SESSION III
Paper (d)

HYDRAULIC EXCAVATOR BASED LOG LOADERS

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INTRODUCTION

Since the 1970's, there has been a trend away from tracked rope operated cranes to rubber tyred front-end loaders (RTFEL). In 1978, 61% of the population of 250 log loaders were RTFEL type, and this trend was continued. From 1990 onward as harvesting moves into regions of steep, wet, and environmentally sensitive terrain, landing sizes will decrease resulting in an increased need for crane type loaders. Loader requirements are expected to rise to a population of over 500 by the year 2000. (Donovan, 1982).

Hydraulic excavators modified for log loading have gained popularity in the last five years, particularly in areas with difficult ground conditions. There are now twenty such machines in use in New Zealand. This report presents a list of loaders in use, with details of machine type, grapple type, and machine location. Notes on applications and equipment modifications carried out are included. This report summarises a LIRA Project Report of the same title, P.R.25, copies of which are available to LIRA members on request.

APPLICATION

There are twenty known excavator based log loaders, ten in each of the North and South Islands. The main areas of use are Southland and Otago, with groups of machines also in Wairarapa, Coromandel, and North Auckland. Table 1 shows the brands of excavators in use and their locations.

Excavators are used in areas with difficult winter ground conditions, where stationary tracked machines are better suited to loading than mobile rubber tyred loaders, which cut up skid sites and require a heavily metalled surface in the wet. Excavator loaders are able to work on smaller skids than RTFEL, and are competitive in terms of purchase price and operating costs. Fuel use is approximately half that for a mobile loader of similar capability. Operation of excavator loaders is very easy, and operator comfort is good. The large number of excavators used in a wide variety of applications means that good parts and service back-up exist.

Most loaders in use are in the 19-20 tonne excavator size range. This size loader has the ability to handle most log diameters and lengths and can usually unload 3 axle trailers weighing up to 5 tonnes. Four loaders in the 12 tonne size range are also used.

Changes made to convert from excavator to log loader involve installing cab guarding, replacing the bucket with a fully rotating grapple, and hydraulic modifications to suit the grapple. The grapple is the key to successful operation of this type of loader due to the limited availability of grapples in New Zealand.

In most cases the loaders are used in small contract crews with annual production around 20,000 m^3. Most loaders were purchased second-hand and commissioned at a 1985 equivalent cost of $50,000 to $100,000. Modification and grapple costs account for $10,000 to $25,000 of this total.

TABLE 1 : EXCAVATOR LOG LOADERS IN NEW ZEALAND

EXCAVATOR	WEIGHT (tonnes)	GRAPPLE	REGION
JSW Nikko RH6	17.5	-	North Auckland
Kobelco K907B	18.9	"Cashmore"	North Auckland
Hitachi UH07	18.3	Mar	Coromandel
Warner & Swasey	37.0	Harricana	Coromandel
JSW Nikko 45	12.0	-	Rotorua
JCB 8D	23.5	Poclain*	Rotorua
Hitachi UH07	18.3	Bell*	Taranaki
Hitachi UH083	18.5	"Havard"	Wairarapa
IHI IS 190	18.8	Hiab	Wairarapa
Kato HD 750	20.0	Palfinger	Wellington
Mitsubishi 110	12.0	Hiab	Otago
Hitachi UH063	12.0	C&R 1000	Otago
Hitachi UH07	18.3	Hiab	Otago
JSW Nikko RH4	12.0	Hiab	Southland
Caterpillar 225	21.5	C&R 1500	Southland
Massey Fergusson 450S	15.6	Grab	Southland
Komatsu PC200	18.8	C&R 1500	Southland
Hitachi UH081	18.5	C&R 1000	Southland
Hitachi UH081	18.5	C&R 1000	Southland
JSW Nikko RH 6	17.5	"Carran"	Southland

* Denotes live heel attachment

EQUIPMENT OPTIONS

Factors to be considered when selecting an excavator for log loading include :

1. Undercarriage type: Long track frame and wide track shoes give the machine additional stability. In most cases, lift capacity is limited by stability. This can be increased by up to 15% by longer track frames and 7% by widening the shoes from 600 m to 800 m.

2. Main Boom type: Single or two piece booms are available. Lift height is sometimes insufficient (e.g. for lifting trailers) and modifications are available to increase lift height with both boom types.

3. Dipper arm: A range of lengths are available. The longer length options are best suited to log loading, to give adequate reach.

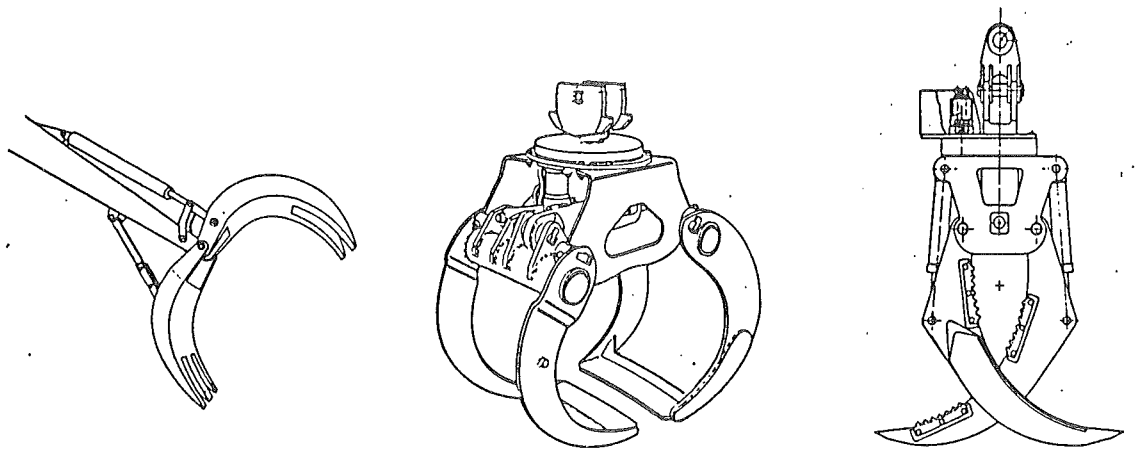
4. Hydraulic system: For grapple operation two extra circuits are required. The bucket circuit can be used for one and some excavator brands also have a spare implement circuit. Those without require an additional pump and valving for the second circuit. Cost is reduced by choice of a machine with spare circuit.

EXCAVATOR MODIFICATIONS

Having purchased an excavator, modifications that may be considered are :

1. Grapple selection: Fully rotating types, and non-rotating grab types are available. The latter have one fixed jaw and the top clamp is operated by the bucket cylinder.

   Only one grab type grapple is used in New Zealand, but they are popular in Australia. Two main types of fully rotating grapple are used. There are the narrow, 3 tine type with side-mounted rams, and the wide jaw pulpwood type with horizontal ram, (usually found on self-loading truck cranes). Prices range from $5,000 to $20,000. The three grapple types are shown in Figure 1.



GRAB TYPE PULPWOOD TYPE 3 TINE TYPE

FIGURE 1 - TYPES OF GRAPPLE

2. Hydraulic modifications: The bucket hydraulic circuit is used for the open/close grapple function. The spare implement circuit (if fitted) is used for grapple rotation and an extra control added in the cab to operate the rotator. Extra valving is required to give correct pressure and flow for the grapple selected. The cost of hydraulic work is $3,000 - $5,000 if a spare circuit is used, and may be in excess of $10,000 if an extra circuit is required.

3. Heel attachments: Live or fixed heel attachments are common on medium and large hydraulic loaders in the United States. In New Zealand, two machines have live heels. Heel attachments allow logs to be picked up off-centre which effectively extends reach and avoids the need to drag logs into the loaders and re-position the grapple to balance the load. Logs are positively controlled when heeled, and more easily loaded. Figure 2 shows live and fixed heels.

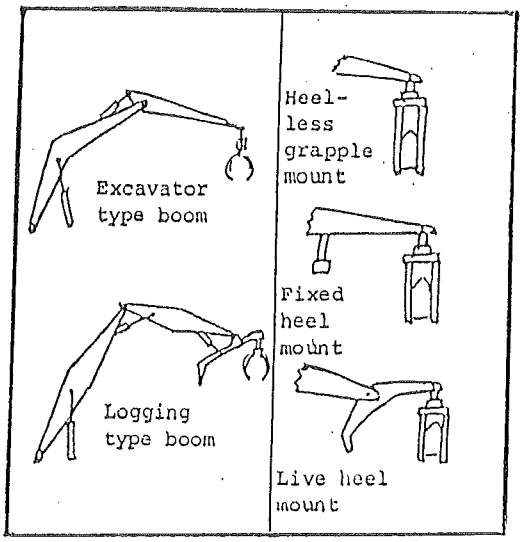


FIGURE 2 - ALTERNATIVE LOG HANDLING DEVICES

4. Main boom and dipper arm: Most excavator booms and dippers are not altered for logging in New Zealand. In the United States most machines are fitted with purpose-built log loading booms. These give greater lift height, reach and operating range than excavator booms which are shaped and stress designed for digging. Cost of a purpose-built boom for a 20 tonne excavator is approximately $60,000. Alternatively, low cost modifications to increase lift height and reach can be made to excavator booms and dipper arms.

5. Cab guarding and raising: Cab guarding is advisable and required by most Bush Inspectors. The cost is approximately $2,000. Raised cabs to give better visibility when loading are considered desirable by most operators, many of whom

position stockpiles so that they can load trucks from a bank to provide a better view. Raising a cab one metre is estimated to cost $6,000. Folding cabs may be advisable to avoid height problems in transport.

LOADING PERFORMANCE

1. Lift and reach: Specifications for five size ranges of excavators from 10 to 30 tonnes, are shown in Table 2. Details are for machines equipped with grapple, and lift capacity is based on 75% tipping load, at 6 m reach.

TABLE 2 : LIFT AND REACH BY MACHINE SIZE

SIZE RANGE	HORIZONTAL REACH (m)	LIFT HEIGHT (m)	FRONT LIFT (tonnes)	SIDE LIFT (tonnes)	POWER (kw)
10-12 tonne	7.5	5.5	1.8	1.5	60
14-16 tonne	7.9	5.7	3.3	2.3	68
18-20 tonne	8.7	6.5	4.6	3.1	79
22-24 tonne	9.3	6.8	6.5	4.4	98
28-30 tonne	10.4	7.3	7.3	5.4	136

Generally, machines in the 10-12 tonne range cannot unload trailers, or lift large logs. Sixteen tonne machines can unload two-axle trailers, while twenty tonne machines can unload three-axle trailers, and handle most log sizes. For heel boom loading long length, medium diameter logs, twenty-four tonne machines or larger are required.

Figure 3 shows a lift capacity chart for a 19 tonne excavator. This illustrates how capacity varies with working radius. The leading figures are for boom at right angles to the tracks, and those in brackets for lift with boom parallel to tracks. Capacities are shown in tonnes.

The lift chart illustrates that although lift capacity close to the machine is large, lift height is limited. This can create problems for unloading trailers from trucks. Operating off a bank improves lift height and visibility, and is a common practice.

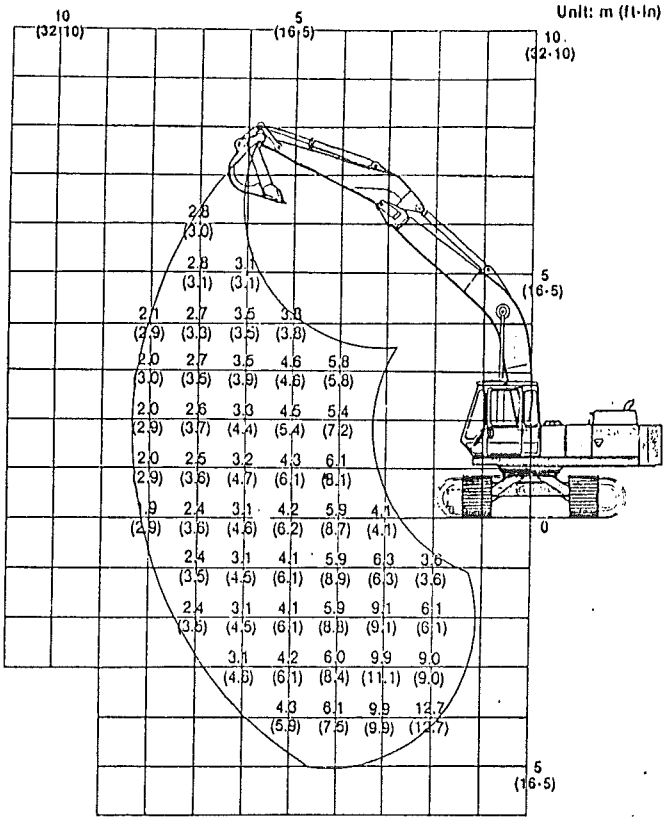


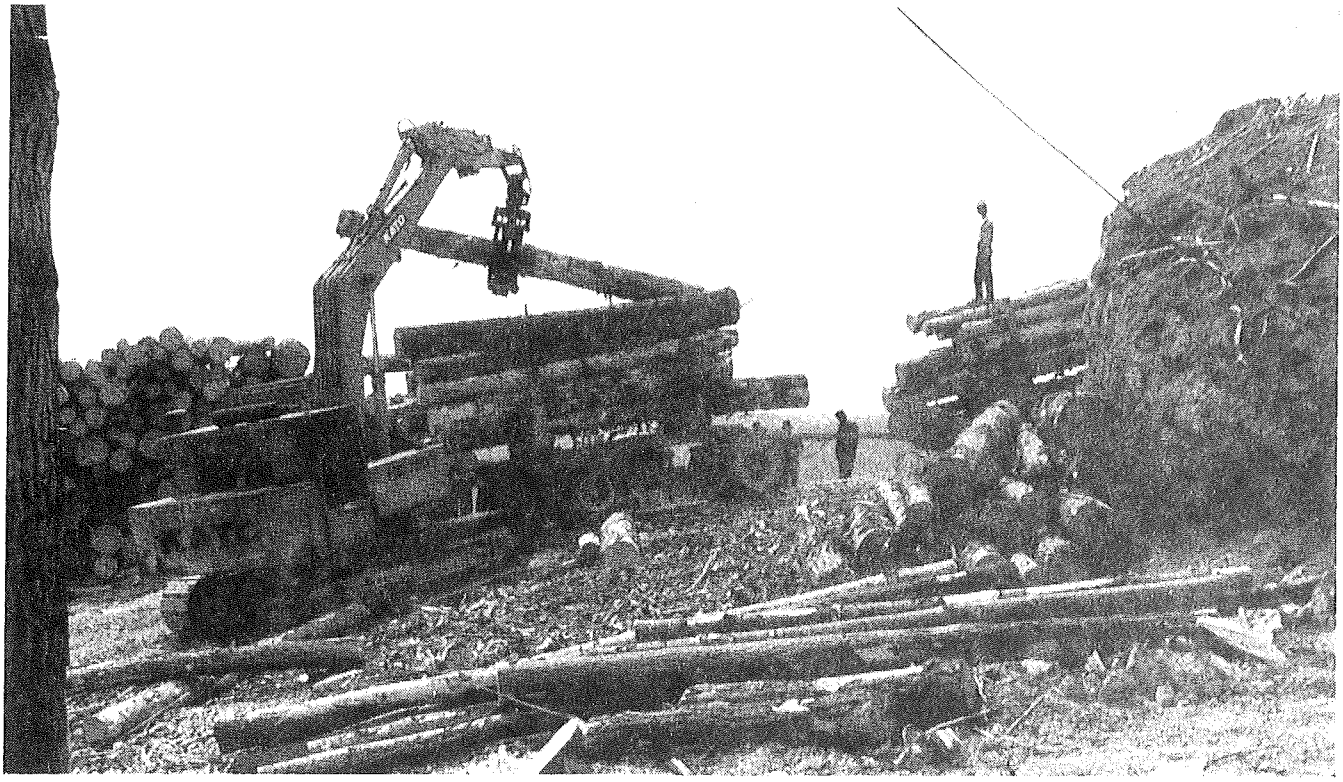
FIGURE 3 - EXCAVATOR LIFT CAPACITY CHART

2. Grapples: The three tine grapple is most suitable for long single stems, and the pulpwood type best suited for small diameter multiple stems. Both varieties of grapple can handle most types of logs but multiple logs may twist in a 3 tine type, and pulpwood types have problems selecting individual logs from stockpiles. The 3 tine type are generally heavier and more robust. Most pulpwood types are designed for truck crane operation and give mechanical problems when fitted to powerful excavator type loaders. Most grapples suffer problems with hydraulic hose failure and operators need to carry spares, and be prepared to change hoses, if downtime is to be avoided.

Table 2 compares specifications of three types of grapple commonly used on excavator loaders in New Zealand.

Excavator-based log loaders are well suited to working on landings of restricted size. In this Hanmer Forest operation, the road is the landing.

(LIRA Photo CN309/24)



Loading out from a steep uphill restricted landing where the truck has had to reverse down the road into place

(LIRA Photo CN242/6)

TABLE 2 : GRAPPLE DETAILS

Grapple Detail	C & R 1000	C & R 1500	Hiab .4 m^2 (3406113)
Load capacity	3500 kg (1)	5000 kg (1)	4000 kg
Grapple weight	450 kg	1000 kg	350 kg
Max. Opening	1100 mm	1500 mm	1610 mm
Min. Opening	200 mm	300 mm	155 mm
Oil Pressure	17 MPa	17 MPa	16 MPa
Flow, Close	34-35 l/min	45-55 l/min	60 l/min
Flow, Rotate	5-10 l/min	5-10 l/min	35 l/min
Overall Height	1350 mm	2000 mm	1108 mm
Jaw Width	300 mm	300 mm	580 mm
Slew Speed	6 rpm	6 rmp	25 rpm
Approx. Price	$12,500	$19,000	$6,500

Notes : (1) C & R capacities are for continuous use. Maximum ratings are 5000 kg and 7500 kg respectively.

3. Operating Details: The functions normally carried out by a loader are :

- Clearing landed logs from extraction machine.
- Sorting and stacking logs.
- Unloading trailers from trucks.
- Loading trucks.

The functions of clearing logs, sorting and stacking are closely associated. Logs are removed from the landing and processing area and sorted into various log types which are then stacked in heaps for loadout. The variables affecting the processing and stacking functions are :

(a) Cycle time of extraction unit.
(b) Volume of wood per extraction cycle.
(c) The number of log sorts.

The number of log sorts varies depending on employer but there is a trend to cutting more special log types, to maximum value. More log sorts require a greater area for stacking and more travel by the loader. It is common for up to 8 sorts to be required and in the case of a crane type loader this generally requires travel with load to some stacks. Crane type loaders are most effective when able to remain static, and with 5 sorts or less this is possible. Even with 8-10 sorts up to 75% of production may be in only 3-4 sorts, and loader shifts may be minimised by accumulating logs of lesser sorts before moving them to stacks. When loading out, the loader can position by a stack and need not travel. Excavator loaders are able to travel loaded more readily than most crane types at up to 4 km/hr.

Older rope cranes can often travel at only 2 km/hr, cannot swing while travelling, and cannot counter-rotate tracks. Truck mounted cranes are not readily moved, as outriggers must be lifted and the operator may have to change from crane cab to truck cab.

Operators of excavator loaders generally arrange stacks alongside the roadways so as to occupy minimum area. Rubber tyred loaders in contrast usually arrange piles around the landing edge with processing and loading areas in the centre. This layout is necessary to allow manoeuvring with logs, and requires a greater skid area. While on the pumice plateau skid site preparation costs are of minor importance, this is not the case in steeper, wetter terrain with difficult soil types. Site preparation will be expensive and skids will need to be kept small. Also the cost of metalling skids will be significant as much metal will be required to allow rubber tyred loaders to operate, and metal may not be readily available. Small skid sites also mean less productive land is lost. The conflicting requirements of more log sorts and small landing size favour the use of excavator loaders which are space-efficient and able to work on smaller, less metalled skid sites.

Some advantages of the excavator loader type are as follows :

(i) ability to work in adverse ground conditions
(ii) ability to work on skid sites with little metal
(iii) ability to work on skids of restricted size
(iv) ability to work from road sides
(v) low fuel usage
(vi) low R&M (with possible exception of grapple and hoses)
(vii) low (relative) capital cost new
(viii) ready availability of low cost, used excavators
(ix) ready resale as excavators
(x) ease of operation
(xi) large excavator population means good parts and service
(xii) operator comfort
(xiii) ability to be used as excavator, for roading, skid formation etc

COST OF EXCAVATOR LOADERS

There are a wide range of excavators available on the new and second-hand markets. There are over 20 brands to choose from, and the market has been very competitive. The market for new machines has stabilised with several major brands handled by established distributors making most sales, and some brands disappearing from the market. An indication of typical excavator prices, new and second hand, is shown in Table 3 below. For use as log loaders no sales tax is payable so new prices shown are retail, less 9% sales tax. Prices are approximate only.

TABLE 3 : TYPICAL EXCAVATOR PRICES (MARCH 1985)

SIZE RANGE (tonnes)	NEW EXCAVATOR PRICE (less sales tax) $	USED EXCAVATOR PRICE 4000 hours $
10 - 12	99,000	60,000
14 - 16	115,000	69,000
18 - 20	129,000	78,000
22 - 24	156,000	99,000
28 - 30	206,000	124,000

Additional costs of equipping a machine for log loading include cab guarding, hydraulic modifications and grapple purchase. Indicative costs for these extra items are shown below.

ITEM	ESTIMATED COST
Cab guarding	$1,500
Hydraulic Modifications for Grapple	
(a) using spare circuit	$5,000
(b) adding one extra circuit	$10,000
Grapple Purchase	
(i) Pulpwood type	$7,000
(ii) Small 3 tine type (1.0 m opening, 3 tonne lift)	$12,500
(iii) Large 3 tine type (1.5 m opening, 5 tonne lift)	$19,000
Live heel attachment (assuming use of bucket cylinder	$6,000
Cab raised 1.0 m	$6,000

Typical conversion costs from an excavator to a log loader would be from $13,000 to $19,000 depending on grapple chosen, and assuming a spare hydraulic circuit was available for grapple rotation. At the other extreme, a machine fitted with raised cab, live heel and large grapple could cost $43,500 to convert.

CONCLUSION

Excavator log loaders are a good alternative to the RTFEL type, particularly on small or wet skids. For low production crews, an excavator can be readily converted into a low cost loader. Higher production operations able to justify good equipment should consider excavators with purpose-built logging booms. These give improved operating range and may be fitted with heel attachments for improved handling of long length logs. Purpose-

built booms increase productivity and reduce machine stress, but add to machine purchase price.

Use of an excavator loader may require some changes to the logging system. Landing layout should be designed to suit the loader, and minimise travel when sorting and stacking. Choice of a suitable grapple is critical to successful operation. The 3 tine type are generally best. Loading speed is generally equal to or better than that with RTFEL, and operating costs are lower.