

# Trial Programme and Recent Use of the Impact Roller in Sydney

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**Summary** The Broons BH-1300 “Square” Impact Roller has recently been used on a site at Chullora, New South Wales. The site had been extensively filled in the past and a treatment of the fill was proposed for the development of site for a new bakery. The paper describes the site and presents the results of a trial programme carried out on two areas of the site. Testing and monitoring included settlement measurements, electrical friction-cone penetrometer tests and vibration measurements. Following the trial, the proposed earthworks were re-evaluated, comparing the use of conventional rollers with the impact roller. As part of the programme for reworking of the fill, it was decided to specify the impact roller for subgrade proof-rolling.

## 1. INTRODUCTION

A substantial bulk earthworks exercise is in progress for a new bakery development at Chullora, New South Wales. The site had originally been cut into former rising ground to develop a level area as part of the Chullora railway yards. Subsequently, the site was used as a tip for surplus spoil. The resulting site surface had a height differential of more than 6m and a filling treatment approach was adopted for the proposed development.

Previous site investigations identified up to approximately 7m of filling on the site, described as generally cohesive and primarily comprising clay, with variable quantities of ripped sandstone and shale, and other materials including metal, ash, glass, concrete, asphalt and cement fibre sheeting. The development necessitated a large level site for the main building and loading bays, with a cut-to-fill approach to minimise off-site disposal.

A trial programme was carried out in November 2003 to evaluate the performance of the impact roller and to assist with the design and specification for earthworks. The project commenced in January 2004.

## 2. OUTLINE OF IMPACT ROLLER TRIAL

Two test strips were set out for the trial, 80-100m long and about 10m wide, one in an elevated part of the site and one in the low part of the site. Each test strip was provided with marker stakes at 10m intervals on each side to facilitate replication of monitoring and testing locations. The impact rolling pattern comprised three rolling paths, wheelpath-to-wheelpath, in a continuous loop, with the rolling direction reversed for each circuit.

Surface levels were measured by robotic total station along the centre of each of the three impact roller paths at 10m intervals. Geotechnical testing was conducted utilising the electrical friction-cone penetrometer (CPT) to check the improvement of the soil strength. In addition, in view of potential sensitivities along one neighbouring boundary, vibration monitoring was carried out during the trial.

## 3. TRIAL TEST RESULTS

### 3.1 SURFACE SETTLEMENT

Significantly larger settlements were observed at Test Strip 1, at the top of the deepest fill, compared with Test Strip 2, located in a low area with little fill and underlying shallow rock. After 30 passes of the impact roller, settlements in Test Strip 1 were as high as 147mm, as can be seen in Figure 1, while maximum settlements in Test Strip 2 did not reach 70mm.

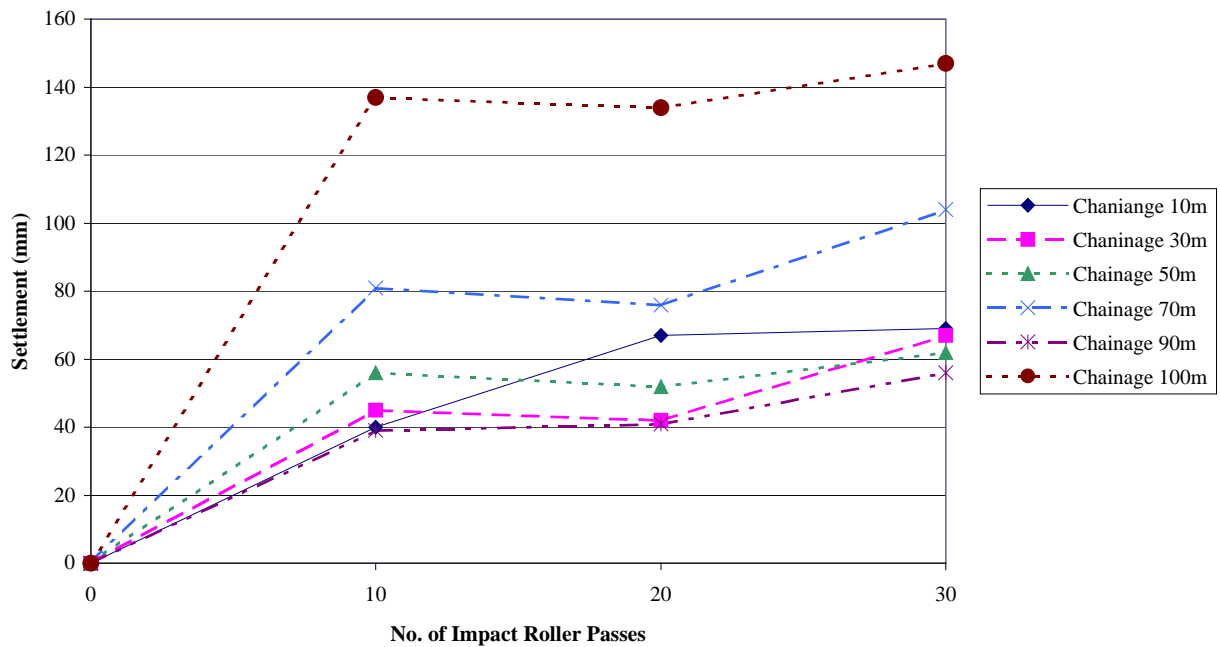


Figure 1. Surface Settlement Measurements along Test Strip 1.

A summary of all the settlement monitoring data is presented in Figures 2 and 3 as plots of average settlement versus the number of impact roller passes, for Test Strips 1 and 2, respectively.

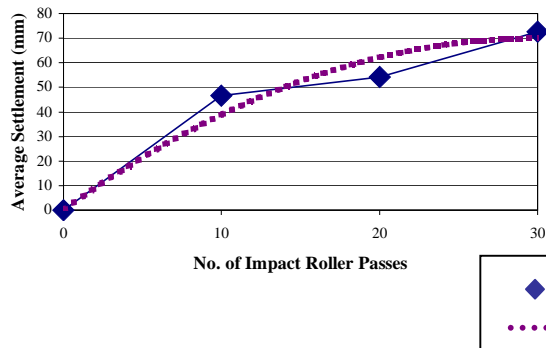


Figure 2. Settlement Data for Test Strip 1

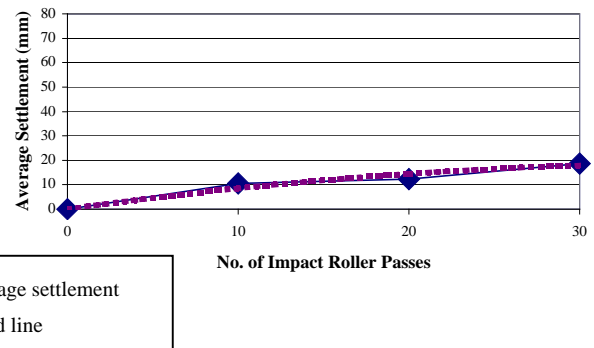


Figure 3. Settlement Data for test Strip 2

Figures 2 and 3 show the polynomial trend lines that illustrate the reduction in the rate of settlement with number of passes, and indicate that the average settlements for Test Strips 1 and 2 approached 70mm and 20mm, respectively, after 30 passes of the impact roller.

### 3.2 STRENGTH PROFILING

The CPT tests to assess the filling strength were extended to a depth of 5m, and the results were particularly useful in assessing the foundation strength in relation to developing appropriate design parameters for the proposed development. A typical set of CPT data from one location is illustrated in Figures 4a and 4b, before rolling and after 30 passes, respectively.

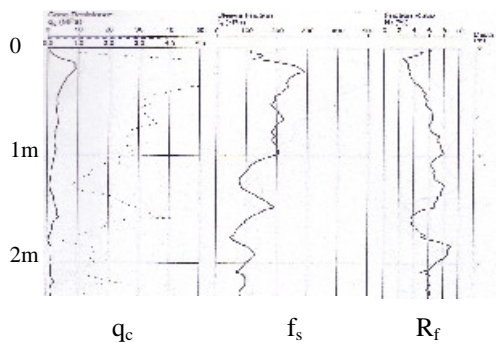


Figure 4a. CPT109 Before Impact Rolling

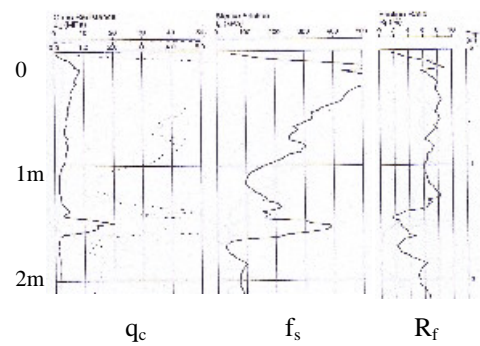


Figure 4b. CPT109 After 30 Passes

Although the CPT output was somewhat inconsistent in terms of assessing impact roller effectiveness, there are some conclusions that can be drawn from the test data, as follows:

- On average, there is a slight increase in strength as reflected by cone tip resistance in the upper 1-1.5m,
- There is a consistent increase in stiffness reflected by the sleeve friction, and hence the friction ratio, for the upper 1-1.5m, and
- All results show less variation in friction ratio in the top 1-1.5m after impact rolling, indicating an increase in uniformity of the material strength properties.

### 3.3 VIBRATION TESTING

Vibration monitoring was carried out at various locations throughout the day of the trial, resulting in a substantial data set. As might be anticipated, vibration responses varied for the two trial strips, reflecting the difference in ground conditions.

Figure 5 shows the upper bound lines from the test data for each test strip, plotting the peak particle velocity against the distance from the Impact Roller (logarithmic scale). Acceptance limits of vibrations vary considerably, for example from 2-3mm/s for historic buildings (German and Swiss codes, respectively) to 50mm/s for industrial buildings (British Standard) or more. Vibration effects from impact rolling form the subject for further research.

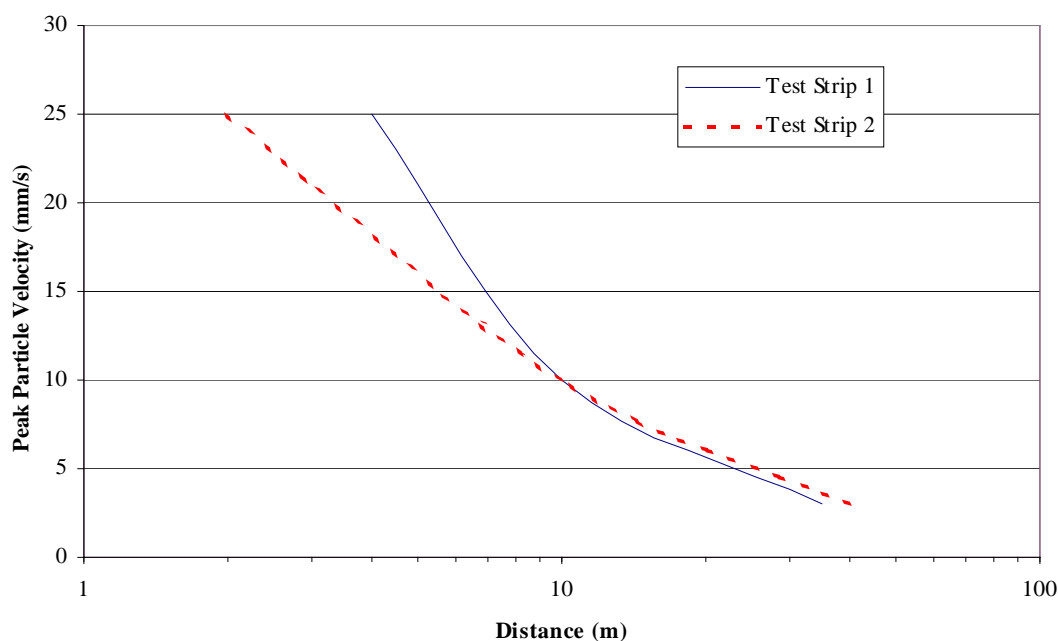


Figure 5. Upper Bound Vibration Test Results

The results in Figure 5 indicate that ground conditions have a significant influence on vibration transmission from impact rolling closer than about 10m. Beyond 10m, the trends are similar and the peak particle velocity rapidly reduces below 10mm/s. A standard buffer zone of 10m was identified to permit future impact rolling, with a high degree of confidence that off-site vibrations are unlikely to exceed 10mm/s.

#### 4. EARTHWORKS SPECIFICATION

The design and specification were finalised utilising the data accumulated from the impact roller trial, in conjunction with the additional site characterisation and understanding of ground conditions.

Re-evaluation of the proposed earthworks, comparing the use of conventional rollers with the anticipated output from the impact roller, was influenced by the variability in the nature and moisture content of the existing fill material at depth. In the end, the design consultants required virtually complete reworking of the fill, and it was decided to carry out proof-rolling with the impact roller at subgrade level where 0.5-1m of existing fill was permitted to be retained in place.

Based on the results of the trial programme, the specification for impact rolling required that a minimum of 20 passes was required for proof-rolling subgrade areas, subject to on-site observations, settlement monitoring and removal of unacceptable material or “soft spots” exposed during impact rolling.

A selection of average settlement graphs is presented in Figures 6a to 6d.

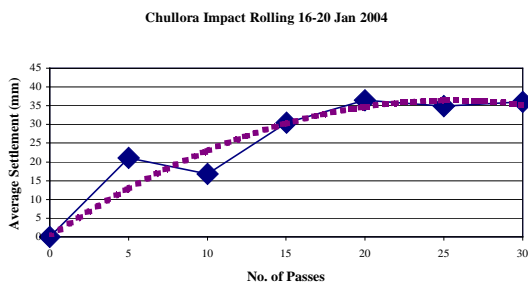


Figure 6a.

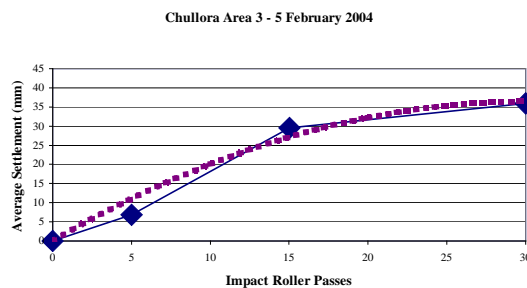


Figure 6b.

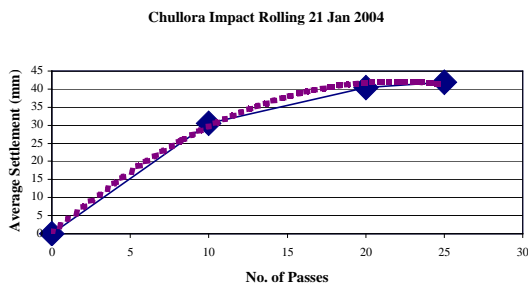


Figure 6c.

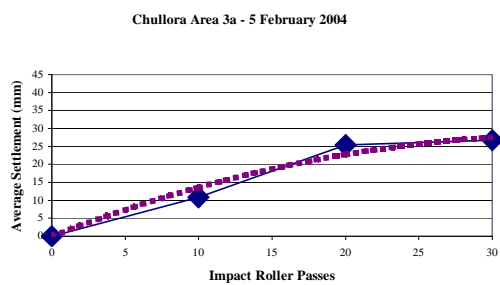
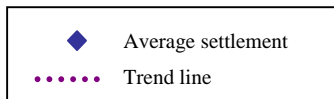


Figure 6d.



Figures 6a to 6d. Settlement Results During Proof-rolling.

As can be seen in Figures 6a to 6d, 25 to 30 passes of the impact roller were applied, which resulted in 25mm to 45mm of surface settlement, on average. There is an evident trend that settlements at this site generally reduced significantly after about 20 passes.

#### 5. CONCLUSIONS

The execution of a trial programme in advance of final design for a major earthworks exercise allowed the evaluation of the Broons BH-1300 “Square” Impact Roller, along with the accumulation of additional site characterisation data.

In the predominantly clay fill at this site, significant improvement was observed in the upper 1-1.5m after 20-30 passes of the impact roller, with slight strength increases and higher and more uniform friction ratios. Vibration testing permitted a buffer zone to be defined with confidence.

Settlement monitoring during the trial reflected average settlement values that were generally replicated during the subgrade proof-rolling that was eventually carried out using the impact roller.

## **6. ACKNOWLEDGEMENTS**

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