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PROBING THE DEPTHS: CHALLENGES AND INSIGHTS FROM DETERMINISTIC REMAINING LIFE ASSESSMENT

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ABSTRACT

This study probes the impact of defect growth on its future effective area using the Effective Area Method (EAM). Through data synthesis and a linear corrosion growth model, metal loss occurrences are categorized into two phenotypes. The analysis raises concerns about the best approach to applying the EAM in remaining life assessment. While modeling the growth of the deepest depth in metal loss offers some resolution, the findings underscore the need for more comprehensive measures.

Keywords: Effective Area Method, remaining life assessment, synthetic data, linear corrosion growth model.

1. INTRODUCTION

The Effective Area Method (EAM), as outlined in ASME B31.G, provides a framework for Level-2 metal loss evaluation [1]. In essence, this method involves taking n depth measurements of metal loss. Subsequently, all possible combinations of adjacent measurements undergo an assessment using a modified allowable stress equation. While the EAM identifies the combination responsible for a failure at the time of evaluation, the anticipated future growth of the defect means that the profile of the assessed metal loss could change. As a result, an entirely different subset of measurements might determine the potential future failure. This paper embarks on an exploration of how defect growth can influence its future effective area. The exploration will delve into the frequency of such changes, the conditions that amplify their likelihood, and potential strategies to address them. This study introduces an initial categorization of these occurrences, delineating them into two distinct phenotypes.

2. MATERIALS AND METHODS

The principal technique used is data synthesis. Numerous potential axial cluster profiles were generated. For each profile, all measurement combinations were assessed to determine the cluster's effective area (EA) that yields the lowest burst pressure. A linear corrosion growth model was then applied to the effective length and depth of these combinations. This analysis was essential to determine which combinations might fail at some future date before the one that defines the current EA.

3. RESULTS AND DISCUSSION

Figure 1 depicts an axial cluster profile comprised of five measurements, with the ones forming the effective area highlighted in red. When growth was applied, the initially failing combination proved to be a shorter one containing the deepest depth measurement, as illustrated in Figure 2. Although this is a stark example — with the deepest point surpassing 80% of the wall thickness — it effectively demonstrates the first phenotype: cluster profiles with shorter, yet deeper, combinations that tend to fail first. Figure 3 displays the application of growth to all sub-lengths (represented by dashed lines). The combination defining the cluster EA is marked with a cross, while the initially failing one is annotated with a star. Solid isolines connect points where the estimated repair factor (ERF) maintains a constant value. The uppermost isoline is termed the acceptance curve.

Figures 4 and 5 delve into the implications of subdividing the cluster into more detailed measurements and then reanalyzing. Numerous shorter combinations are expected to reach the acceptance curve first. Modeling the growth of the cluster's deepest point is considered a suitable method for deriving a conservative failure date.

Figures 6 through 10 present a parallel analysis for a different phenotype of clusters. In these, longer combinations of measurements are projected to fail before the one governing the current EA. While the discrepancy in time-to-burst might be slight, devising a strategy to address this circumstance proves more challenging.

4. CONCLUSION

Limitations inherent to simply growing cluster's effective dimensions were revealed in this study. While simultaneously modeling the growth of the cluster's EA and its deepest point provides some mitigation, a more comprehensive approach is imperative.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Anon, *ASME B31.G-2012*

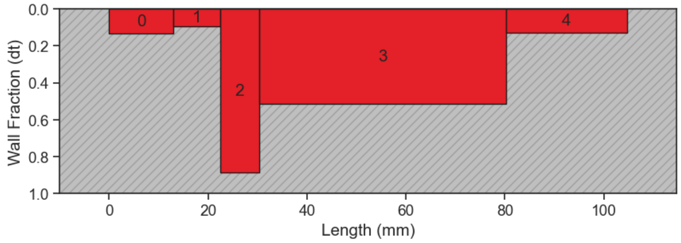

FIG.1: Cluster 1 with marked EA-defining measurements

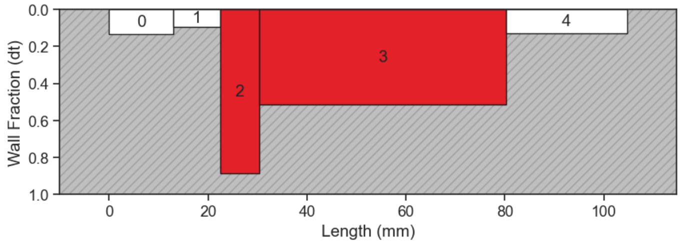

FIG.2: Cluster 1 with marked area governing future burst

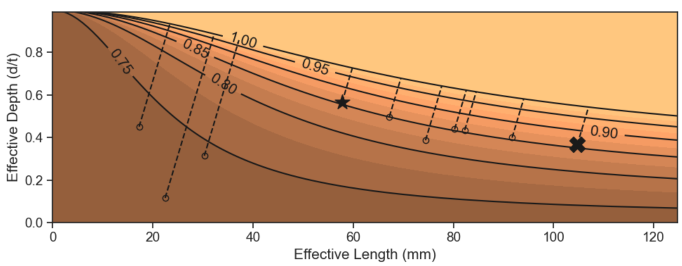

FIG.3: Sentenced plot for cluster 1 initial measurements

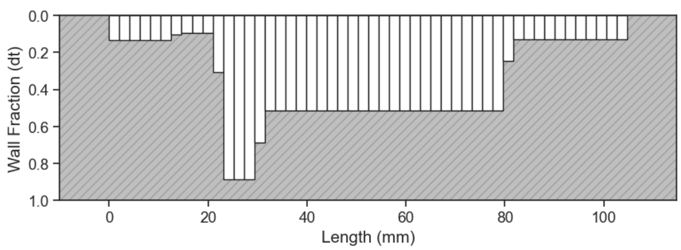

FIG.4: Cluster 1 split into finer measurements

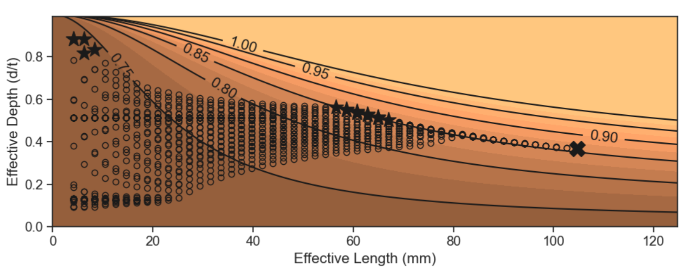

FIG.5: Sentenced plot for cluster 1 finer measurements

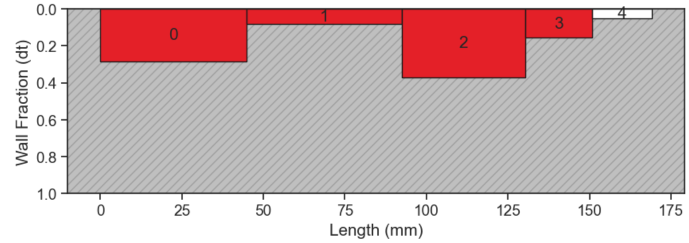

FIG.6: Cluster 2 with marked EA-defining measurements

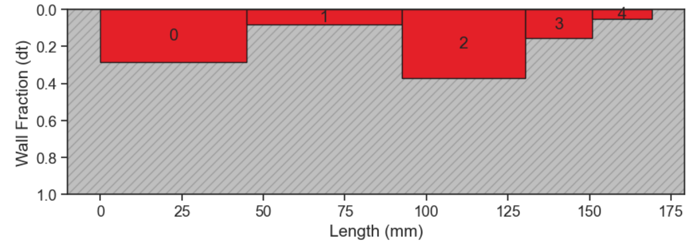

FIG.7: Cluster 2 with marked area governing future burst

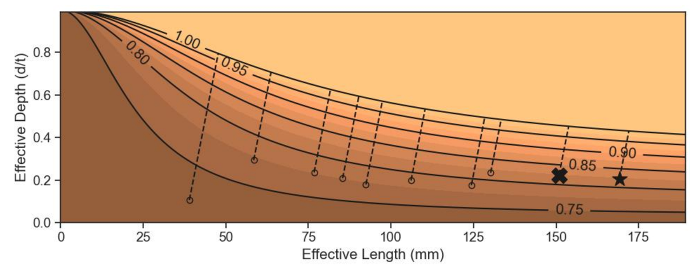

FIG.8: Sentenced plot for cluster 2 initial measurements

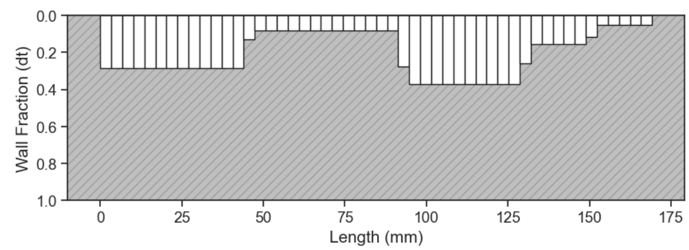

FIG.9: Cluster 2 split into finer measurements

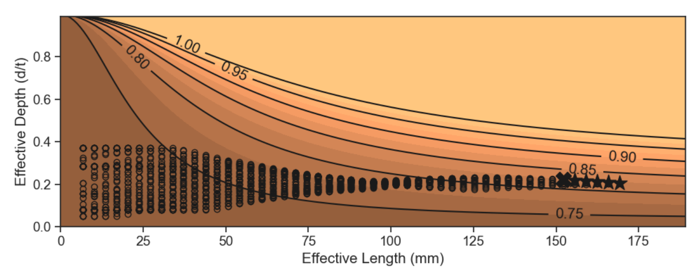

FIG.10: Sentenced plot for cluster 2 finer measurements