Integrity Testing

MOD-SHOCK™ TESTING OF PILES AND POLE STRUCTURES CORRELATIONS

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Integrity Testing Pty Ltd

- **INTRODUCTION**
- Integrity Testing Pty. Ltd. is a testing and consulting company specialising in providing consultancy services in Civil Engineering fields, including the new and existing buildings, transport structures and power distribution sectors
- Our team consists of qualified engineers and professionals with vast practical experience in the various aspects of the Engineering and construction industry.

Mod-Shock testing of Piles Etc.

- **The Mod-shock test was developed by the founding company Materials Consultants in Hong Kong in the early 80's and was a hybrid test of the vibration testing of piles and PDA testing of piles.**
- The system has continued in development and is now used in over 12 countries throughout the world, being specified in Hong Kong, Malaysia, Singapore and Australia.
- **There have been over 1 million successful tests carried out over the past three decades and the test becomes more widespread.**

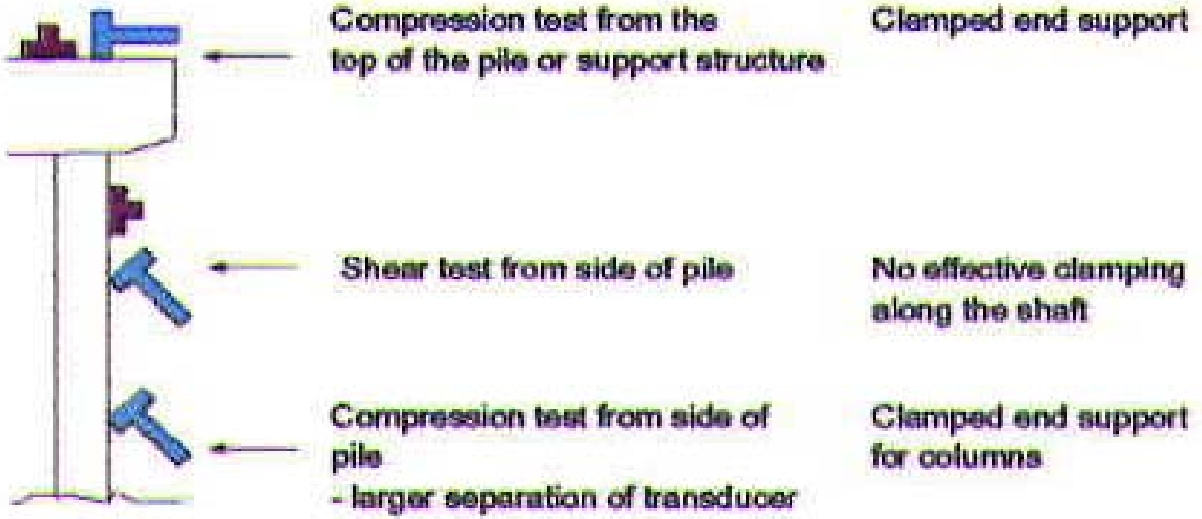
Insitu Testing

Nearly all our testing is on existing structures which are usually connected to buildings or jetty

Our usual brief is to find out what has gone wrong with the structure or determine what more the structure can carry, Safe Additional Load (SAL).

Shock testing of structures

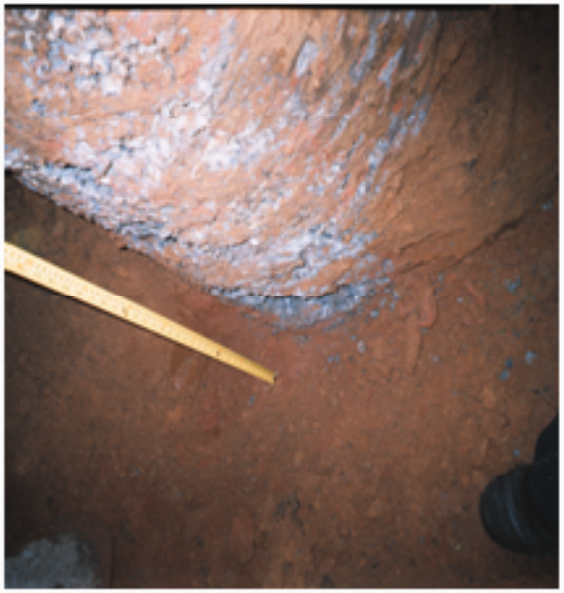
Methods of data capture

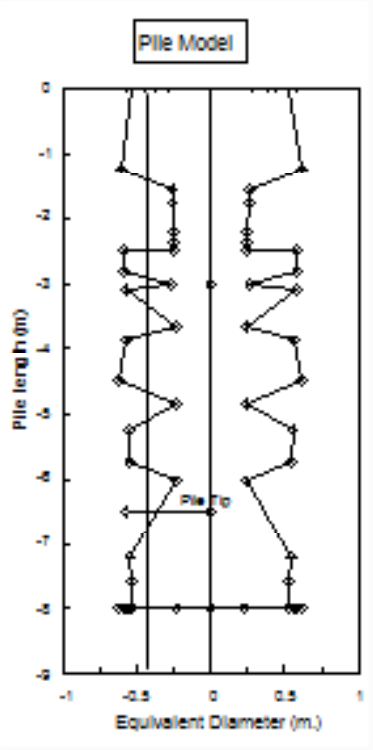


Methods of data capture for columns

A test on a piled foundation to a lattice tower in New Zealand, towers had fallen over in high winds.

Pile Testing Result and Photo





Results of testing.

- We discovered that a number of the bored piles supporting the towers had not been properly compacted.
- The client dug down on a number of the piles to indicate whether our findings were and the previous slide indicated that this particular pile the concrete had not be compacted properly and under high wind loadings similar piles had failed in the shaft of the piles.

Calibration of pile testing.

A trial was carried out on selected piles from one of our projects in Melbourne

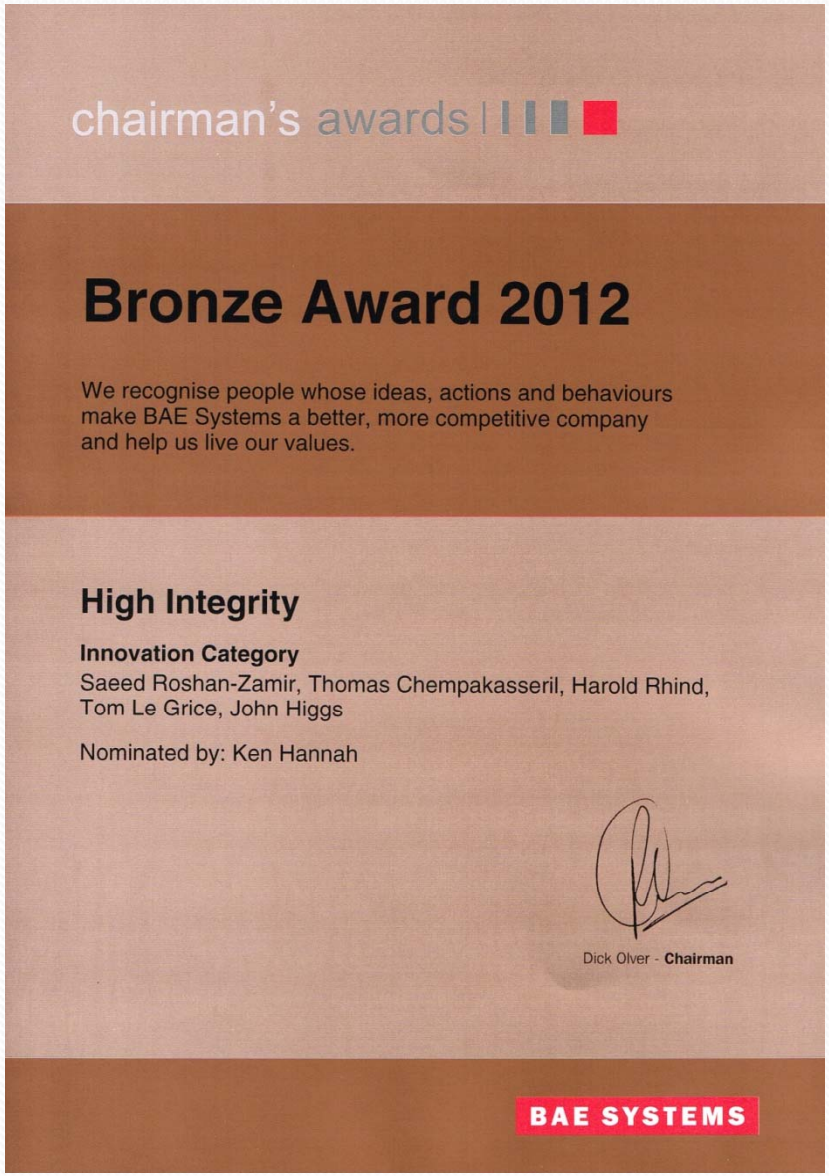
- We carried out extensive tests on a large number of piles supporting a large dock in Melbourne.
- The lead consultant questioned our test results, in particular the Safe Additional Load (SAL)the piles could carry, still within the elastic range of the piles.
- The lead consultant carried out independent PDA tests on three piles where they doubted our results for the SAL.

BAE in Australia was concerned with the capability of the Nelson Pier to accommodate the latest and heaviest of the Australians navy fleet.

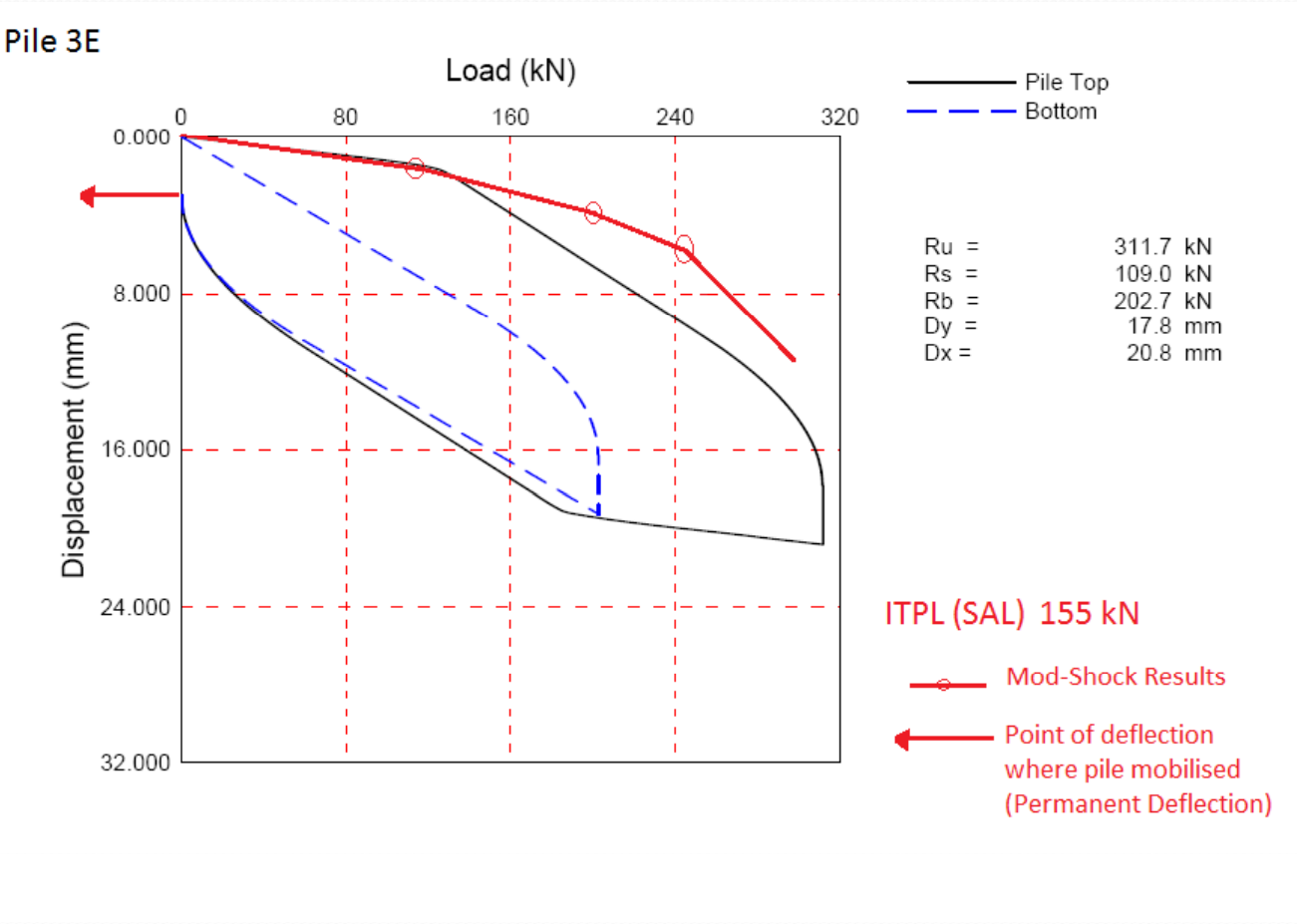
We were commissioned to test the piled supports and the deck of the pier to see if the pier was suitable for these heavier loadings.

After we produced the information the consultant wanted to check our information and the next three slides indicate the correlation of the results.

Our work was recognised by BAE, with the presentation of the Bronze award.



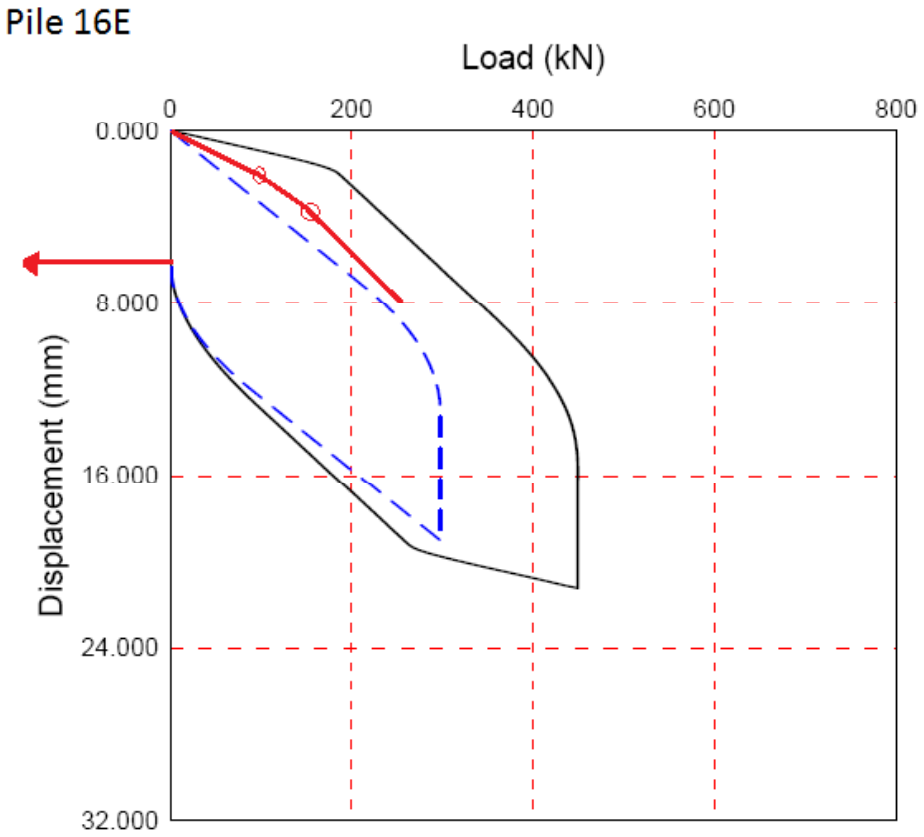
Result for pile no 3E.



Analysis of results for pile 3E

- PDA results indicated that the pile moved at approximately 4mm deflection and there was a permanent set of minus 4mm.
- The load at this point was 170 Kn
- Our SAL indicated at a 3.0mm deflection a load of 155Kn.
- We consider that we may be slightly conservative, but well safe from permanent deflection.

Result for pile 16E



Pile Top
Bottom

Ru	=	449.1 kN
Rs	=	150.9 kN
Rb	=	298.2 kN
Dy	=	15.3 mm
Dx	=	21.3 mm

ITPL (SAL) 210 kN

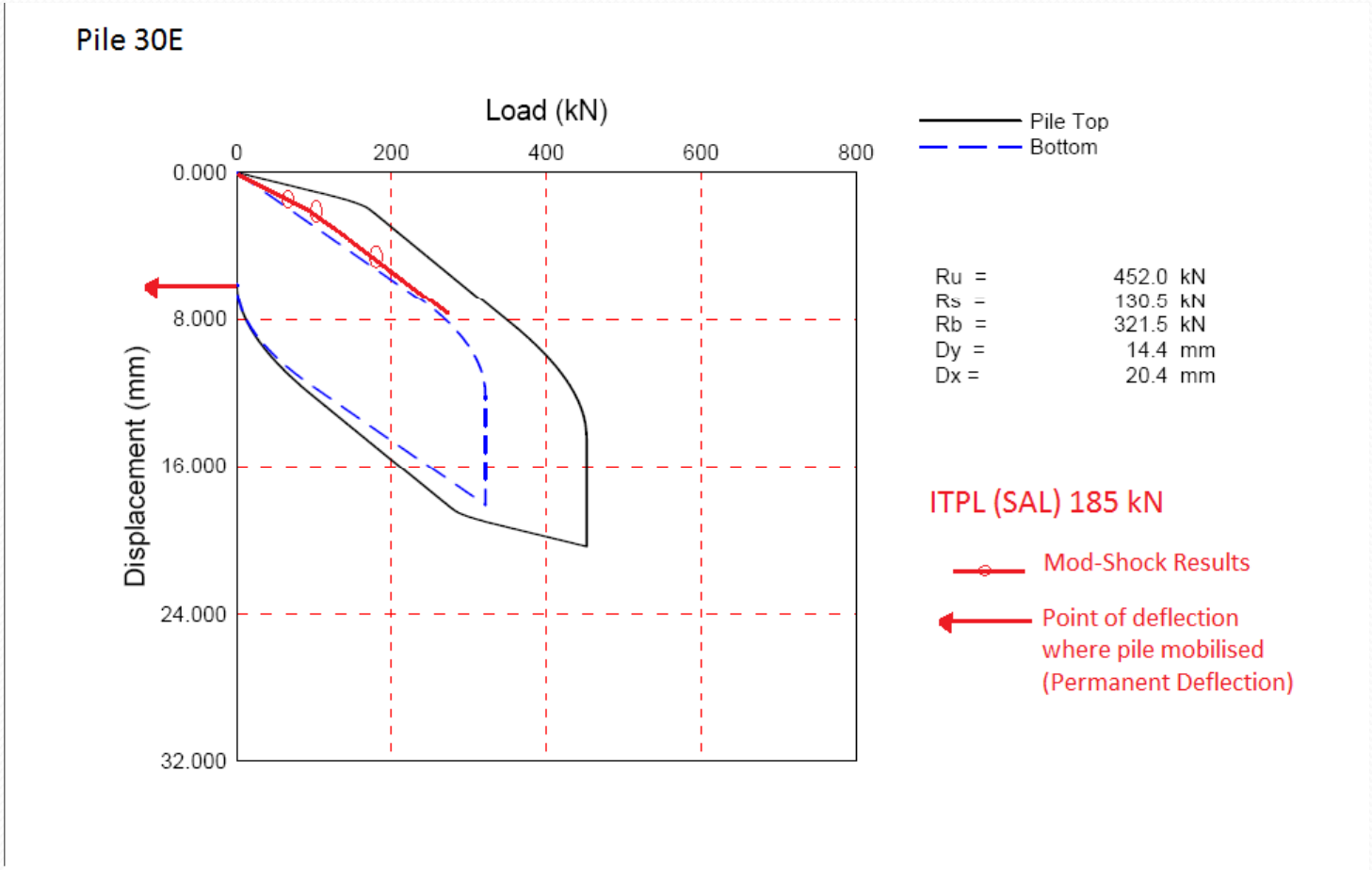
Mod-Shock Results

Point of deflection where pile mobilised (Permanent Deflection)

Analysis of results for pile 16E

- PDA results indicated that the pile moved at approximately 7mm deflection and there was a permanent set of minus 7mm.
- The load at this point was 240Kn
- Our SAL indicated at a 5mm deflection a load of 210Kn.
- We consider that these results indicate a virtually similar result and still within the elastic range of the pile.

Results for pile 30E



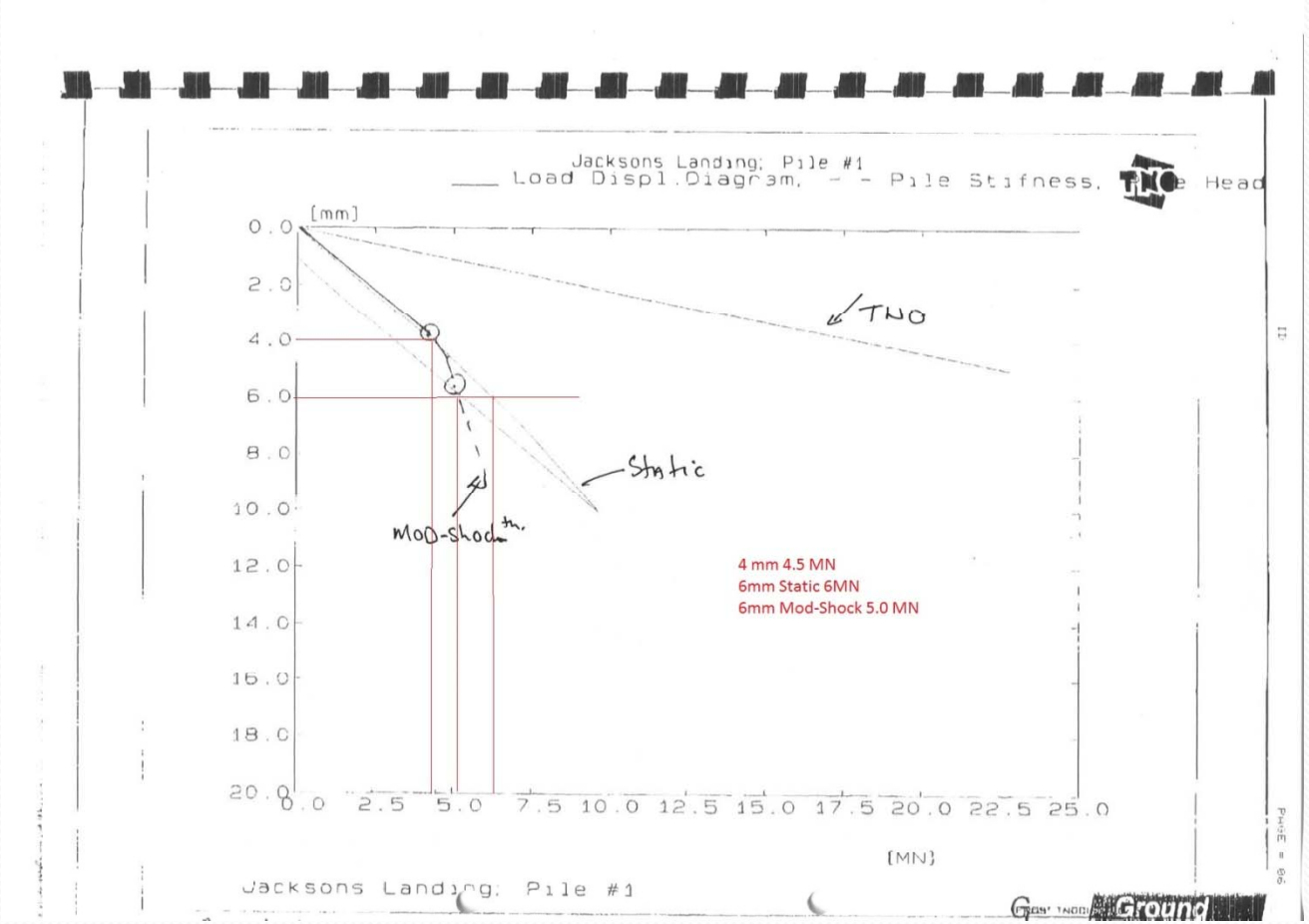
Analysis of results for pile 30E

- PDA results indicated that the pile moved at approximately 4mm deflection and there was a permanent set of minus 4mm.
- The load at this point was 220kn.
- Our SAL indicated at a 3.0mm deflection a load of 185Kn.
- We consider that these results indicate a virtually similar result and still within the elastic limit of the pile.

Jacksons Landing Sydney Non BAE

- Similar to BAE, Williamstown, Jacksons landing was one of the finger piers in Sydney Harbour total number of piles in excess of 4000.
- These consisted of timber piles up to 30m deep in two sections, 850, tubular steel piles in filled with concrete working load 250 tonnes, concrete 450 square driven piles, concrete encased timber piles and 96 lbs/yrds rail section plus combinations.

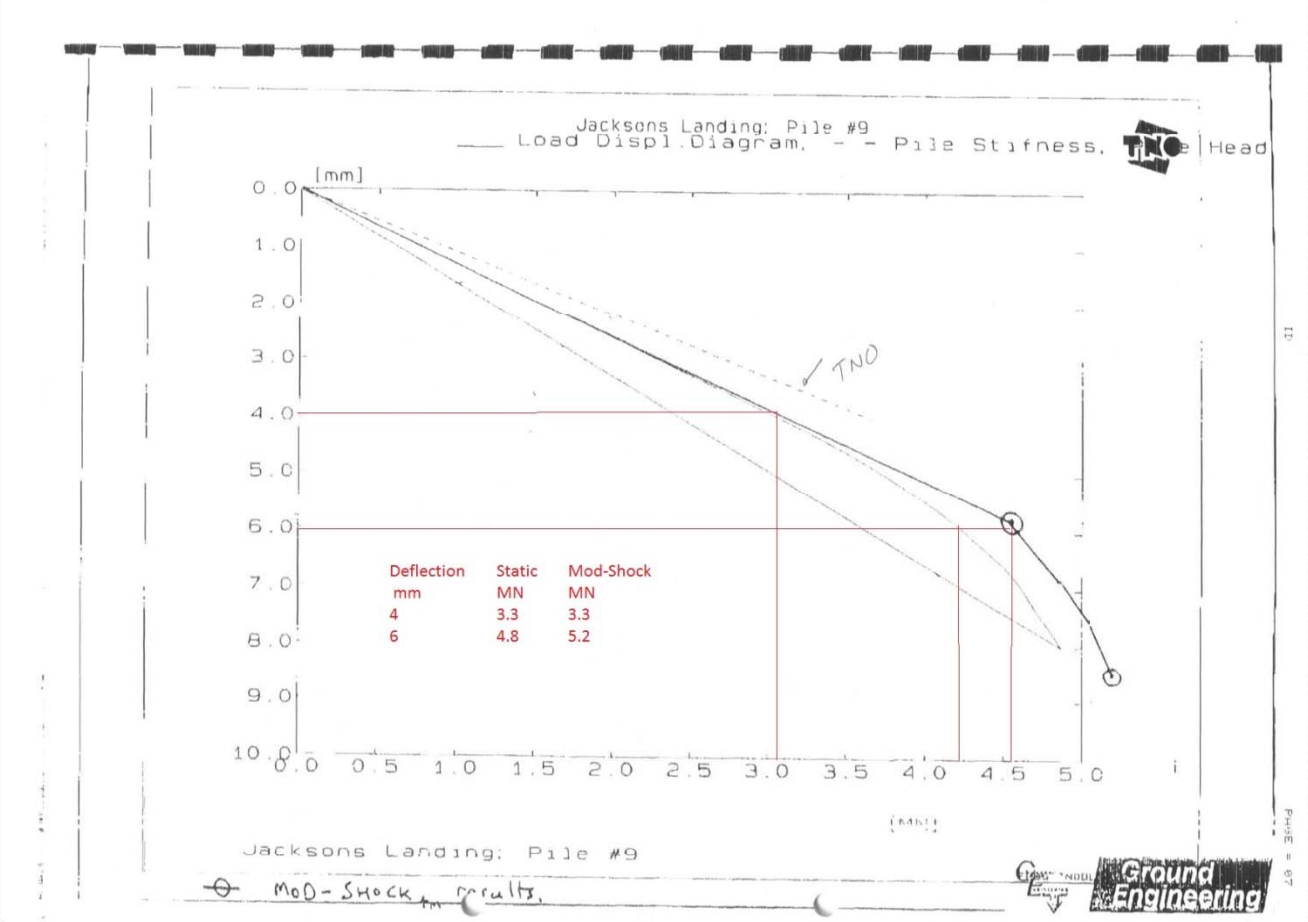
Results pile #1



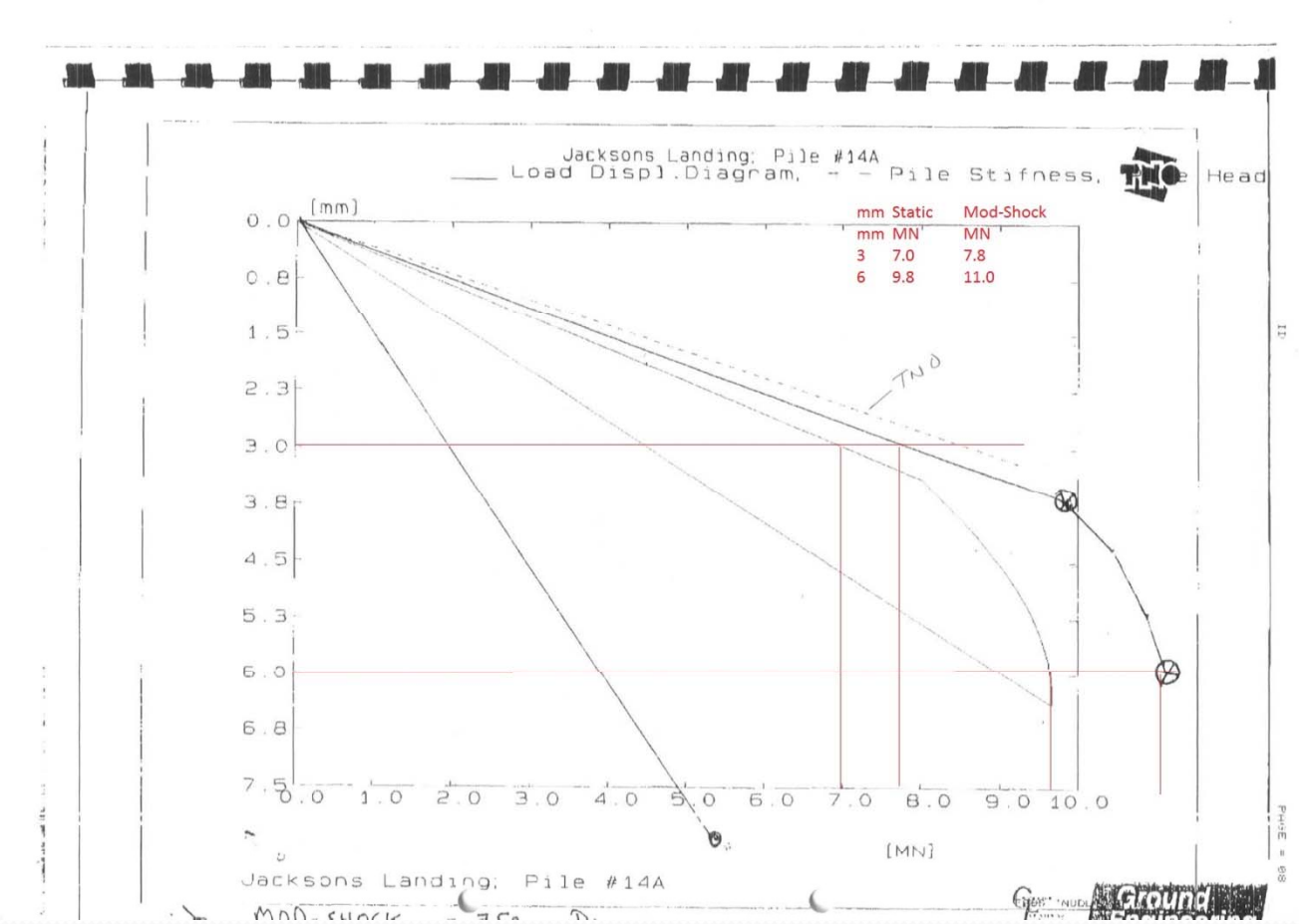
Analysis Pile #1

- The Static results indicated that the pile moved at 4mm deflection both results were equal
- The load at this point was 4.5 MN
- Our SAL indicated at a 6mm deflection a load of 5.0 MN, Static was 6.0 MN.
- We consider that these results indicate a virtually similar result and still within the elastic range of the pile.
- Other piles follow with a summary at the end

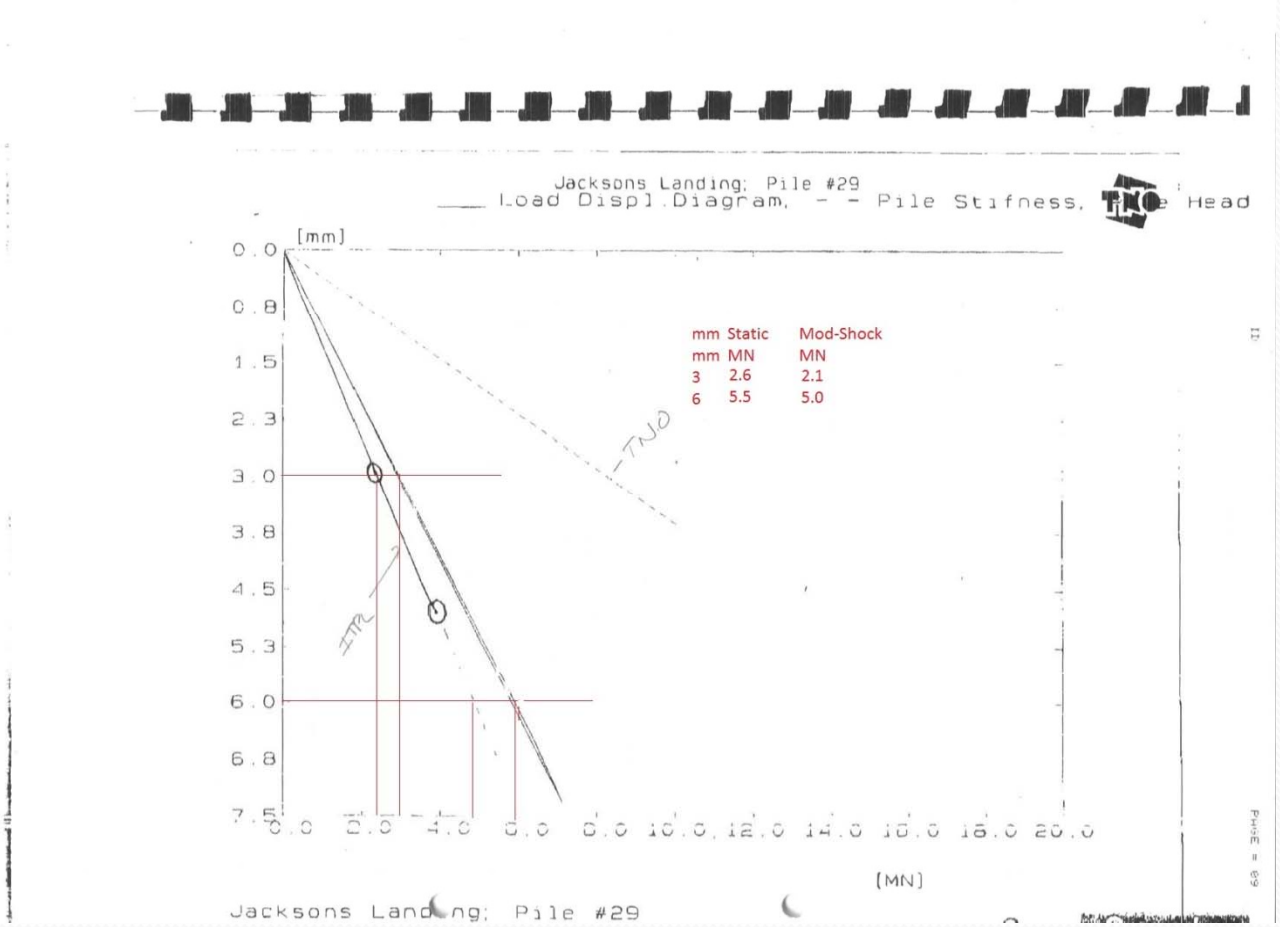
Results Pile #9



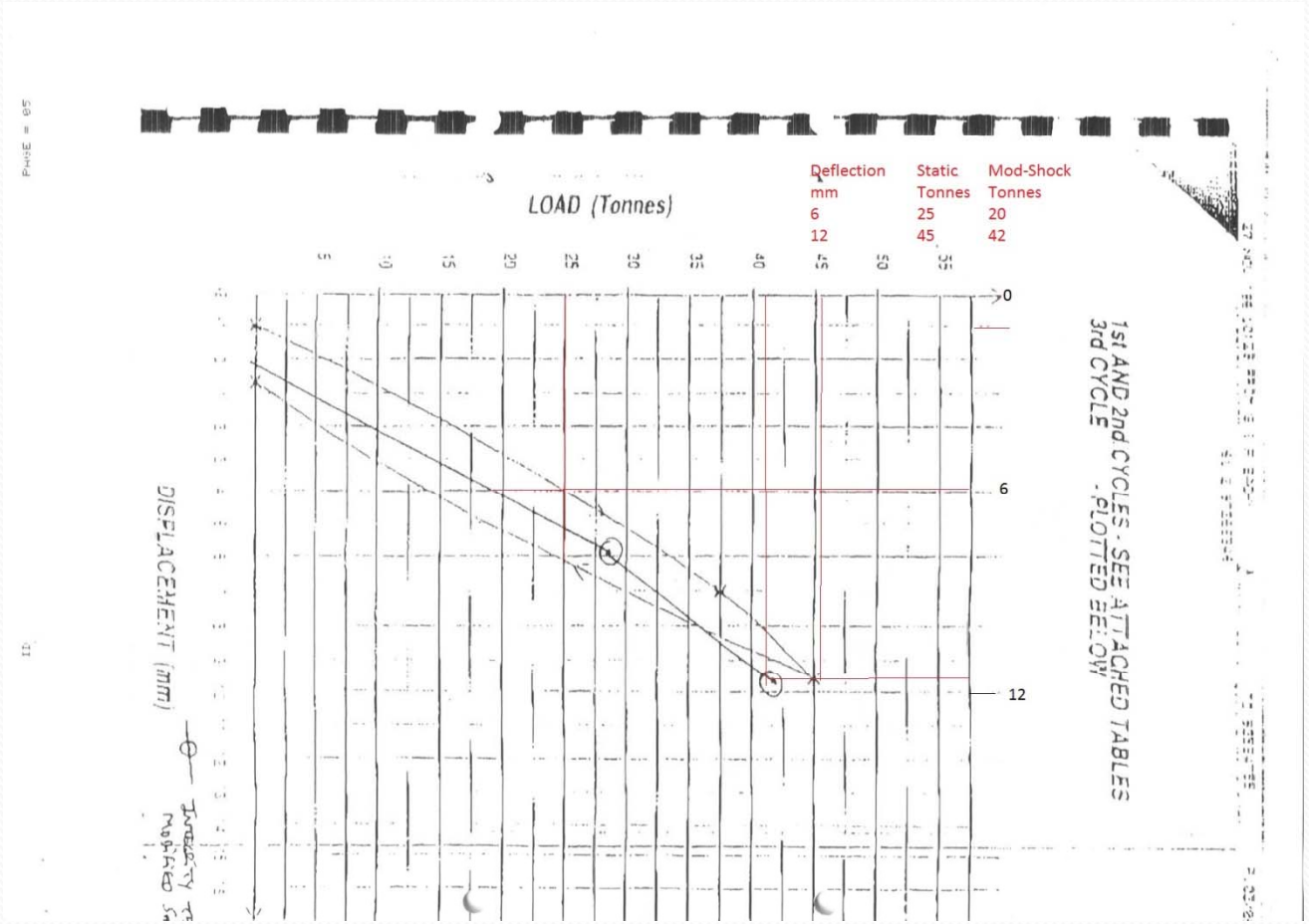
Results Pile #14A



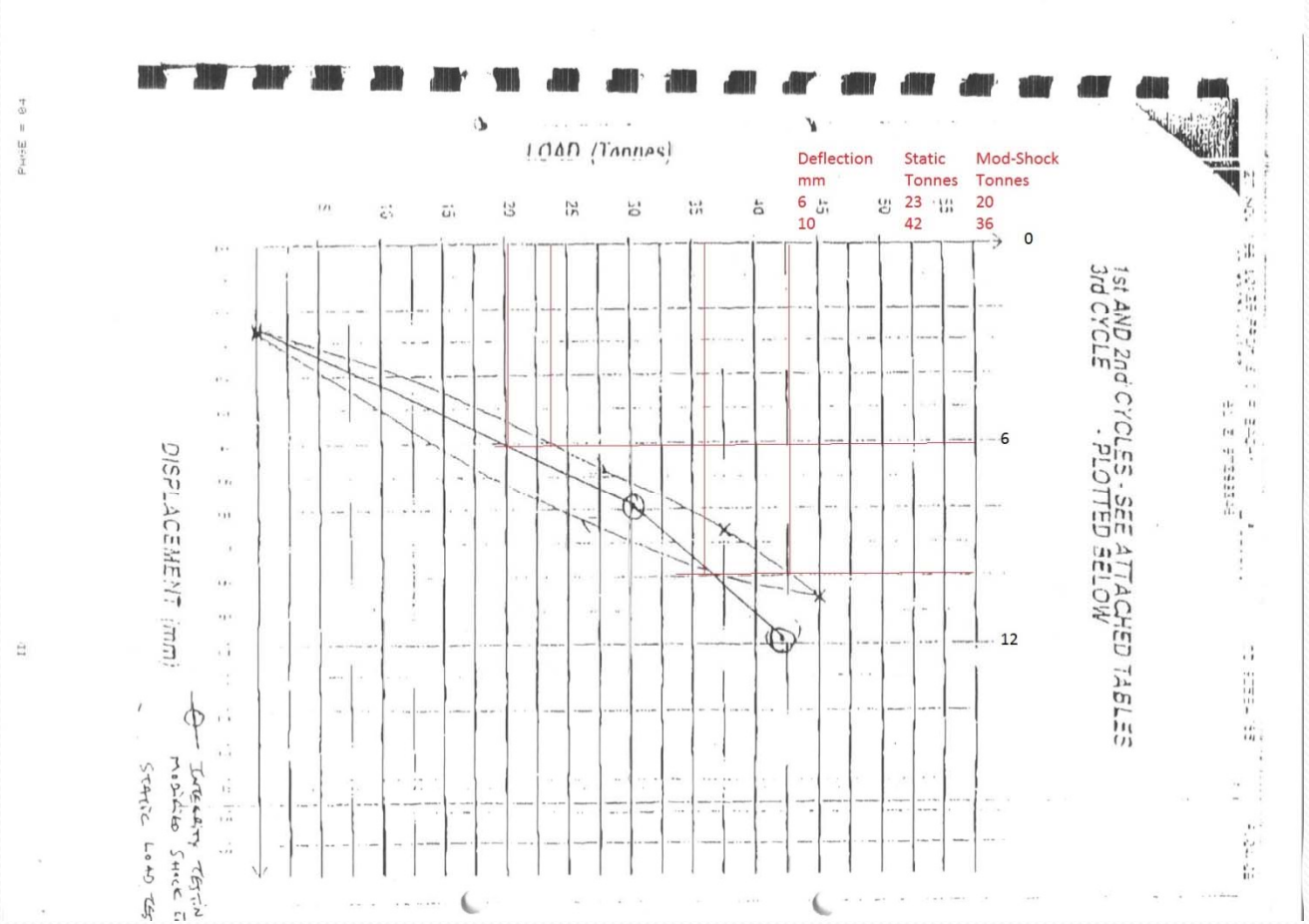
Results Pile #29



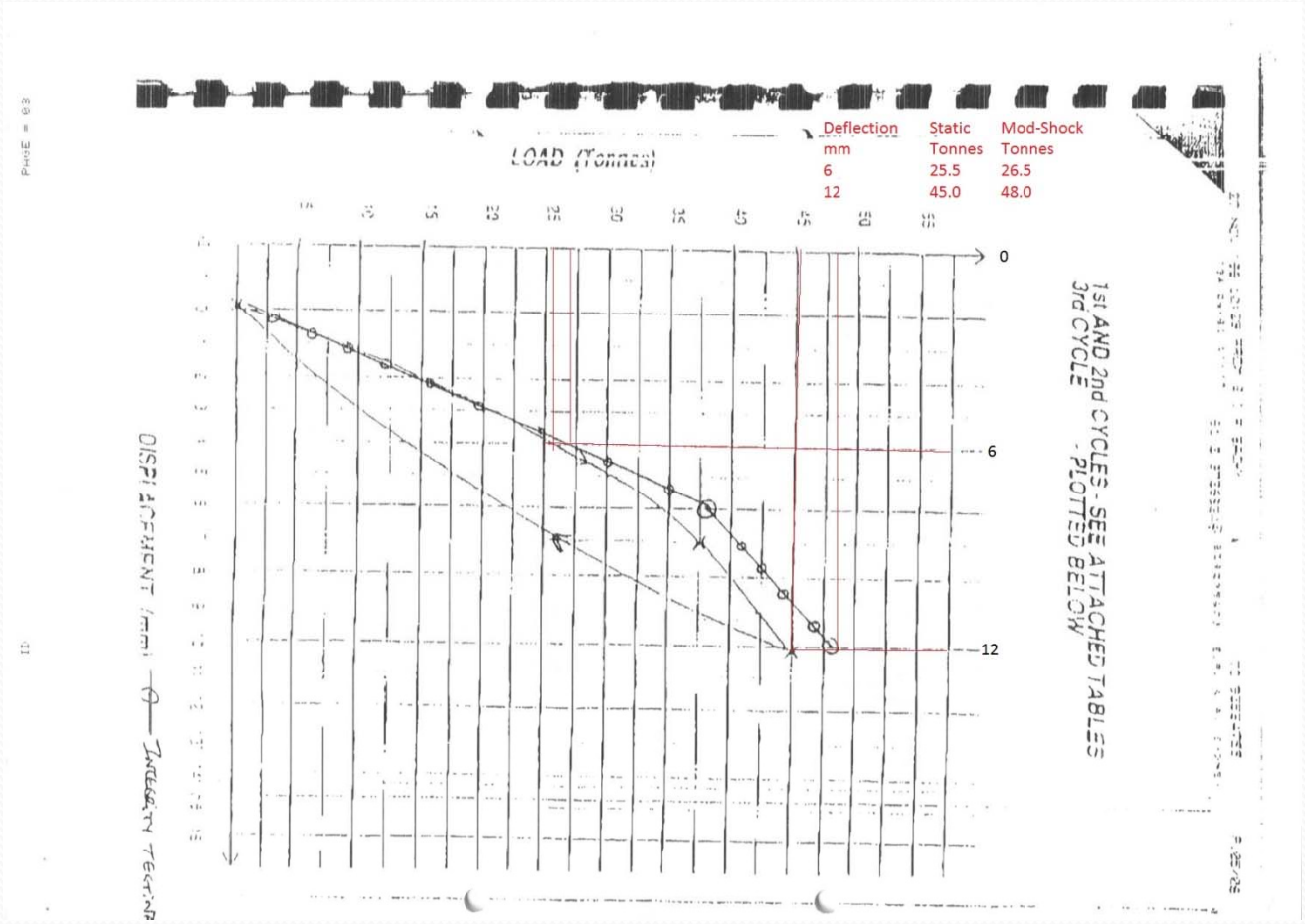
Results Pile # T1 concrete



Results Pile # T2 concrete



Results Pile # T3 concrete



Analysis of load test results

Pile	Deflection mm	Static (t)	Mod-Shock (t)	Remarks Static - Mod-Shock
# 1	4	450	450	Mod-shock 17% lower at 6mm load 600 t
#9	4	330	330	Mod-shock Over by 8% at 6mm load 500 t
#14A	3	700	780	Mod-shock Over by 11% at 6mm load 1100 t
#29	3	260	210	Mod-shock under by 10% at 6mm load 550 t
T1	6	25	20	Mod-shock under by 7% at 12mm load 45 t
T2	6	23	20	Mod-shock under by 15% at 12mm load 42 t
T3	6	25.5	26.5	Mod-shock over by 7% at 12mm load 45 t

Tables from old papers given

TABLE 2 : COMPARISON WITH STATIC LOAD/SETTLEMENT DATA

2a: SINGLE END SHOCK TEST

PILE NO.	TYPE/LOCATION	DIAMETER (mm)	(1)SHOCK TEST STIFFNESS (t/mm)	(2) LOAD TEST STIFFNESS (t/mm) ON RELOAD	RATIO (1)/(2)	SINGLE END SHOCK TEST BEFORE/AFTER LOAD TEST
159	Bored cast in-situ Malaysia (K.L.)	1200	124	129	0.96	After
185	"	1300	198	170	1.16	After
201	"	920	258	268	0.96	After
194	Pre-cast driven Hong Kong	300-350 hollow Daido piles	48	54	0.89	After
187	Bored cast in-situ Malaysia (K.L.)	1400	275	265	1.04	After
WR-C1/8.2	"	680	87	90	0.97	After
KS-159	Pre-cast driven Malaysia(Penang)	350	27	33	0.82	After
AM 158	Bored cast in-situ Malaysia (K.L.)	1520	206	222	0.93	After
AM 101	"	1520	169	225	0.75	After

Tables from old papers given

2b: STEADY STATE VIBRATION TESTS

PILE NO.	TYPE/LOCATION	PILE SHAFT DIAMETER (mm)	(1)VIBRATION STIFFNESS E' (MN/mm)	(2)STATIC LOAD STIFFNESS (MN/mm)	RATIO (1)/(2) LOAD TEST	VIBRATION BEFORE/AFTER
P1	Bored cast in-situ	1050	1.32	1.49-1.63 (reload)	1.22-1.12	After
P2	United Kingdom	1050	2.0	2.33(1.77) (Virgin (reload))	0.86	Before
P3	Driven cast	400	0.40	0.178 (reload)	2.23	After
P4	in-situ	400	0.357	0.234 (reload)	1.52	After
P5	"	400	0.385	0.213 (reload)	1.80	After
P6	"	400	0.244	0.172 (reload)	1.42	After
				0.243 (CRP)	1.00	
P7	"	400	0.480	0.36 (virgin)	1.33	Before
	United Kingdom					

Davis and Robertson - Vibration Testing of Piles - Structural Engineer, (June 1976)

Tables from old papers given

2c: CONVENTIONAL SHOCK TEST

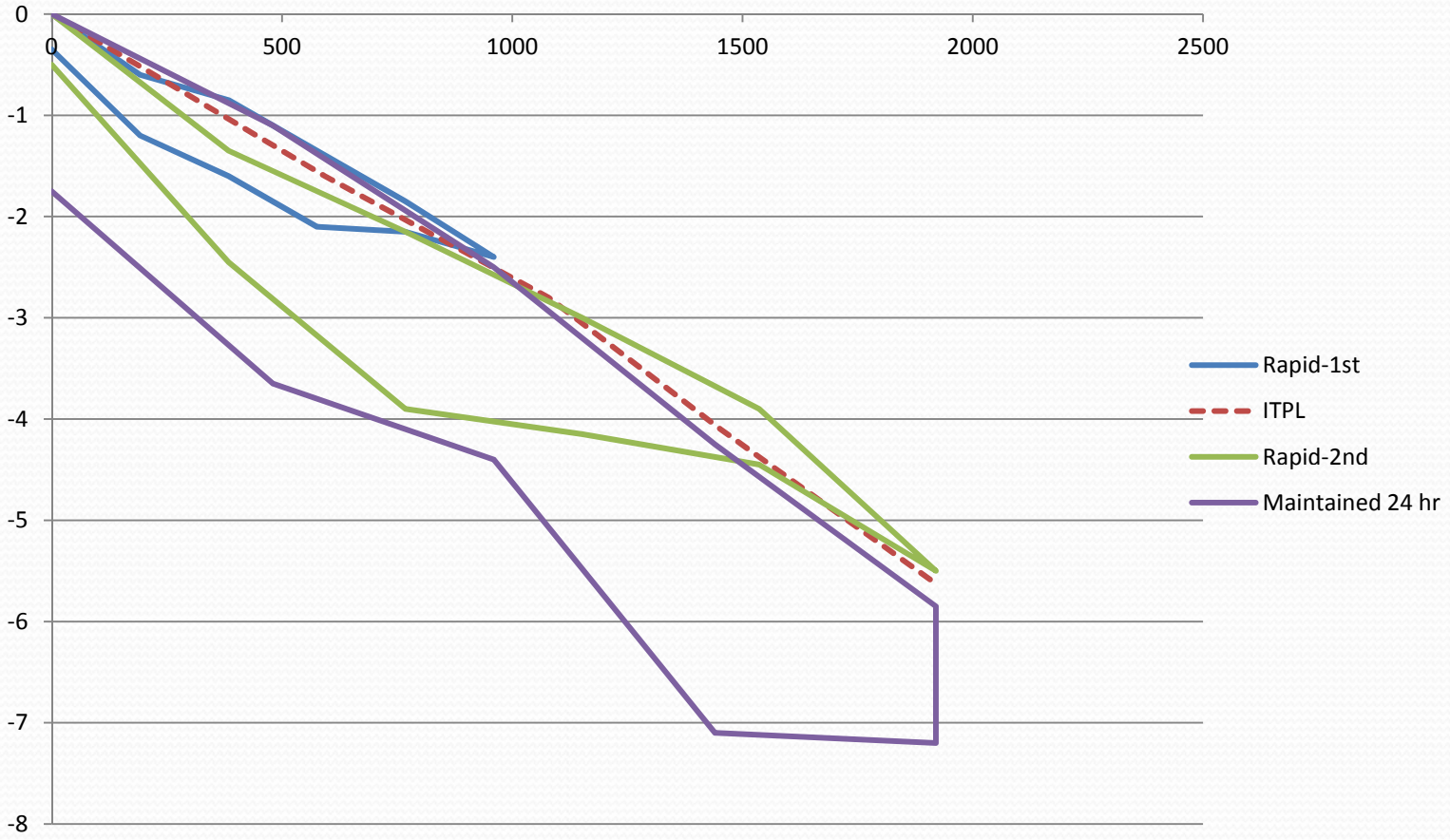
TYPE/LOCATION	PILE NOMINAL DIA. mm	(1)SHOCK STIFFNESS MN/mm	(2)STATIC LOAD STIFFNESS MN/mm ON RELOAD	RATIO (1)/(2)	SHOCK TEST BEFORE/AFTER LOAD TEST
Driven shell type United Kingdom	381 444	0.43 0.66	0.30 0.50	1.43 1.32	Before Before
Augered grout pile United Kingdom	450	0.5	0.32	1.56	Before
Augered grout pile United Kingdom	450	0.2	0.19	1.05	Before
Bored cast in situ United Kingdom	600	1.21	0.98	1.23	After

J.S. HIGGS - Integrity Testing of Concrete Piles by Shock Method
- Concrete Magazine (October 1979)

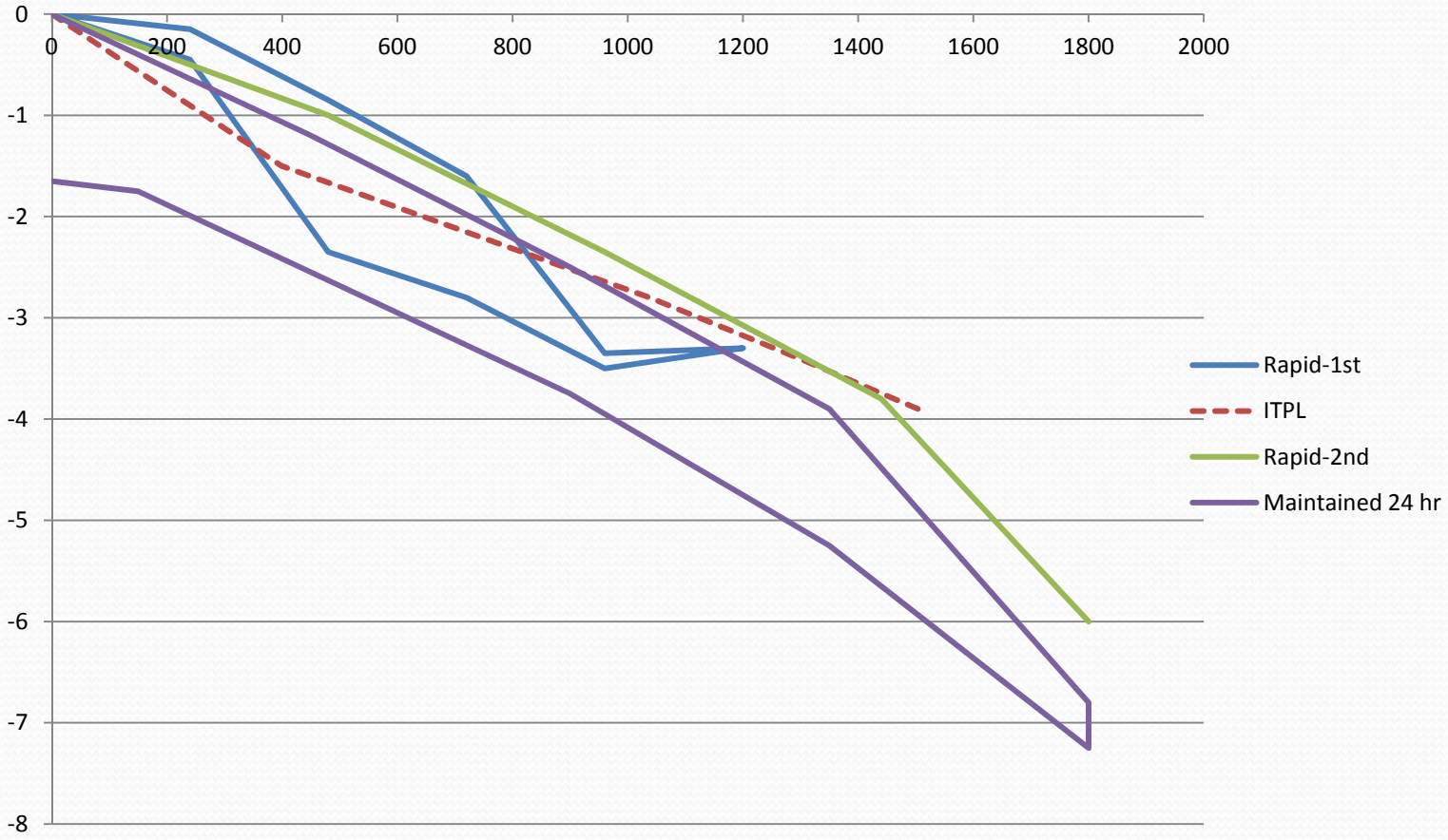
DEAD WEIGHT PILE TESTING IN UK

- Due to the location of the tests we cannot give too much information on the next two calibrations, but we have included the graphs as evidence of a controlled calibration carried out by Lloyds in the UK.
- One was taken on a concrete pile and another on a steel pile and both tests confirmed that at a deflection of 3mm, both the dead weight tests and the Mod-Shock test results were within 4% if each other.
- Due to the excellent results the client has commissioned further work this and next year.

DEAD WEIGHT PILE TEST ON CONCRETE PILE. UK.



DEAD WEIGHT PILE TEST ON A STEEL PILE. Uk.



Conclusion of Static Vs Mod-Shock

- At our predicted working load of 3mm deflection the predicted loads were either equal to the static tests or within 10%.
- At ultimate loads the prediction was within 15% as an average.
- Another good method to access the accuracy of the Mod-Shock test data with poles is to do “pull over tests”, as our loads are a measurement of the section modulus of the timber, and this virtually dictates the load that in this case timber poles will safely carry.

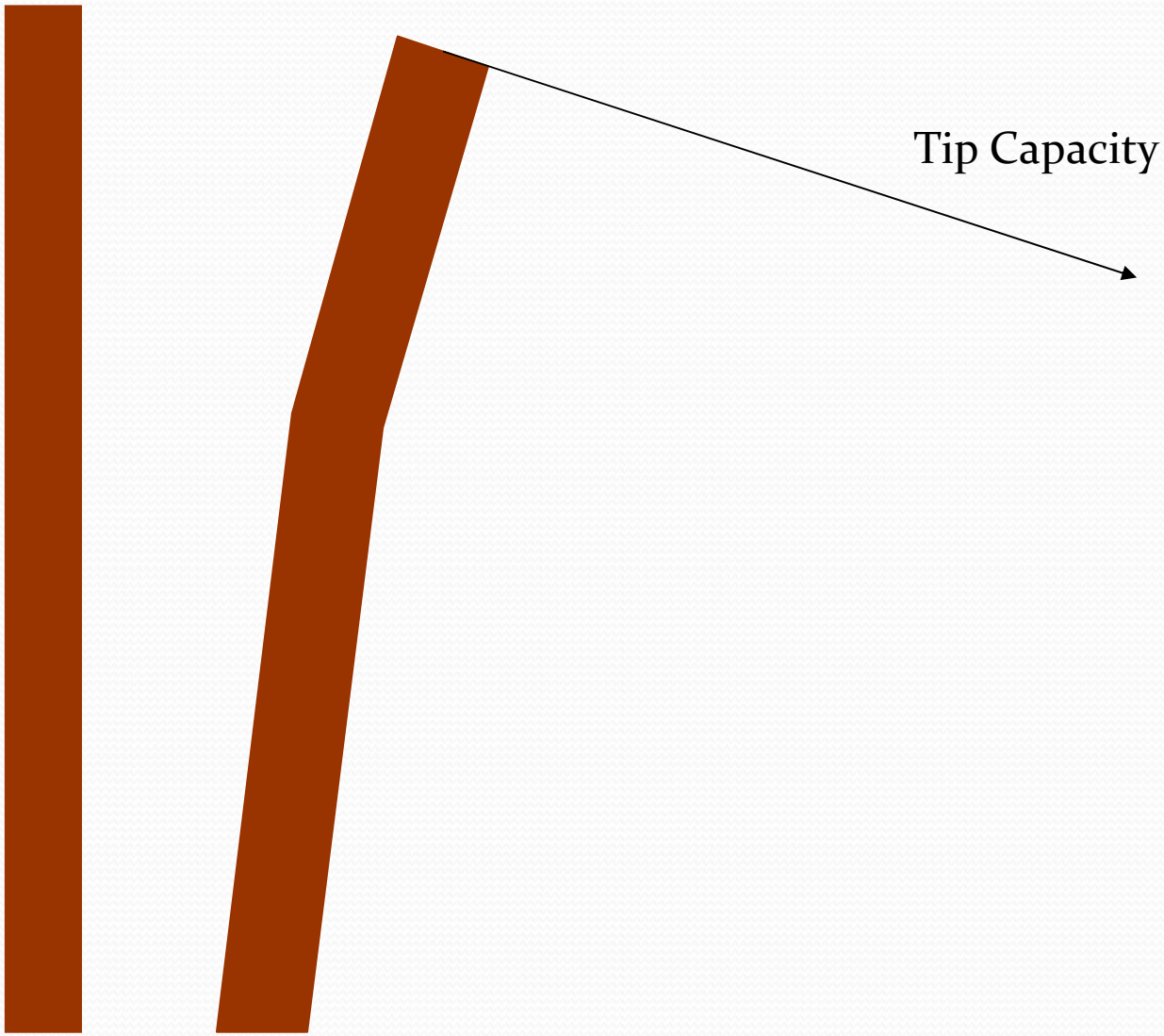
Bending moment or horizontal capacity of tested piles

- As part of our test deliverables we are to give berthing or horizontal capacity of the piles tested
- We were able to correlate the horizontal capacity measurement of Mod-Shock using a test environment at Energy Australia's test site in Sydney
- We tested the free standing poles then pulled them over till destruction.

Pole Testing-Method Example

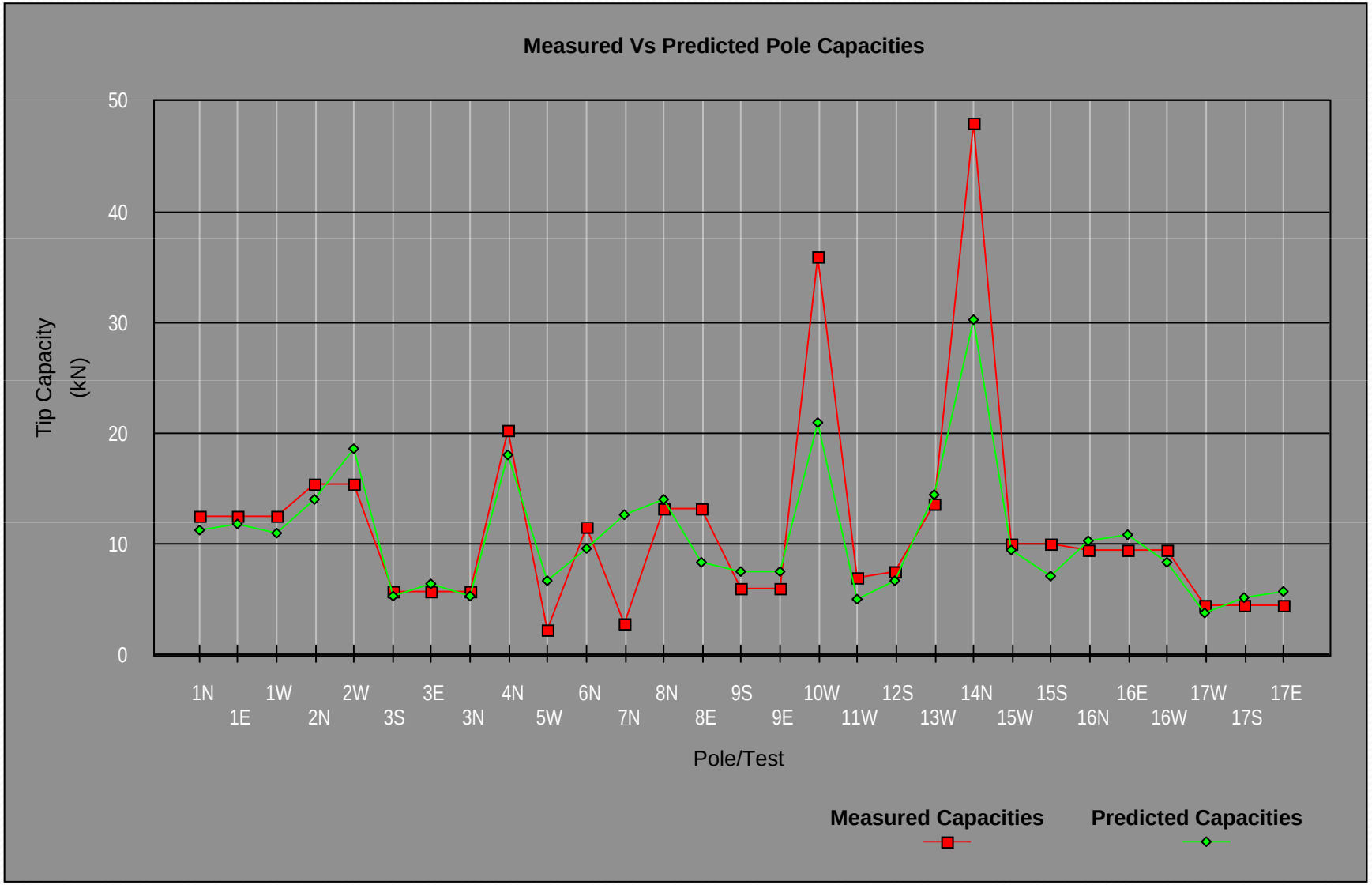
- Excite Pole by using striking with a suitable hammer.
- Record response in laptop computer and analyse.
- Analysis using established parameters yields results on pole length, buried depth, defects and load capacity

Predictions from work with Energy Australia

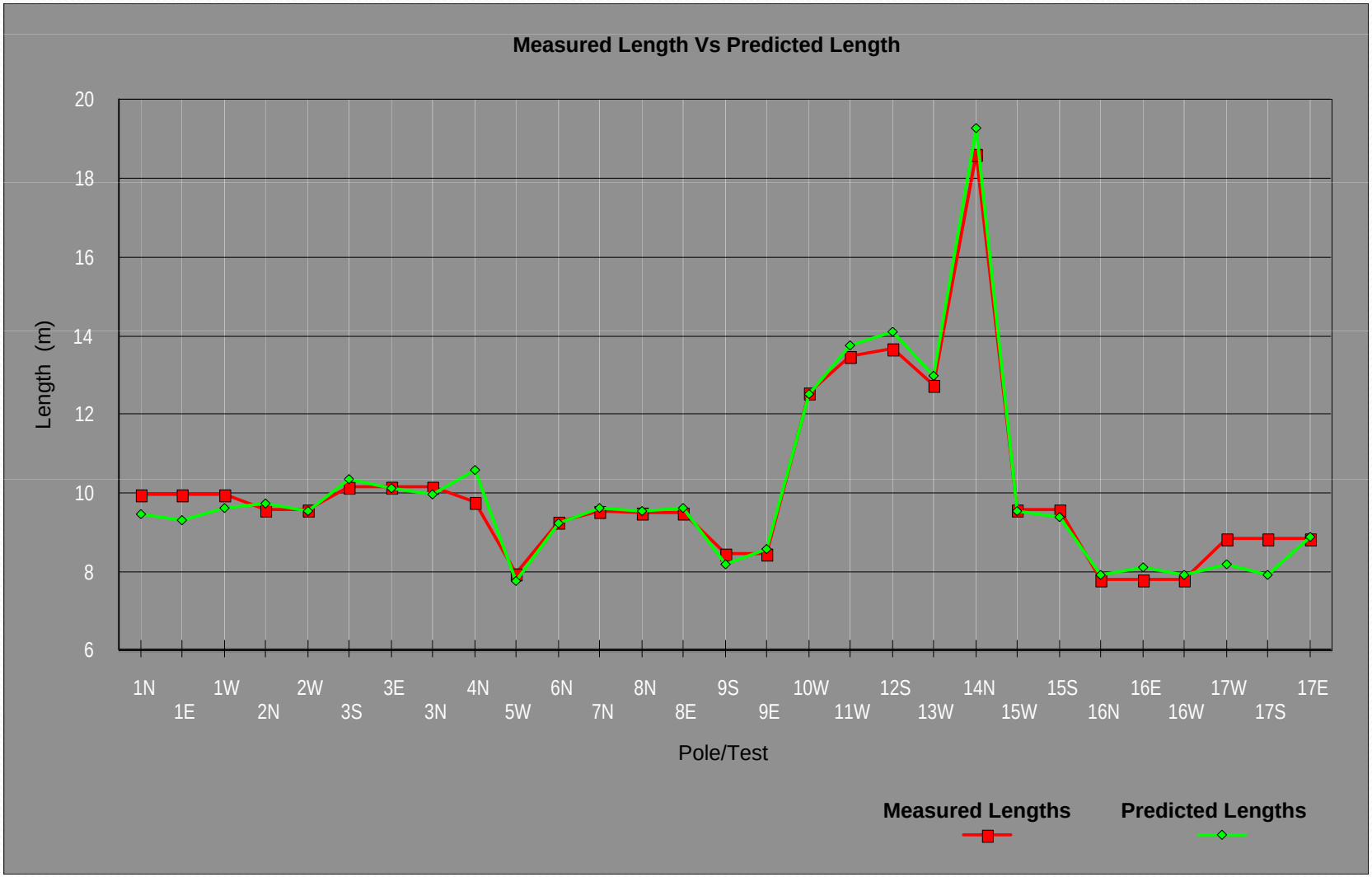


The test site and our Capacity Predictions

Pole Capacities Predictions



Length measurement and Deflect detection Determination of unknown burry depth



Conclusions on Mod-Shock testing.

- **Over 1,000,000 Mod-Shock tests successfully performed in the last three decades.**
- Extensive calibrations in Asia for pile testing with dead weight tests, all successful.
- **Limited calibrations for marine structures, as difficulty with dead weight testing and only PDA testing, which is considered an accurate test on piles.**

Mod-Shock testing

- If you require testing of piles, foundations, poles, bolts, anchors or any structure you may consider that the testing will assist you in the structural integrity or strength please contact the undersigned.
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- David Tongue on +61409900123 or on djtongue@integritytesting.com.au
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