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THE EFFECTS OF OVALITY ON RECORDED PERCENTAGE PENETRATIONS

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EXECUTIVE SUMMARY

ANSA is proud to announce a significant advancement in well integrity analytics within the Clarity software suite: the Ovality Compensated Maximum Penetration (OCMP) module.

For decades, the industry has relied upon standardized circular assumption by utilizing Nominal Internal Diameter (NID) and Nominal Outer Diameter (NOD) to calculate pipe penetration. While functional in idealized environments, these legacy models fail to account for the elliptical deformation frequently encountered in practice, as physical pipes rarely maintain a perfectly circular cross-section.

The OCMP module introduces a computational framework that departs from rigid circular geometry. By integrating real-time survey data to model the actual elliptical profile of the pipe at every depth interval, the algorithm eliminates the systemic overestimation and underestimation of penetration values caused by ovality.

This ensures that integrity assessments are based on the true physical state of the asset, providing operators with unprecedented precision in identifying structural vulnerabilities and optimizing intervention schedules.

TRADITIONAL ASSUMPTIONS

The Challenge of Geometric Deviation (Ovality)

In wells subject to significant tectonic or mechanical stress, casing and tubing rarely maintain a perfect circular cross-section. Instead, they exhibit varying degrees of ovality, where the cross-section deforms into a non-circular, elongated state. When a pipe becomes ovalized, the traditional circular assumption creates a mathematical disconnect:

- **Overestimation**: In areas close to the major axis of the ovalised pipe, the calculation may register a "false" penetration, suggesting metal loss where only geometric shifting has occurred.

- **Underestimation**: Conversely, if the ovality masks actual corrosion or wear, the system may report the asset as being within safety margins when the actual damage is more severe than what was calculated.

To address the inherent limitations of traditional modelling, ANSA developed a computational workflow that mathematically separates geometric from measured metal loss. The OCMP module represents a paradigm shift in MFC analysis, transitioning from static nominal references to a dynamic, data-driven baseline.

OVALITY COMPENSATED MAXIMUM PENETRATION (OCMP)

The OCMP Methodology: A Decoupled Analytical Workflow

The core innovation of the OCMP approach lies in its ability to isolate ovality as a geometric variable. Rather than comparing raw caliper data against a theoretical perfect circle, the software performs a "geometric reconstruction" of the pipe's reference state at every sampled depth. The process is executed through a three-stage logical framework:

Elliptical Regression Modelling

At every individual depth interval, the software ingests the high-resolution radial measurements from the MFC array. The software applies a least-squares elliptical regression algorithm to these data points, where it also excludes the outliers that corresponds to deposition or high penetration features. While 'ovality' refers broadly to the extent of non-circular deformation, the software uses an elliptical model to mathematically define this deviation. This identifies the precise orientation, major axis, and minor axis of the current pipe profile, effectively defining the specific "ellipticity" of the pipe at that exact coordinate in the wellbore.

OVALITY COMPENSATED MAXIMUM PENETRATION (OCMP)

Dynamic NID Ovalisation

Once the regression parameters are established, the module applies these exact geometric transformations to the NID. Instead of a rigid, circular NID, the software generates an Ovalised Nominal Internal Diameter (OVNID). This ensures that the baseline against which penetration is measured is a true representation of the pipe's intended form as it exists in its deformed state.

Consistent Nominal Thickness Assumption

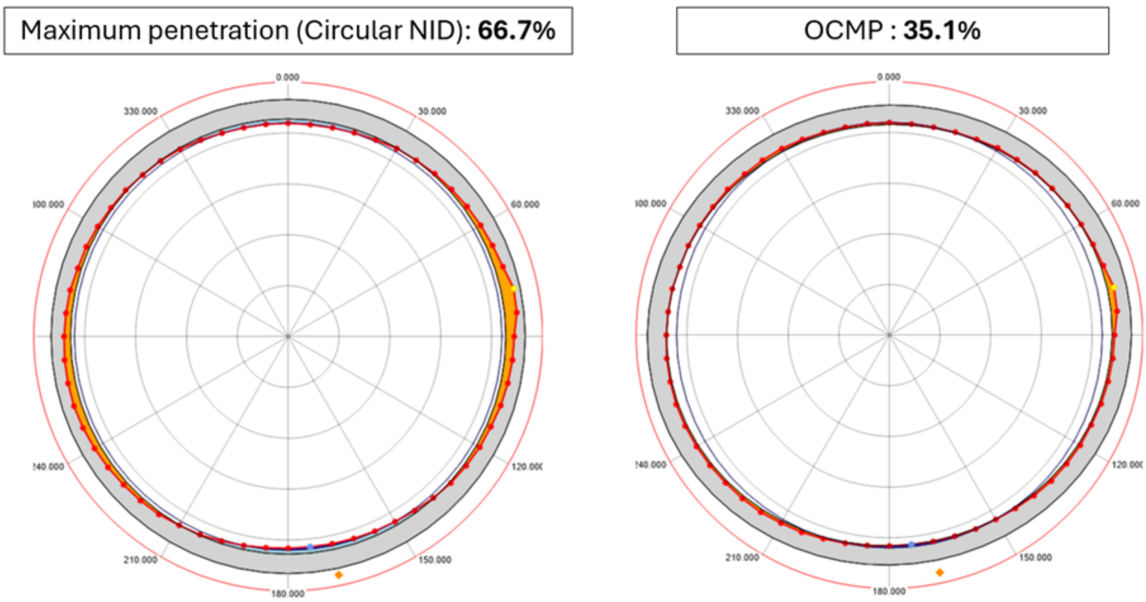
To maintain mathematical integrity during this transformation, the OCMP module operates on the engineering assumption of Isotropic Nominal Wall Thickness. By assuming that the nominal thickness remains constant even as the pipe undergoes elliptical deformation, the software can accurately project the corresponding Ovalised Nominal Outer Diameter (OVNOD) i.e: the OD is always the fitted elliptical ID + nominal thickness. This allows for a precise calculation of penetration that is purely indicative of material loss, rather than a byproduct of ovality.

CASE STUDY

Scenario 1: Feature Detection within the Major Elliptical Axis

The first study focuses on a wellbore interval where structural stress has caused the casing to expand along its horizontal plane, creating a pronounced major axis. In this scenario, we analyse penetration features such as corrosion pitting or mechanical wear located specifically along this widened axis.

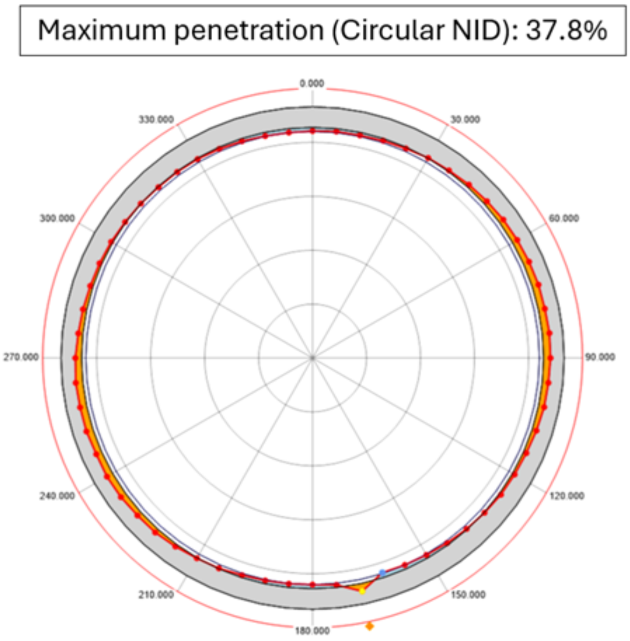
Under traditional circular assumptions, the software treats the expanded radius of the major axis as "extra material" or a baseline shift, which frequently results in a significant overestimation of the true penetration depth. This case study details how OCMP identifies the elliptical expansion and re-calibrates the reference baseline, ensuring that the detected metal loss is accurately quantified despite the outward deformation of the pipe wall.

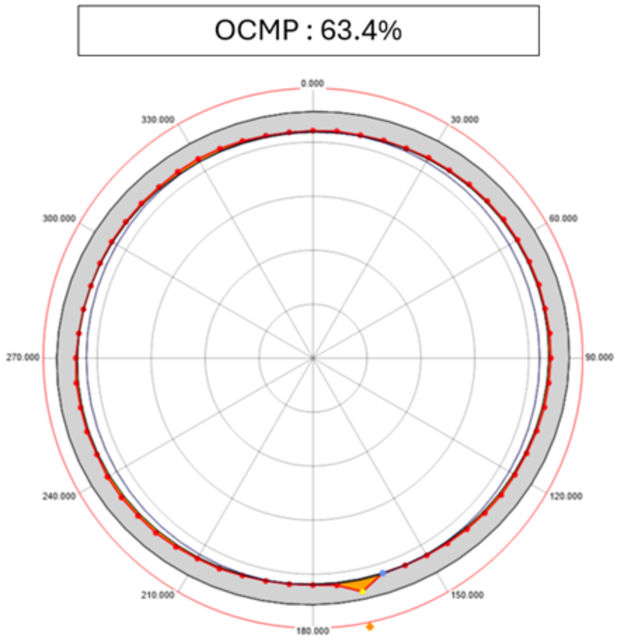


CASE STUDY

Scenario 2: Feature Detection within the Minor Elliptical Axis

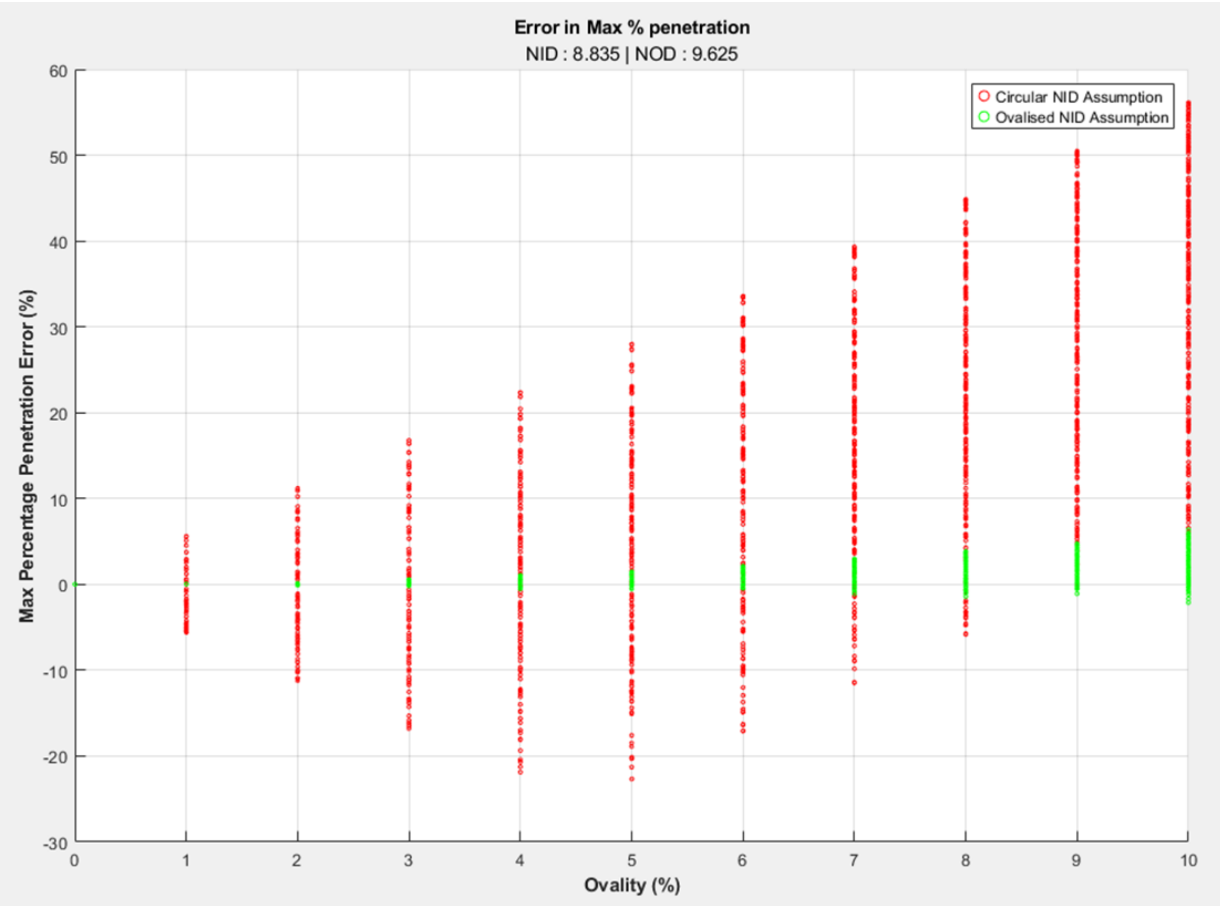
The second study addresses the more critical risk: a penetration feature occurring along the minor axis, where the pipe has been compressed or "flattened" inward. Because the pipe wall is closer to the center than the nominal circular reference, the traditional calculation perceives an artificial "surplus" of material. This geometric encroachment effectively masks actual metal loss, leading to a dangerous underestimation of the true penetration depth. This scenario demonstrates how the OCMP algorithm compensates for the inward shift of the wall, "unmasking" the hidden integrity threats that traditional methods would have overlooked, thereby preventing potential catastrophic failures.





COMPOUNDING INACCURACY

The severity of these inaccuracies is directly proportional to the degree of ovality in highly deformed wells. The figure below illustrates the effect of ovality on the estimated penetration values based on synthetic data, comparing results derived from the circular NID assumption (red) with those obtained using the OCMP method (green). The results clearly show that the OCMP method produces a significantly smaller error range than the traditional calculation approach.



CONCLUSION

The introduction of the Ovality Compensated Maximum Penetration (OCMP) module within ANSA's Clarity software marks a pivotal shift from generalized modelling to high-fidelity, data-driven diagnostics. As wellbore environments become increasingly complex and assets age, the margin for error in integrity reporting continues to shrink. The industry can no longer afford the ambiguous result created by legacy circular assumptions.

By mathematically decoupling geometric ovality from material degradation, OCMP addresses the two most significant risks in tubular inspection:

- **Operational Inefficiency:** By correcting the overestimation of penetration in the major axis, OCMP prevents the scheduling of redundant and costly remediations based on "false positive" data.
- **Catastrophic Risk Mitigation:** By unmasking the underestimation of penetration in the minor axis, OCMP ensures that critical thinning is identified before it results in a breach or collapse.

By quantifying the influence of ovality on penetration calculations, OCMP provides analysts with improved transparency and confidence in reported results. Overall, the OCMP workflow supports more reliable integrity evaluations, enabling operators to make informed maintenance decisions and extend the operational life of well assets.