

A Note on Specifications for the Use of the Impact Roller for Earthworks

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Summary Since their introduction almost 20 years ago, impact rollers have been used on a wide variety of applications and have proved effective for many soil types and differing ground conditions. Specifications for the use of impact rollers have ranged from very simple to fairly complex, and this paper discusses a range of specifications that have been used in the past. Suggestions are made in relation to the preparation of specifications for earthworks that involve impact rolling, along with alternative strategies for verification testing.

1. INTRODUCTION

Broons introduced impact rollers into Australia in 1985 and made the technology available internationally. The Broons BH-1300 “Square” Impact Roller has been used on more than 700 projects around Australia and overseas. Impact rollers provide deep layer compaction for a wide variety of applications and have proved effective for many soil types and differing ground conditions, frequently delivering both cost and environmental benefits.

A major factor in the effective use of the impact roller on any particular project is the selection or preparation of an appropriate specification for the work. Specifications to date have varied from very simple to fairly complex, depending on the nature of the project, the sensitivity of proposed structures to ground strength and the preferred testing regime.

Earthworks specifications tend to fall into two broad categories, as defined in AS 3798-1996, Clause 3.3.a.vii:

- Method specifications, which specify “the methods to be used for construction”, and
- Performance specifications, which specify “the requirements to be met by test in the finished product”.

AS 3798-1966 notes that it is generally unwise to mix performance and method specifications. However, in the author’s experience, various hybrid specifications have been utilised for impact roller projects.

2. METHOD SPECIFICATIONS

A method specification often proves effective for a proof-rolling exercise. Where there is a requirement to locate soft spots or unsuitable material, it can simply be sufficient to carry out a certain number of impact roller passes under observation, for example, as was successfully undertaken on the Port River Expressway (Avalle and Grounds, 2004).

Method specifications are also applicable to projects where a detailed trial programme is undertaken in advance of the project earthworks so that the actual effects of impact rolling can be analysed and assessed. The outcome from such a trial might lead to a method specification, although some testing or monitoring regime is often implemented as well. The impact rolling trial at Adelaide Airport, for example, (Avalle and Grounds, 2004) resulted in a method-type specification, although a proving exercise was also specified in some areas of the site. Another recent project, at Chullora, NSW, (Avalle and Young, 2004) involved a pre-tender impact roller trial, particularly to assess the implications of impact rolling versus conventional compaction methods; on this project, again, a true method specification did not eventuate and post-rolling testing and monitoring were also implemented.

Method specifications, to be effective, require a high level of confidence that the proposals will achieve the desired result. The risk of not achieving some lower-bound attribute needs to be addressed, so that a method specification can be appropriately implemented, supervised and validated.

Method specifications sometimes nominate “energy” values, either as impact roller potential and/or kinetic energy ratings, or as an energy input requirement per unit area (or sometimes both). Fortunately, these specifications, in the

author's experience, usually have a performance element as well, which generally tends to negate the need to consider the "energy" aspect at all once work commences. In fact, the "energy" tends to be only a notional factor in the specification, although it can actually confuse the tender process. If the energy rating of an impact roller cannot be independently verified and if the "energy" is not actually measured (or is not even readily measurable) on site, then impact roller "energy" may not really be the most appropriate quantity for an engineering specification. Such method specifications may eventually prove to be effective if the "energy" can be efficiently validated.

A method specification was applied to a recent project at Port Botany, NSW. In the absence, in this case, of pre-defined development proposals, the resulting site was tested after completion of the impact rolling so as to provide subgrade strength parameters and a level of confidence for future development of the site (Davies et al, 2004). The decision to use the Heavy Falling Weight Deflectometer, in this case, enabled Young's modulus values to be generated for sub-surface layers, data of particular relevance in the design of heavy-duty pavements.

3. PERFORMANCE SPECIFICATIONS

Performance specifications generally define ground characteristics (such as field dry density and moisture content, CBR, Young's modulus, etc.) required to satisfy certain design assumptions (such as strength, bearing capacity, settlement, etc.).

Due to the nature of the impact roller's effect, a conventional approach to testing may be inappropriate, which may place limitations on a performance specification. The impact roller has a depth of influence far greater than conventional rollers, with significant improvements measurable to 1-2m or more, depending on material type, moisture and groundwater conditions. In addition, the impact roller generally disturbs the top 100-200mm as it travels across the surface, which is usually addressed with a smooth drum roller for finishing. The regime for performance testing needs to take these factors into account.

Performance specifications can therefore prove difficult to apply to impact rolling for various reasons, including:

- The presence of old fill comprising a heterogeneous mix of materials that may not be conducive to conventional earthworks requirements or test methods,
- Obtaining the right balance between supervision, testing methods and costs, and speed of decision-making,
- And, of course, the perception that you may not actually be able to achieve the specification, or, more usually, the question: what if the post-rolling testing and assessment indicate that the ground conditions have not achieved expectations?

4. EFFECTIVE REFUSAL

One form of performance specification that has been utilised to good effect is to identify a limiting settlement criterion. The underlying assumption with this approach is that, after a given minimum number of passes required to minimise the risk of soft or weak zones remaining within the depth of impact roller influence, settlement at the surface will reduce or stop. This condition, sometimes referred to as "effective refusal", may be defined as the situation where any additional ground improvement resulting from continued impact rolling becomes insignificant or non-cost-effective. This represents an approaching limit to the effectiveness of the impact roller at that location.

Settlement can be measured by a variety of means, including a simple string line and tape measure, laser level, total station and robotic total station methods. In all cases, output is relatively quickly obtained, although data downloading and computer processing may be required (usually done using a laptop on site).

Using the "effective refusal" criterion, the process for making the decision to stop impact rolling is relatively simple. One physical constraint is that the ground surface after impact rolling is uneven, which can be addressed in a number of ways. The surface can be lightly trimmed with a grader to even out the indentations, or some other "averaging" technique can be used (e.g. at any particular location, survey a high and a low point and take the average as the surface level).

Another factor to be considered is the spacing between settlement monitoring points (or grid dimensions), which needs to be fine enough without significantly slowing down the whole process with too many points. An example of this approach is given in an accompanying paper (Avalle and Young, 2004).

5. VERIFICATION TESTING

Many different tests have been employed in association with impact rolling and the author has set out the range of these encountered in his experience in an accompanying paper (Avalle, 2004). Geotechnical engineers will have their particular preferences and clients will undoubtedly impose budget constraints. The wide range of site conditions, combined with the design load implications of differing development proposals, mean that there is no single simple rule for deciding on the verification testing regime. In order to strive for the most cost-effective/efficient/lowest risk earthworks design, each particular site and its particular development proposals will necessitate detailed appraisal. Should impact rolling be selected for the earthworks, for a trial, for the final specification or merely as an option for further evaluation, consideration should be given to appropriate possible test methods, either for use on a detailed trial programme to achieve a method specification or for performance verification.

6. CONCLUSION

Impact rolling can offer appreciable productivity and cost benefits for earthworks due to its significant depth of influence and high speed of operation, as well as environmental advantages resulting from in situ ground improvement and reduced off-site disposal. Careful consideration should be given to the formulation of an appropriate specification for the impact rolling component of any particular project, as well as to the overall benefits that might result from an impact roller trial programme. The testing regime for trials and performance monitoring and verification should be tailored to the particular attributes of the site, including ground conditions and development proposals. Whatever the nature of the project involving the use of an impact roller, whatever the type of specification prepared, and irrespective of advice provided by equipment suppliers, the engineering specification, in the author's opinion, should reflect best practice and sound engineering judgement.

7. REFERENCES

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