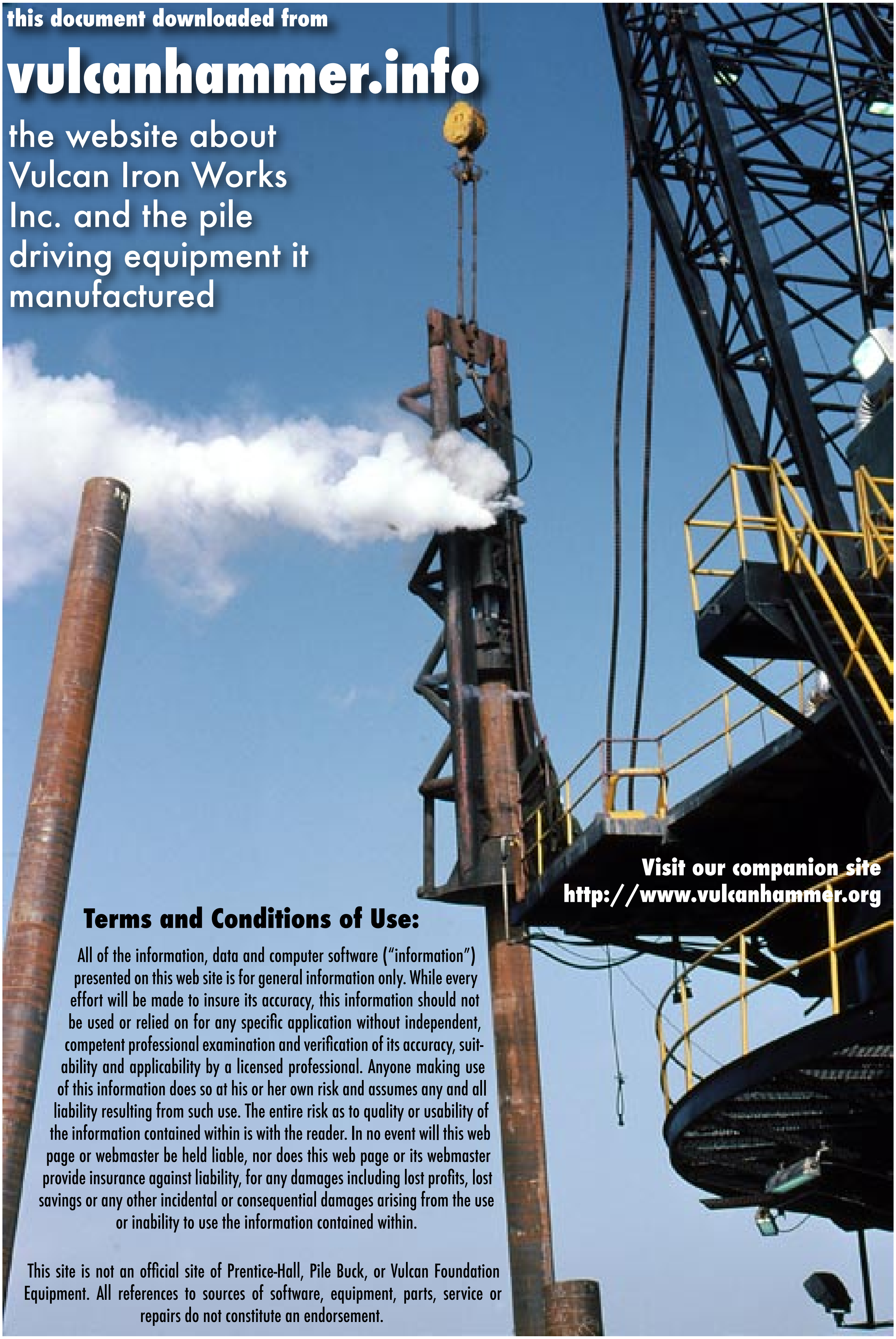

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For presentation at
Associated Pile & Fitting Corp. PILETALK Seminar
Miami Beach, Florida, March 1978

GLEN BARBER has worked with piling for twenty years, starting on inspection; he has supervised pile installation for Candler-Rusche and for Ford Motor Co. He joined L. B. Foster as pile driver specialist in 1970 and served in New Orleans and Houston before assuming his present top management position at L. B. Foster corporate headquarters.

Pile driving is perhaps one of the oldest forms of heavy construction. Our distant ancestors probably beat a few sticks into the shoreline to tie up their boats or to provide a means for reaching them in early Bible times. The builders and engineers of the day proved highly ingenious in the ways they devised to set piling with various crude forms of drop hammers, which used gravity as the source of energy. A number of the structures they erected are still standing to this day.

Then, as now, soil was the greatest variable in the pile-soil-hammer chain for support of structures over areas where adequate bearing material is at considerable depth. The type of pile can be a choice; the hammer can be selected for energy and characteristics. The soil is what is there and generally is not what is desired; if it were ideal, piles would not be needed. Fortunately for those of us who try to make a living in the foundation field there are a lot of difficult areas where soils are a problem.

Soils easily divide into cohesive—which have a clay base that binds the soil together—and non-cohesive—usually gravel or sands with no binders holding the particles together.

Cohesive clays can be dry and stiff, requiring strong blows to force a pile to bearing strata. Or they can be soft, permitting penetration under little more than the weight of the hammer.

Gravels or coarse to fine sands with little or no clay binders are classed as non-cohesive soils. Double or differential-acting hammers or vibratory drivers work well in such soils. The vibratory drivers are especially efficient in highly water bearing soils. But in dense clays or boulders they may not penetrate at all. Some soils are mixtures of cohesive and non-cohesive soils. The varying densities and water content of these soils make it difficult to apply any hard and fast rules regarding hammer selection and application.

Knowledge of the characteristics and composition of the soil may be obtained through various methods. Consistency of cohesive deposits or the relative density of non-cohesive deposits can be determined and further classified by the results of a penetrometer test. This test, which involves no drilling for samples, utilizes a device that is pushed or driven into the ground to measure the soil's resistance to penetration.

The most common and widely used test for indication of the consistency or relative density of most soils is the Standard Penetration Test (SPT). The

TABLE--1

SANDS (NON-COHESIVE SOILS)		CLAYS (COHESIVE SOILS)	
NO. OF BLOWS PER FT.	RELATIVE DENSITY	NO. OF BLOWS PER FT.	CONSISTENCY
0-4	VERY LOOSE	BELOW 2	VERY SOFT
4-10	LOOSE	2-4	SOFT
10-30	MEDIUM	4-8	MEDIUM
30-50	DENSE	8-15	STIFF
OVER 50	VERY DENSE	15-30	VERY STIFF
		OVER 30	HARD

test consists of driving a 2 in. O.D. split spoon to a distance of 18 in. into the soil below the bottom of the casing or drill rods of a cleaned borehole by the blows from a 140 lb. hammer free falling 30 in.

The number of blows for each 6 in. of the total 18 in. is recorded. The first 6 in. of soil below the bottom of the casing are considered to be disturbed, and the hammer blows corresponding to that penetration are ignored. The number of blows for the second and third 6 in. of penetration are then added to give the SPT value "n" in blows per foot. In addition to the measure of penetration resistance the SPT provides a soil sample which can be visually examined and classified.

SANDS (NON--COHESIVE SOILS) TABLE--2

	WOOD	PIPE OPEN	PIPE CLOSED	H-BEAM	SHEET PILE	CONCRETE
VERY LOOSE	DA	V (NB) DA	V (NB) DA	V (NB) DA	V DA	DA
LOOSE	DA	V (NB) DA	DA	V (NB) DA	V DA	DA
MEDIUM	SA	V (NB) DA	DA	V (NB) DA	V DA	SA
DENSE	SA	V (NB) DA	SA	V (NB) DA	V DA	SA
VERY DENSE	SA	SA	SA	SA	V DA	SA

DA---DOUBLE-ACTING (DIESEL OR AIR/STEAM)
SA---SINGLE-ACTING (DIESEL OR AIR/STEAM)
V ---VIBRATORY DRIVER
NB---NO BEARING FORMULA REQUIRED

highly refined and completely reliable, its values do give a u[illegible] indication of the consistency or relative density of most soil deposits wh[illegible]contributes to the final selection of the pile hammer as well as other aspec[illegible] a pile driving project.

CLAYS (COHESIVE SOILS) TABLE--3

	WOOD	PIPE OPEN	PIPE CLOSED	H-BEAMS	SHEET PILE	CONCRET
VERY SOFT	DA	V (NB) DA	DA	V (NB) DA	V	DA
MEDIUM	DA	V (NB) DA	SA	V (NB) DA	V DA	SA
STIFF	SA	DA	SA	DA	DA	SA
VERY STIFF	SA	SA	SA	SA	SA	SA
HARD	SA	SA	SA	SA	SA	SA

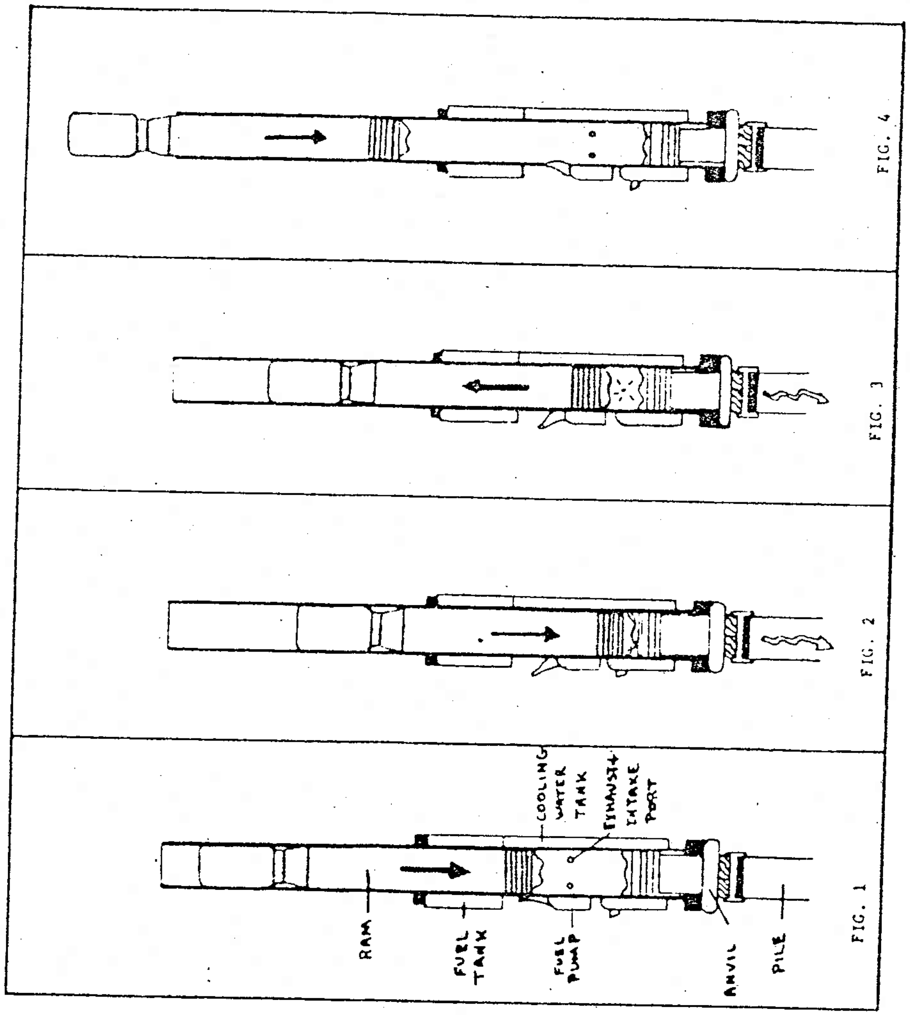
DA---DOUBLE-ACTING (DIESEL OR AIR/STEAM)
SA---SINGLE-ACTING (DIESEL OR AIR/STEAM)
V ---VIBRATORY DRIVER
NB---NO BEARING FORMULA REQUIRED

*Charts 1-3 are for quick reference as a general guide in selecting a hammer. A readily apparent, soil on a specific job will rarely be homogeneous; therefor applying the charts to a particular job, the contractor must decide which typ soil makes up the majority of the driving conditions.

Pile Evaluation

The type of pile to be driven is another major consideration in the choice of a pile hammer. Although the contractor is not often the deciding authority on the type of pile to be installed, for him to select a pile hammer to drive the piling, he must evaluae the piles from various standpoints: What are their functions? Are they steel, wood, concrete or a combination thereof? Are they displacement type or non-displacement type piles? Vertical or batter piles? What is their total length and weight and probably most important, what is their required penetration and/or designed capacity? A contractor must give almost equal consideration to the type of pile to be driven as he does to the soil conditions in which they are to be driven.

There are other requirements that must be given consideration in the hammer selection process: Noise and Air Pollution are two which are becoming increasingly important. Speed of installation in critical areas of the project. Size of available cranes which would be handling the pile driving; overall site conditions are others. Even availability of equipment is a criterion. Not all piling contractors own hammers of varying types and ratings; the availability of pile hammers locally on a rental or lease basis could be a determining factor in which hammer is chosen. There will be more about rental later.



OPERATION OF SINGLE ACTING DIESEL HAMMER

Pile Hammers

There are basically six types of pile hammers available and in use today. Pile hammers are generally classified by type, size, energy rating, speed, weight, and source of power.

In the broadest terms, the classification of hammers by type refers to either impact type or vibratory type. Impact type hammers are further classified into drop hammers, air/steam hammers and diesel hammers. Air/steam hammers may be of the single-acting, double-acting and differential-acting type, while diesel hammers are either single-acting or double-acting type. Vibratory type hammers are also further classified into high frequency, medium frequency and low frequency type hammers.

The energy of an impact pile hammer is the weight of the ram times its height of free fall. This may be increased by added acceleration in some hammers. Energy is commonly rated in foot-pounds per blow. Efficiency may vary but manufacturer's ratings are based on full length of drop. For vibratory drivers, either eccentric moment (in.-lb) or dynamic force (pounds or tons) may be used. Soon there will be the further confusion of SI (metric) units.

Speed for impact hammers is the number of blows per minute. Speed of vibratory type hammers is the frequency or the number of vibrations per minute (VPM) which is one complete rotation of the eccentric weights causing one complete up and down movement of the pile. The classifying of pile hammers by their source of power is self-explanatory.

Drop Hammer: The oldest and simplest type of pile hammer is the drop hammer. The drop hammer consists of a heavy solid metal casing (RAM) which is operated between guides. It is lifted by means of a cable operated by a winch to a desired height above the pile and released to fall freely, striking the head of the pile. The driving energy is computed by multiplying the weight of the ram by the height of the drop. The operation is comparatively slow and cumbersome and is seldom employed in modern heavy construction in this country; it is used much more in Europe. Drop hammers are available in weights from 1,000-6,000 lbs.

Single-Acting Air/Steam Hammer: The ram of a single-acting air or steam hammer is lifted by compressed air or steam acting against a piston which is attached to the ram and contained within a cylinder. When the piston reaches a pre-determined height the air or steam is exhausted and the ram falls of its own weight. The manufacturer's rated energy is based on the weight of the ram and the controlled length of the stroke.

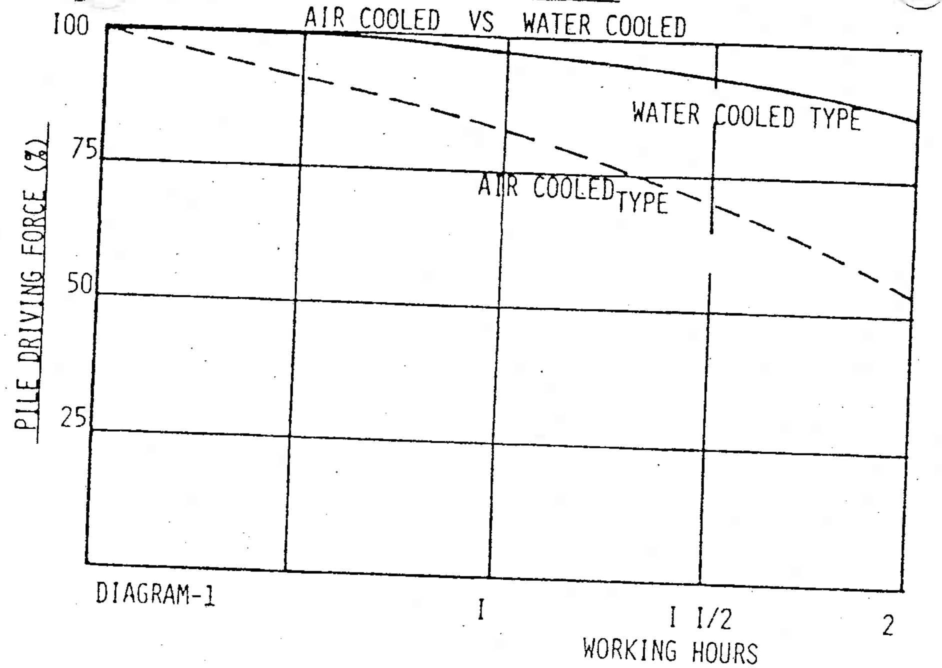
Single-acting hammers are available with energy ratings from 7,660 ft lb to 60,000 ft lb and up to 1,200,000 ft lb for offshore hammers. The speeds range from 35 to 60 blows per minute.

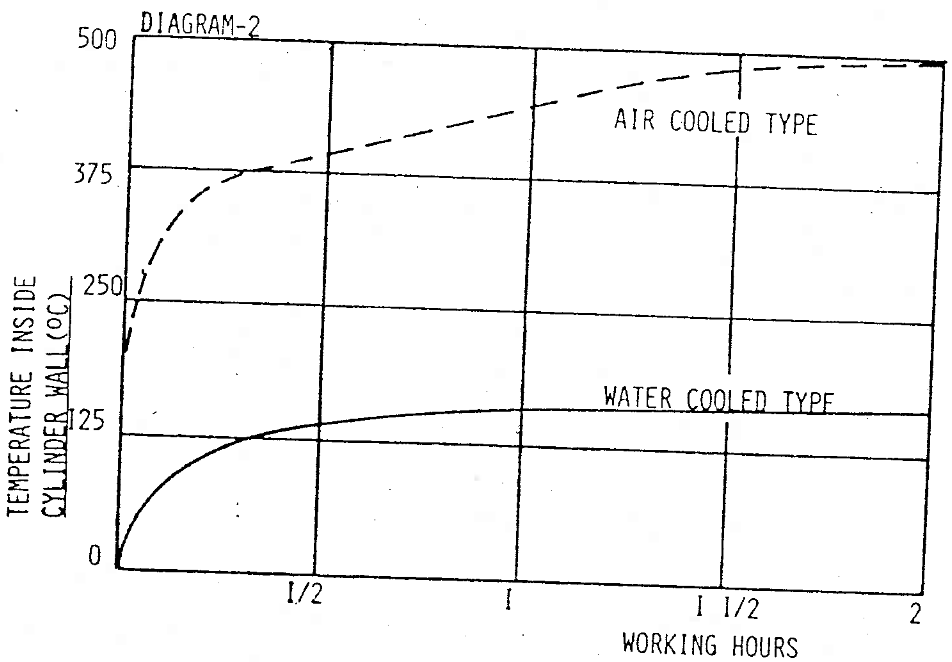
Single-acting hammers are advantageous when driving piles in true cohesive soils and mixtures of soils which are predominantly cohesive. Under these soil conditions the slower blows allow the soils and pile to relax before striking the next blow, thereby giving greater penetration per blow.

Double-Acting and Differential-Acting Air/Steam Hammers: These hammers differ from the single-acting in that compressed air or steam pressure not only lifts the ram but is also used to accelerate the downward movement of the ram as well. Not only are the foot/pounds of impact energy increased, but the downward acceleration increases the total number of blows per minute, i.e. nearly double that of single-acting hammers of comparable [illegible] Rated

COMPARATIVE TEST

AIR COOLED VS WATER COOLED





energy is derived from both the weight of the falling ram an[d the] compressed air or steam pushing it downward.

The significant difference between double-acting and differential-acting is the manner and sequence of exhausting on the upward and downward strokes of the cycle. In the differential-acting hammer there is no drop from the entering pressure to the main effective pressure moving the piston on the downward stroke.

Double-acting and differential-acting hammers normally give better results in granular non-cohesive soils or in soft clays. Used in proper soil conditions with the right pile, almost twice the production can be obtained as with a single-acting hammer.

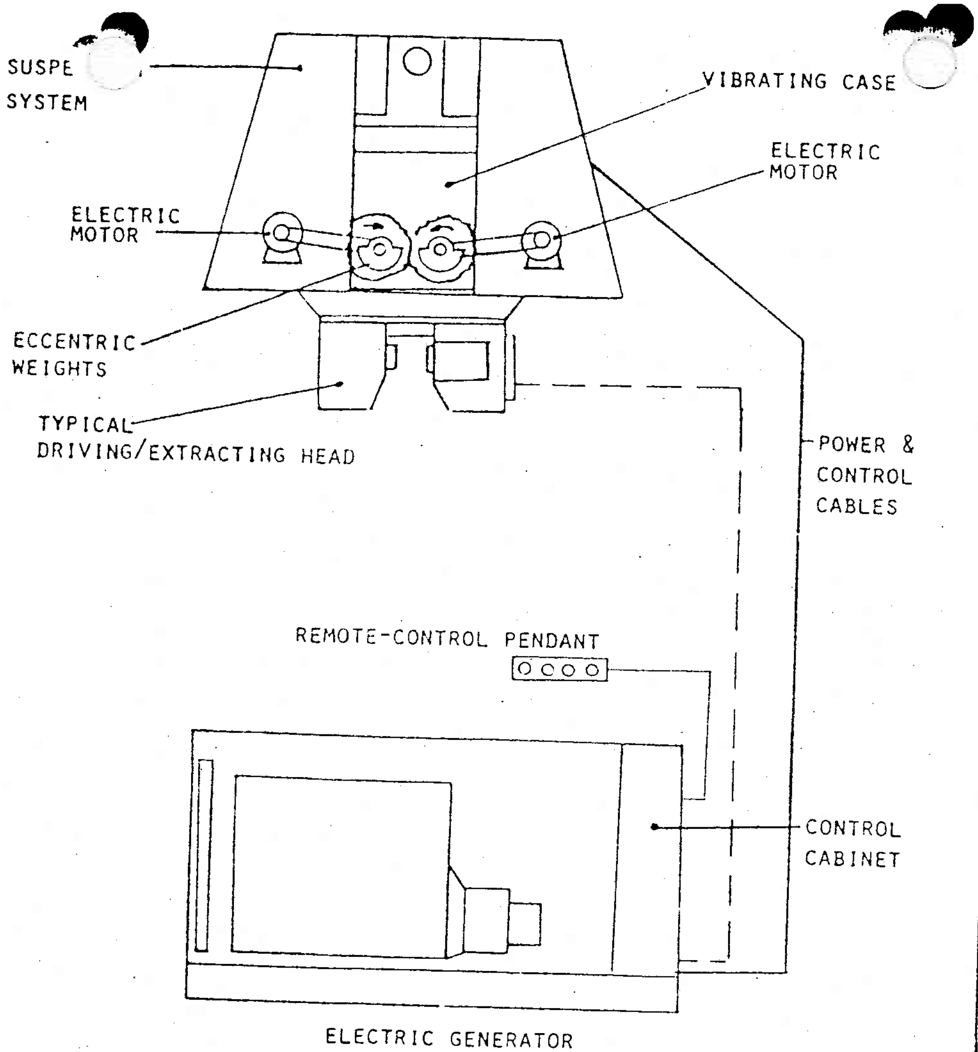
Single-Acting Diesel Hammers: The single-acting diesel pile hammer operates on the same working principle as a two cycle diesel engine. The ram, or piston as it is sometimes called, is lifted by a tripping device to a predetermined height and is automatically released. The ram falls under its own weight and actuates the cam of the fuel pump which injects a measured amount of fuel into a specially designed receptacle in the anvil. Continuing its downward fall, the ram closes the intake/exhaust ports and compresses the air in the cylinder ahead of the ram. The compression of the trapped air tightens the anvil and drive cap against the top of the pile in preparation for the impact blow. The compression also assists in starting the pile downward, Fig. 1.

The ram strikes the anvil and delivers its impact energy to the pile, driving the pile downward, Fig. 2. As the ram impacts the anvil, the fuel is simultaneously atomized into the annular combustion chamber around the ram and the anvil. The hot compressed air ignites the air-fuel mixture, and the resulting explosive force pushes the pile further into the soil and propels the ram upward. The expanding gas in the cylinder is discharged when the rising ram opens the intake/exhaust ports, Fig. 3.

As the ram rises above the intake/exhaust ports, fresh air is drawn into the cylinder due to the negative pressure which is created. The fuel pump cam returns to its original position in preparation for injection of fuel on the next stroke. The ram continues freely upward until arrested by gravity and then again begins its downward stroke for the next cycle, Fig. 4. The hammer is stopped by disengaging the fuel pump for a short period to shut off the flow of fuel.

Diesel pile hammers are cooled either by water or air. The cooling system of a diesel hammer deserves particular attention because of the close relationship it has with the overall performance and life of the hammer. A water-cooled hammer dissipates the heat generated by the combustion in the cylinder through evaporation of the water surrounding the cylinder in the water jacket.

The air-cooled hammer depends greatly upon the convection of the surrounding air and there is a stronger tendency for the cylinder to become overheated. An overheating condition may cause the lubricants to lose their viscosity or burn and the lubrication of the inside of the cylinder becomes unsatisfactory causing the compression rings to collapse. This results in loss of compression, a decrease in the generated blow and reduced striking force. Overheating also causes pre-ignition of the fuel prior to the impact blow of the ram, which cushions the impact blow and reduces the effectiveness of the downward push of the explosive force, thus adversely affecting the performance of the hammer. Diagrams 1-2 show the results of comparative test of air-cooled and water-cooled diesel pile hammers after two hours of continuous operation.



VIBRATORY DRIVER/EXTRACTOR SYSTEM

ELECTRICAL TYPE

FIGURE-5

the fall. Height of fall is the maximum allowable stroke stat[illegible] the manufacturer. Rated energy of single-acting diesel pile hammers ra[illegible] from 9,000 ft lb to 298,000 ft lb. They operate at 35 to 60 blows per mi[illegible]

Diesel hammers have certain advantages over air/steam hammers. They are operated without auxiliary equipment such as air compressors or boilers. The weight of a diesel pile hammer is generally about 1/2 to 1/3 the weight of an air/steam hammer having the same driving energy. Thus, smaller capacity cranes may be employed. The design of the diesel hammer provides a presetting of the anvil and drive cap against the top of the pile which minimizes damage to the pile head.

Diesel hammers operate best in medium to hard driving conditions on all types of piles. In soft ground conditions, the lower resistance does not force the ram to recoil sufficiently to permit the needed compression for ignition to occur.

Double-Acting Diesel Hammers: The double-acting diesel pile hammers or closed end as it is sometimes called, is similar to the single-acting diesel hammer in operation. The double-acting, however, employs a bounce chamber above the ram, and on the upstroke of the ram the air is compressed between the compression rings at the top of the ram and the enclosed top of the hammer. The compressed air limits the upward travel of the ram and then adds to the force of gravity to accelerate the ram downwards. It is this force of the rapid expansion of the compressed air on the ram, in addition to the force of gravity, that results in increased ram velocity and the increased number of blows per minute. The ram weight of a double-acting hammer is approximately twice that of a single-acting diesel hammer of similar energy rating, while the height of stroke is approximately half that of the single-acting hammer.

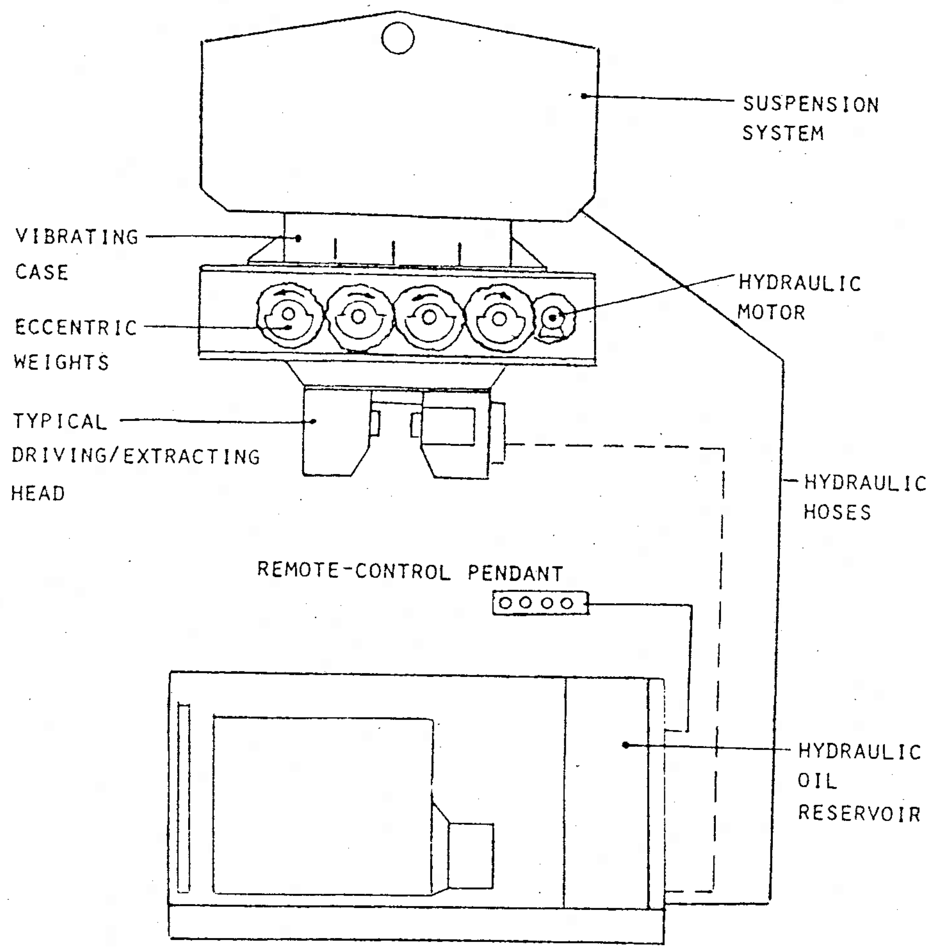
Rated energies of these hammers range from 8,000 to 80,000 ft lb and speed ranges from 80 to 100 blows per minute. Double-acting diesel hammers are most effective in non-cohesive and soft clay soils.

Vibratory Pile Driver: All of the previously discussed pile driving hammers have one common denominator; i.e., they pound the pile into the ground.

A little over a decade ago the vibratory type pile driver-extractor was introduced to the American pile driving industry. Instead of pounding the pile into the ground, the hammer installs them using vibration. Driving rates in non-cohesive soils on non-displacement type piles are up to eight times faster than impact type hammers. Pile damage is practically eliminated, since there is no impact.

Additional advantages of the vibratory type driver is that it does not require leaders or guides but some units can be mounted to operate on leaders if required. The vibratory driver operates much quieter than impact hammers and becomes an excellent extractor by applying substantial line pull or tension to the crane link. The vibration breaks the grip of the soil on the pile and the crane pulls the pile out.

The vibratory driver-extractor has three main components: a vibrating case which contains the rotating eccentric weights; a suspension system with vibration suppressors; and a driving or extracting head with a hydraulic clamp. Electric vibratory units have electric motors mounted within the suspension system, while hydraulic vibratory units have hydraulic drive motors mounted on the vibrating case. In both the electric and hydraulic type vibratory units the power source is external and separate from the vibratory driver with the power supplied to the motors by cables or hoses. Figs. 5 and 6 illustrate the



VIBRATORY DRIVER/EXTRACTOR SYSTEM

HYDRAULIC TYPE

FIGURE-6

typical electric and hydraulic vibratory ... components of each called out.

A simplified description of the working principle of a vibratory driver-extractor is that electric or hydraulic motors rotate the eccentric weights contained in the vibrating case at high speed. The eccentric weights, which are equal in weight, are rotated in opposite directions and only vertical vibration is created in the vibrating case. The vibration is transmitted undiminished to the pile through the hydraulic clamp of the driving or extracting head. The vibration of the pile breaks the grip of the soil on the sides of the pile and also permits the soil at the tip of the pile to be readily displaced during driving. The vibration also loosens the pile for extraction.

The vibrating case is isolated from the crane line by the suspension system containing the vibration suppressors, so only the minimum of vibration is transmitted to the crane boom in either the driving or extracting mode of operation.

The total effectiveness of a vibratory driver-extractor is dependent upon the balanced inter-relationship of the performance factors inherent to a vibratory unit. The inter-relationship of these factors may seem complicated, but it is quite similar to an impact type hammer where the ram weight, ram stroke, hammer speed and pile weight all affect the driving results. The performance factors common to a vibratory driver-extractor are amplitude eccentric moment, frequency, dynamic force, vibrating weight and non-vibrating weight.

Amplitude is the amount of vertical movement of the pile produced by the vibratory unit and is measured in inches. It is the direct result of the applied force generated by the rotating eccentric weights. Pile penetration rate is directly related to amplitude.

Eccentric Moment of a vibratory driver is the value, expressed in inch-pounds, equal to the weight of the eccentric multiplied by the distance from the center of rotation to the center of gravity of the eccentric times the total number of eccentrics the unit uses. The rotating eccentrics generate the vibratory force which creates amplitude of vibration of the pile. Therefore, increasing eccentric moment will increase amplitude.

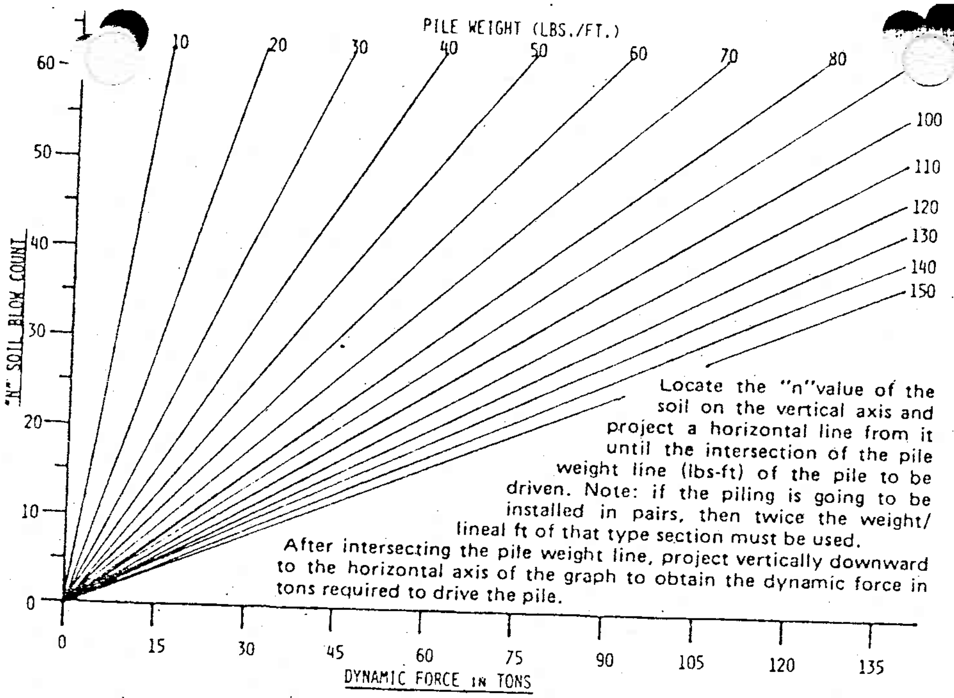
Frequency is the number of vertical movements or vibrations per minute. The vertical movement is created by the rotation of the eccentric weights. Each rotation of the eccentric weights causes one complete up and down movement of the pile. The number of vibrations per minute is the same as the revolutions per minute of the eccentric weights.

Dynamic Force, or centrifugal force as it is commonly referred to, is generated by the rotating of the eccentric weights. The calculation of this force, in tons, is:

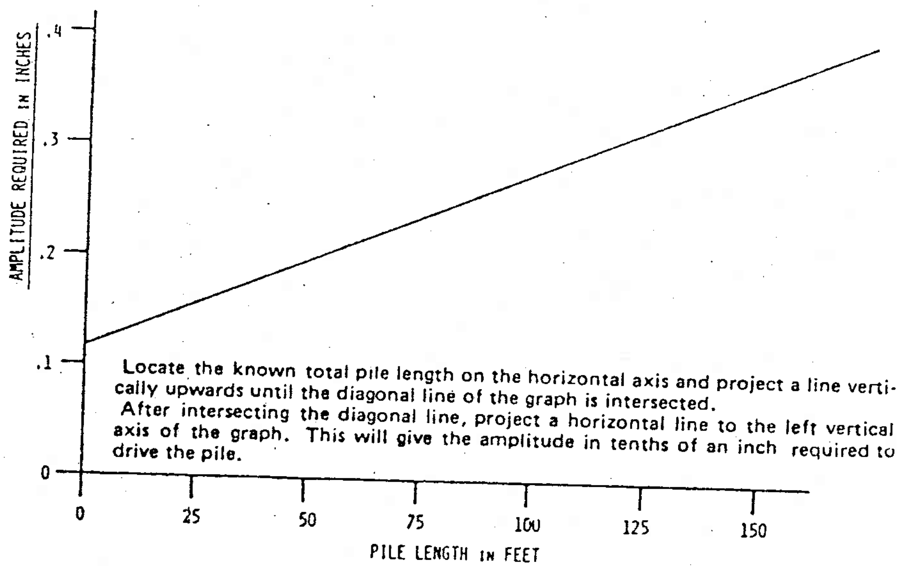
$$\text{Dynamic Force (Tons)} = \frac{\text{Frequency}^2 \times \text{Eccentric Moment}}{70.4 \times 10^6}$$

Comparing the dynamic force of different vibratory hammers is applicable only when the eccentric moments are equal.

Vibrating Weight is the weight put into vibration which includes the vibrating case, driving head and the pile itself. Non-vibrating weight is basically the suspension system. Non-vibrating weight pushes down on the pile and aids in driving. Some non-vibrating weight is helpful, but too much makes a bulky, difficult-to-handle unit.



GRAPH NO. 1
DETERMINATION OF REQUIRED DYNAMIC FORCE



GRAPH NO. 2
DETERMINATION OF REQUIRED AMPLITUDE

Vibratory driver-extractor hammers are classified into three types—high frequency, medium frequency and low frequency. High frequency drivers, also called "sonic" or "resonant" drivers, operate at a speed or frequency in the range of 3,500 to 10,000 vibrations per minute. They generate amplitude—the vertical movement of the pile tip—by actually expanding and contracting the pile. Maximum amplitude is achieved when the frequency of vibration approaches the resonant frequency of the pile material, hence, the name "resonant pile driver". High frequency vibratory drivers have had limited use and success. The large power requirements and high operating and maintenance costs have restricted their commercial success.

While high frequency drivers expand and contract the pile, medium, and low frequency drivers move the whole pile as a rigid unit. However, despite this similarity, medium and low frequency drivers do differ in basic design concept. Vibratory force on a pile can be created two ways, i.e., rotating light eccentric weights at high frequency or by rotating heavier eccentric weights at low frequency.

The low frequency driver has generally been the most successful. The frequency range of low frequency vibratory units, 400-1,500 vibrations per minute, covers the range of minimum frictional forces, medium frequency drivers, at 1,500-3,500 vibrations per minute, operate above the range of minimal frictional forces. Amplitude increases as frequency decreases because the pile can move down farther before the rotating eccentrics pull it back upwards. Therefore, low frequency units can be expected to give higher penetration rates since their amplitudes are higher.

Generally, vibratory drivers are most effective in non-cohesive soils and somewhat less effective in cohesive soils. In granular soils and sands, the vibration easily forces the pile downward. The effectiveness of a vibratory driver is greatly enhanced if the soil water content is high as the water acts as a lubricant on the pile. In cohesive soils or clays, the vibratory motion keeps the soil from developing much of a grip on the pile and the larger vibratory drivers are successful in forcing the pile tip to cut through.

The type of pile being driven also influences the effectiveness of a vibratory driver-extractor. Displacement type piles with large tip areas such as closed-end pipe, concrete or wood piles must move, or displace, the soil a relatively large distance to permit the pile's downward movement. Vibration may not be able to move the soil this far. However, with non-displacement type piles, such as sheet piling, H-sections, open-end pipe or caissons, the soil particles need to move only a short distance to allow the pile to pass.

There are no set rules to determine where or when a vibratory driver will be the most effective tool to use. They should definitely be considered for driving non-displacement piles in any soil and also, for any kind of extraction job. Although displacement piles have been and can be driven by vibratory drivers, these applications should be studied carefully.

However, when it has been decided that a vibratory driver is the best selection, it is possible to determine the size of the vibratory driver based on the dynamic force and amplitude by utilizing graphs 1 and 2, if the "n" value (blow count) for the soil is known at the desired depth, the total length of pile to be used and the weight of the pile per lineal foot. These charts are valid for non-cohesive soils where non-displacement type piles are to be installed.

When the required dynamic force and amplitude are known from the graph; a vibratory hammer can be selected that will produce these requirements. Most manufacturers and distributors make available the maximum dynamic force and amplitude of their various size vibratory hammers.

the o[illegible] difficult equipment acquisition choice. This decision sometimes mea[illegible] difference between job profit and loss.

Equipment Acquisition

A contractor is faced with many equipment acquisition choices. Cash purchases, various installment plans, rental plans, and a number of different leases and loans are available to contractors who want to acquire equipment. The question is: what financing alternative offers the most advantages for a certain piece of equipment on a particular project: The alternatives here must be considered as carefully as those project variables which led to the choice of equipment in the first place.

Basically, in total dollars spent, the least costly method of financing a piece of equipment is the cash purchase; the most expensive is renting. But, there are other costs to consider: costs imposed by missed tax deferrals, and costs of lost profits from work missed due to lack of funds or bonding capacity, and costs of lost dollar value because of inflation.

When a contractor weighs the alternatives, all costs must be figured in. A knowledge of the effects of each financing alternative on business ratios, bonding capacity, income tax, equipment salvage value kept or lost, and on future profitable projects is imperative.

In some instances, a future cash-flow analysis will show a cash purchase to be impossible. In other cases, business ratios and bonding needs necessitate leasing; in still others. paying more per month in rental fees could be the most profitable method of acquisition.

Let's discuss the advantages and disadvantages of buying, renting and leasing.

Cash Purchasing

The advantages of outright purchase of equipment are many. It allows contractors to do whatever they want with the equipment. It is not dependent on future income. It allows contractors to dispose of the equipment whenever they wish and earn profits from the transaction. Buying gives the contractor greater freedom of choice. It allows using the equipment as collateral for credit in future acquisitions. Lastly, the equipment's depreciation value, investment tax credit and repair allowance always belong to the contractor.

Major disadvantages in buying equipment are also numerous. Cash purchases freeze large amounts of capital that might earn more elsewhere. It hurts business ratios and bonding capacity. Due to prevailing tax laws, the tendency is to keep a piece of equipment longer than is economically feasible. In addition, obsolescence often cuts down a machine's competitive value. And, inflation causes the contractor to pay for the equipment in high-value dollars, while it depreciates and earns income with dollars of less value.

Renting Equipment

There has been a greater tendency during recent years for contractors to rent equipment. Renting is, in effect, instant equipment; the contractor gets what he needs, when and where he needs it quickly. And, rental firms are obliging by building up their heavy-duty inventories, offering more services than ever before and expanding their product lines.

Contractors are often not sure of what lies down the road, thus they dislike

have the money to buy. Others want to get out from und[illegible]ntenance costs, between-job moves, and insurance. Renting may be the [illegible]er.

Paying more per month for a rented machine could be mu[illegible]ore profitable than allowing it to sit rusting in the yard for half its useful life. Most contractors only own equipment they can keep working for at least 60 percent of its life. A popular rule of thumb most contractors follow is: rent equipment that will be used for less than one year.

Other advantages in renting are: it can improve business ratios because there is no major capital expenditure; all rental payments are tax deductible; modern, efficient and well-maintained equipment is always available; contractors can use specialized or high capacity equipment, and various models without accumulating a parts inventory; and renting eliminates or drastically reduces storage costs, repair costs, and administrative overhead.

In addition, inflation does not affect rental rates, cash flow can be planned more effectively through equipment rental, and rental allows contractors greater flexibility. Renting is also a hedge against losses on equipment obsolescence, and an aid in estimating and preparing bids.

Most renters calculate rates on a monthly basis. Weekly rates run about one-third of monthly rates, and daily rates one-third of weekly rates. Number of shifts the equipment will work, site conditions, and length of working season all affect rental rates.

Choosing the best rental firm is also an important consideration. The best organizations have the following qualifications:

Wide range of equipment – Experienced rental firms in the construction business have a tailor-made inventory to provide the types of equipment needed now.

Quick Delivery – If a good rental firm doesn't have what is needed, it knows where to get it. And, can get it fast.

Trained Personnel – A good rental company has management, salesmen, and yardmen who are familiar with the equipment. They can answer all your questions, which gives you help in choosing the right piece of equipment at the best price.

Complete Recordkeeping – Better agencies maintain an accurate history of each piece of equipment, including total rental time, uptime and various cost and maintenance figures.

Complete Service Department – When you rent a machine, it has to perform properly. If there is a breakdown, you want the repairs made as quickly as possible. Trained mechanics, a good parts inventory and emergency service all mean less downtime and better profits.

Pickup and Delivery – Good rental firms deliver to the jobsite and pick up the machine when you are done with it. This service is another time and money saver to you.

Modern Equipment – Top-notch rental firms dispose of old equipment through sale or auction, maintaining a line of modern, efficient equipment.

Contracts are Clear – A good rental contract spells out all terms in detail; repairs, maintenance, transportation, insurance and accidents are clarified before you sign.

A final note to renting is the rental-purchase option (RPO) plan. Many contractors favor this option because they can rent an unfamiliar machine and if it works well and they like it, most or all rental payments can be applied to the purchase price. Most rental firms subtract a finance charge from all payments and apply the rest to the purchase price; others apply all of the first month's payment and declining amounts of further rentals; and

Leasing provides the contractor with yet another alternate form of equipment acquisition. Many banks are willing to offer lease contracts. Distributors are well equipped to put together a lease package; many major finance companies are deeply into leasing construction equipment.

Advantages in leasing are: leasing allows the contractor to pay for equipment with tomorrow's more inflated dollars; leasing conserves capital when money is tight; leasing offers certain tax advantages (rentals paid on leased equipment may be fully deductible operating expenses); leasing allows greater control over a contractor's expenses; and leasing can help a contractor find a way around budget limitations.

Leasing offers the widest number of options available to contractors acquiring equipment. It also offers the widest range of costs. Two major disadvantages are: It usually prevents contractors from taking profits from equipment salvage value, and leasing is often more expensive than borrowing to purchase.

To conclude, realizing profits by selecting the right pile hammer is the result of two major decisions: choosing the right hammer for the job and deciding on the best method of equipment acquisition. There are no hard and fast rules in making either choice. Each situation calls for individual evaluation based on all the variables discussed. There is no one hammer that will "do it all" and no one method of equipment acquisition that will assure profitability.