reliability of bearing life ensures that the mill can be operated for a longer time, without the risk of lost time due to bearing failure, thus increasing productivity. Together with specific roller and insert designs product tolerances are maintained for long periods and guide component wear is minimized.

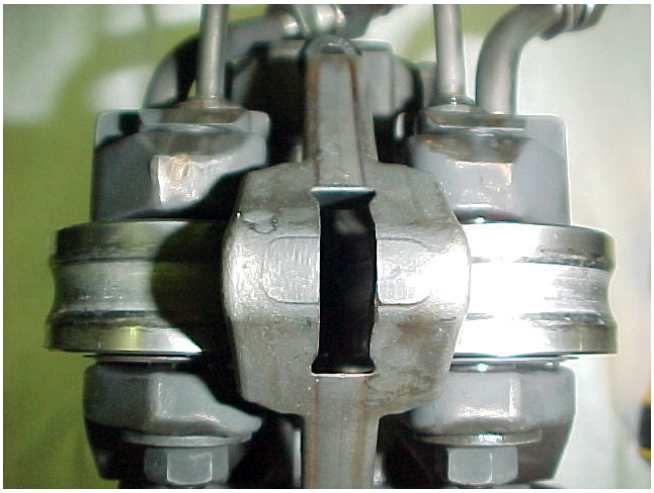

Figure 2: RE-20 USX-2 Guide Assembly after 4000+ tons rolled over 90m/s

Morgan Precision Optical Alignment System

The Morgan Optics Alignment Systems are of high quality with the highest clarity and optical resolution available. The System works similar to a shadow comparator allowing the operator to set the shadow of the guide rollers to accurately match the desired contour and settings for the guided section, using the Bench Optics, as well as setting the position of the guide mounting to the image of the mill rolls, using the Portable Optics. These systems are used in order to provide the most precise alignment of all types of roller entry and delivery guides within a very wide size range.

Morgan Precision Bench Optical Alignment System

There are basically 2 versions of the Morgan Bench Optic: The Universal Bench Optic and the Finishing Mill Bench Optic.
The Universal Bench Optic is the most versatile, as it can align 2 and 4 roller guides from the smallest, RE-20, to the largest RE-75. Roller delivery guides can also be set including the smaller CSR Series guide up to RTD-75 as well as slitting guides Depending on the size of guides being set as well as the size of the section, 3x or 5x magnification lenses are used.
The Universal Bench Optic utilizes a rack and pinion system to move the lens and screen assembly, allowing the guide to stay mounted in one place, while the magnification lens and screen are relocated to attain the correct focal distance from the guide rollers.
The Finishing Mill Bench Optic is generally used to align smaller, higher speed roller entry guides installed in the finishing mill. A 5x lens is used for increased magnification and guide setting accuracy. Please see Figure 3 for the X-Clamp Finishing Mill bench optics setup in calibration mode for positioning the 5x lens.

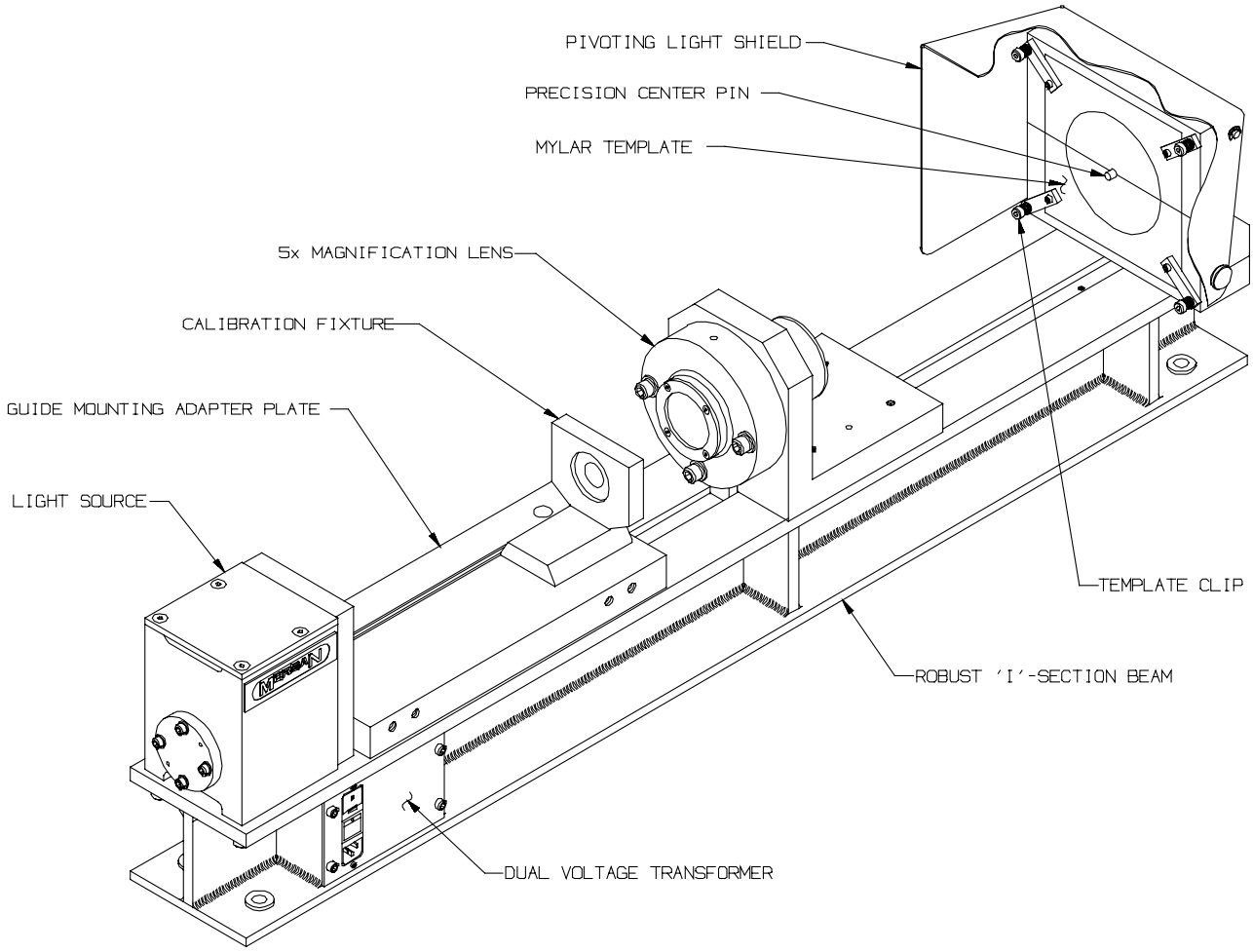

Figure 3: Finishing Mill Bench Optics in Calibration Mode

The 5x Bench Optics is designed to enable extremely accurate setting of roller entry guides off line in the roll shop. Heights and partings of rollers can typically be set within ± 0,05mm of theoretical incoming stock dimensions.
The system comprises a robust 'I'-section beam, with a precision light source, guide mounting plate and a fixed magnification lens and screen.
The light source is a high intensity (100 Watt), precision manufactured halogen bulb, having a filament position tolerance of ±0,2 mm. This ensures that the system maintains high repeatability even after changing bulbs. The light is filtered to single color, prior to the collimating lens in order to provide a high clarity image without distortion from refraction.
A large diameter, specially coated collimating lens provides parallel light which passes through the guide assembly prior to the 5x magnification lens.

The screen has an accurately located, steel center pin and four pivoting clamps for precise mounting of the computer generated, precision center punch mylar optical templates.
The use of the Bench optics precision alignment system eliminates the operating feel and guesswork inherent with use of mechanical guide setting techniques and allows the mill to provide standard operating setups and procedures to minimize guide delays.

Once the guides are prepared in the roll shop there are sent to the rolling mill for positioning on the X-clamp guide mounting bracket.

X-CLAMP SERIES GUIDE MOUNTING BRACKET

Once the finishing mill guides are prepared for the rolling mill in the roll shop on the Finishing Mill bench optics they are mounted to the roll housing on the X-clamp guide mounting bracket.
The X-clamp guide mounting bracket is robustly constructed to enable secure mounting of the roller entry guide in front of the roll bite. The assembly has a fine adjustment saddle to enable precise positioning of the guide on the centerline of the pass.
The stainless steel saddle is furnished with a precisely manufactured side dovetail on its upper surface that accurately engages with the side dovetail of the guide assembly, creating a zero tolerance mounting condition with the most repeatable and durable alignment accuracy available.

Figure 4: X-Clamp Bracket Assembly

The saddle is axially displaceable by means of a stainless steel adjusting screw secured in the mounting bracket by bronze bushings. A stainless steel keeper plate, secured to the bracket by two high-strength socket head cap screws, retains the screw to allow adjustment in two directions.
A rear locking clamp mechanism is provided to eliminate all but the minimum working clearance, for optimum accuracy when adjusting the saddle. The clamp is then firmly tightened securely locking the saddle in position. This clamp does not require adjustments when changing a roller guide assembly so the basic guide changes does not disturb the setting accuracy of the guide centerline.

The guide is clamped to the saddle by a positive cross clamp design. A stainless steel clamp with serrated teeth at the lower clamping surface engages with corresponding serrations machined within the saddle of the guide bracket. This enables the roller entry guide to be accurately and securely located in front of the roll bite for optimum guiding conditions.
The guide mounting bracket is fully compatible with the Morgan portable optics system, enabling the viewing scope to be clamped to the saddle for quick, precise setting of the roller entry guide. Figure 5 shows the portable optics clamped in place on the X-clamp guide mounting bracket.

Figure 5: Portable Optics on X-clamp bracket

PORTABLE OPTICS ALIGNMENT SYSTEM

The Portable optics is used in the rolling mill in once the guides are set in the roll shop with the Bench optics. The System is used to check and verify precision alignment of the entry guide with the centerline of pass and can be used to check the overall position of the mill roll grooves.
A high intensity halogen light source, producing single color, collimated parallel light is mounted on the delivery side of the mill and is pointed back through the roll bite of the mill.
The viewing scope is located in place of the roller entry guide on the adjustable saddle on the receiving side of the mill enabling the image of the roll pass and gap to be projected onto the graduated viewing screen at a 2.5x magnification.
After viewing the image, it is simply a case of adjusting the bracket to centralize the image projected on the screen. This insures that the roller entry guide will be perfectly aligned on the center of the pass. Please see Figure 6 for showing a guide bracket position set with the portable optics.

Figure 6: Portable Optics Setting on the Mill

High precision optical equipment is used in the portable optics system to provide a very high resolution. The portable optics can be used to detect an 'off the hole' condition of 0.05mm and has the additional advantage of diagnosing crossed rolls. See Figure 7 for examples of roll cross detection with the portable optics.

Figure 7: Portable Optic and Roll Cross

Using the portable optics to diagnose roll cross can indicate issues in the mill such as worn flingers, incorrect mill roll groove grinding, worn mill roll grooves, worn tapered sleeves or roll pinions, worn thrust bearings, or incorrect roll mounting. This allows the mill operator to correct issues that may result in scrap or out of tolerance material before the finished rod coils are in the inspection area of the mill, resulting in significant cost savings for the mill.

To achieve the maximum performance for the Morgan guides at the highest rolling speeds and tolerance requirements the Morgan Precision Optical Alignment System is calibration matched. Calibration matching is completed using the same alignment tooling and guide mounting adapters as used to setup the roller guides and can be easily checked, confirmed, and certified by Morgan Guides or Service engineers.

Calibration matching the Bench and Portable Optics systems the guide setters and mill operators are assured that the guides are set with the highest level of consistency and accuracy. The need for trial billets and mill delays associated with inconsistent guide setting and alignment is removed and gives the mill more utilization of rolling time for the highest quality finished rod.

CONCLUSION

Morgan guide engineers are continually striving to maximize the utilization of the rolling mill by providing the highest quality, durable guiding systems available. The X-Clamp guide system has provided mills around the world with guide life, product tolerances, and overall reliability at high rolling speeds that are leading the way for the future developments in the main mill equipment without worries about guiding delays. Figure 8 shows a typical installation of the X-clamp roller entry guides on a 6" roll housing.

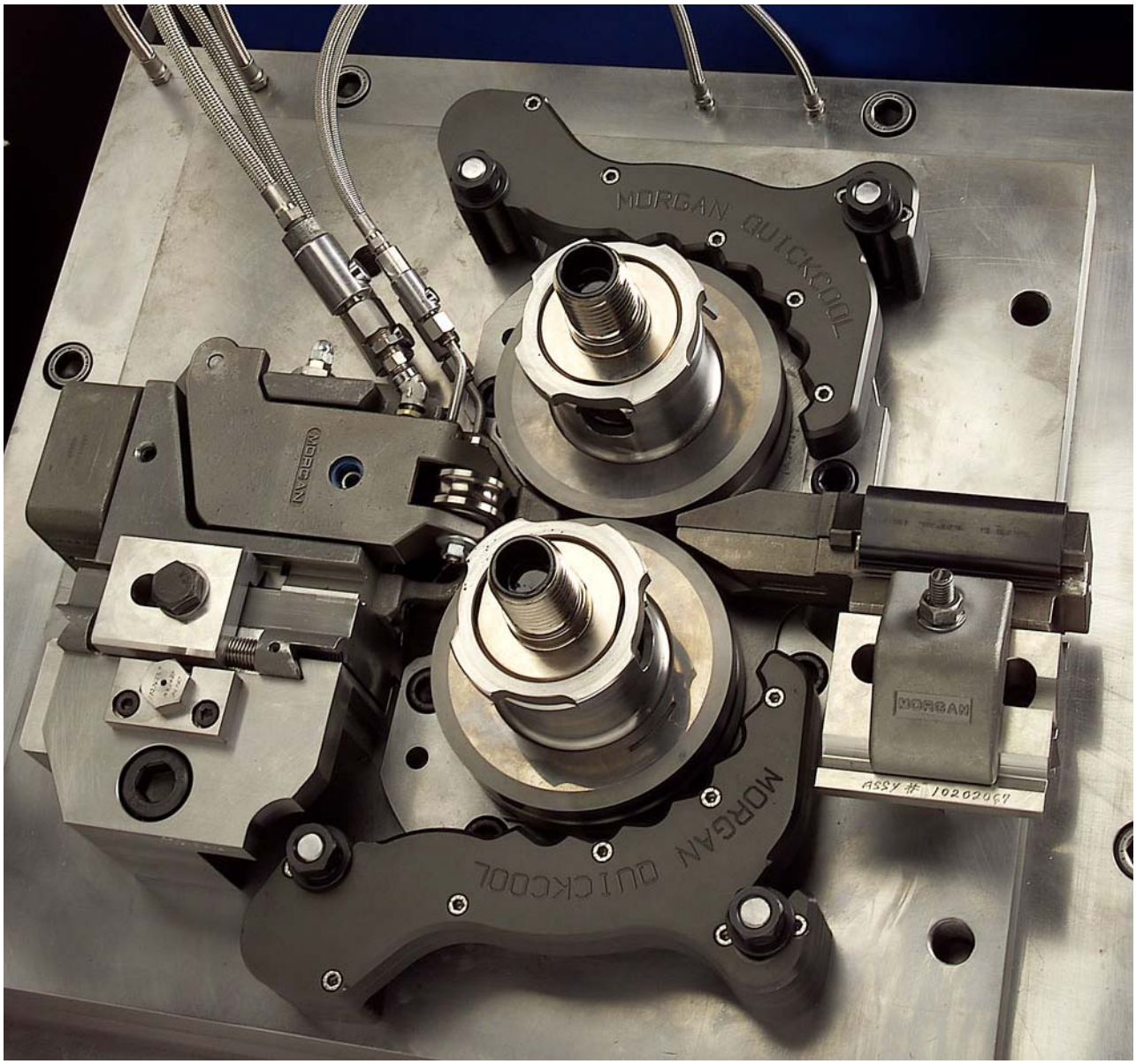

Figure 8: Typical X-Clamp Installation With Re-20usx-2 Guide

The X-clamp system can be applied to the older Morgan RE-25A series roller entry guide as well as the RE-20AS and RE-35AS series roller entry guides via modification and some new components, allowing the conversion to X-clamp guides to fall within most monthly maintenance budgets.
So, what matters the most…

Return on Investment

Morgan Guide equipment enables the end user to obtain a quick return on investment by:

Fully Meeting Production Requirements

Highest rolling speed possible, using proven and highly reliable equipment producing exceptional finished product quality. The X-clamp guide mounting system of guides, optics, and mountings fully meet demanding production requirements with reduced down-time and minimum yield losses.

Exceeding Quality Requirements

Quality guide equipment that allows precision set-up, exactly to the section size, positioned on the center of pass and having the capability to firmly hold and guide the section directly into the roll bite.

Reducing Down-time and Yield Losses

Off line equipment, with exact duplicate set-ups, ready to install in the mill with minimum down time.
Precise alignment minimizes cobbles as well as reducing loading conditions, resulting in exceptional service life.
Consistent guide setups for all mill crews using the Precisions Optical Alignment System to remove the human variations inherent in precise guide setting requirements versus conventional mechanical guide setting methods.
A mobile team of Morgan Engineers with ‘hands-on’ experience are on call to help improve your rolling process. Our engineers are more than Guide specialists and can provide field support in many other areas. We also are able to provide access to the specialist resources of Morgan Construction Company - providing you with the complete experience of a World Class Mill Builder.