CME Automatic Hammer Operations Bulletin

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Abstract

This report is a summary of experience with the Central Mine Equipment (CME) automatic hammer operation during performance in the Standard Penetration Test (SPT). The CME automatic hammer is run by a hydraulic chain-cam lifting system, and the drop height of the hammer depends on the speed of the chain cam. This report addresses energy transmission characteristics of the hammer system. Historical energy transmission data are reviewed. Manufacturer's operating instructions are reviewed. In a field study, the rate of the hammer was changed, and the drop height and energy measurements were taken. The data show that when the hammer is run at a slow rate of 30 blows per minute, energy loss was almost 15 percent. The data show that it is important to observe the hammer rate while testing and to operate the hammer at the design speed of 50 blows per minute.

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Purpose

This bulletin provides an update on the proper use of the Central Mine Equipment (CME) automatic Standard Penetration Test (SPT) hammer based on recent drop height and drill rod energy measurement studies. Recent observations of the testing by government crews and contract drilling has shown these hammers are not always operated correctly. The CME hammer system, when operated according to manufacturer's instructions, can result in N values up to a factor of 1.5 times lower than the SPT N values obtained by conventional rope and cat-head safety hammer systems. The hammer is rate dependent and can deliver drill rod energy ratios varying from 60 to 90 percent. This guide will show engineers how to evaluate the hammer performance and how the operation can be adjusted. The information in this bulletin can be used to estimate SPT drill rod energy for this hammer system based on hammer rate and drop height observations.

Background

The Central Mine Equipment Company has been selling an automatic hammer for over 15 years. Figure 1 shows the exterior of the hammer system. This hammer uses a cylindrical hammer of lead encased in steel enclosed in a guide tube. The hammer is lifted by a chain cam mechanism. On the chain is a finger cam which picks up the hammer. The cam carries the hammer upward and, at the end of its travel, the hammer is "flung" farther into the air. The distance the hammer is flung, in excess of the top of the chain travel, is a function of the speed of the chain. *Therefore, the drop height of the hammer is a function of the speed of the chain.*

In an important paper on the influence of SPT procedures in liquefaction analysis, Seed et al. [1][1] recommended 30 to 40 blows per minute (bpm). In addition, the recently released American Society for Testing and Materials (ASTM) Practice D 6066-97 for determining normalized penetration resistance in sands recommends 20 to 40 bpm [2]. Consequently, there have been numerous occurrences where a slower hammer rate has been used. However, the rate required to develop a 30-inch drop using the CME hammer equipped with a standard anvil is 50 to 55 bpm.

It should be stated clearly here that a blow count rate of 50 to 55 bpm is acceptable for most geotechnical explorations, and the reduced rate is considered to be an issue only with liquefaction investigations of sands. There have been numerous occurrences where the hammer has not been operated according to instructions, and the rate has been slower. Because of these slower rates, there have been questions regarding the energy transfer and effect on SPT blow counts.

Recently, the Los Angeles District Army Corps of Engineers evaluated the effect of blow count rate on the efficiency of the CME hammer used in their investigations of Whittier Narrows Dam. This report will summarize the results of this rate study and make recommendations on energy delivered under these variable rate conditions.

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[1] Numbers in brackets refer to entries in the bibliography.

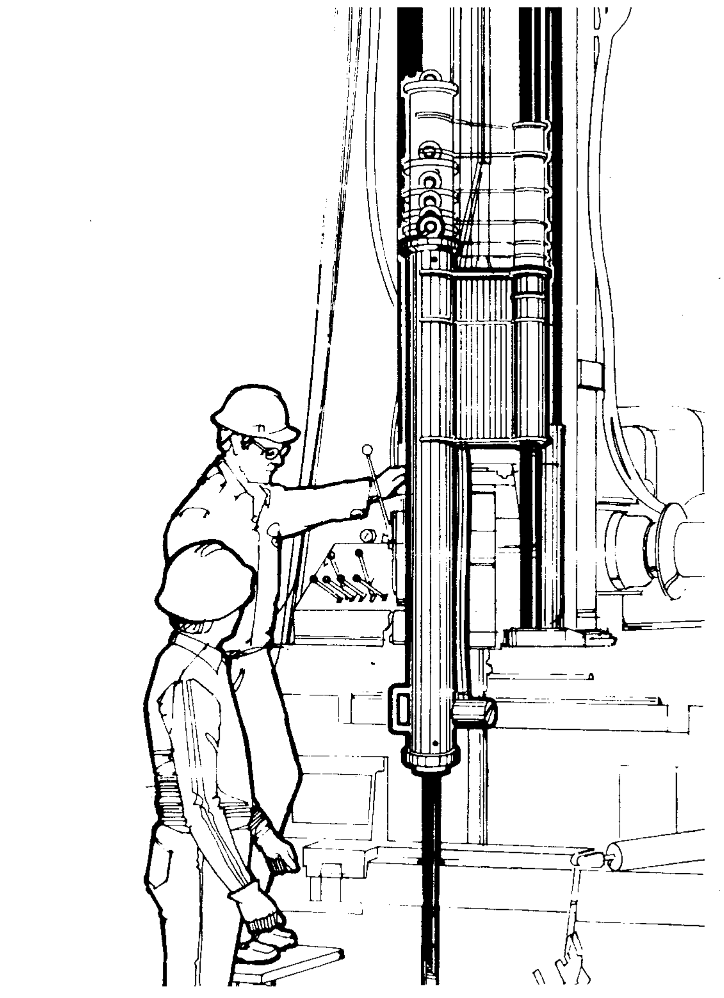

Figure 1.—CME automatic hammer system.

There have been numerous SPT energy transfer measurements on the CME automatic hammer. A compilation of energy measurement data from our files is shown in table 1 [3-10]. Energy measurements performed prior to 1990 were performed in accordance with ASTM standard D 4633 [11]. This method consists of measuring the force-time history of the first compression pulse in the rods and integration of the square of the force. This method will be denoted as EF2. The EF2 measurement provides the drill rod energy ratio (ER_i) by using a force transducer housed in the drill rods below the impact anvil. Early work by Schmertmann and continued measurements have shown that the penetration resistance "N" is inversely proportional to ER_i.

Table 1.—Summary of SPT energy measurements on the CME automatic hammer

Reporter	Drill rig	Average Er_i -% EF2 method	Average Er_i -% EFV method	Standard deviation - range[1] (%)	Rate (bpm)	Comments
Schmertmann and Smith (1977) [3]		90				
Riggs (1982) [4]	CME 750	83		2-0.9		Demonstration on USBR CME 750 drill. Rate not measured.
Riggs, et al. (1983) [5]		>100				Considered unreliable due to reflected compressive wave integration.
Riggs, et al. (1984) [6]		88-91		1.1-1.3		Single hammer system, in 14 drill holes.
Kovacs (1984) [7]	CME 750	92 87[1]		4-0.8	55-57	USBR 750 drill at Jackson Lake.[1] Reduced energy when hammer has noticeable tilt - off vertical.
Farrar (1990) [8]	CME 750, 55	95		1-2		Three drills, 21 series of tests, data possibly high due to piezoelectric load cell.
Goble (1990)		86	86			USBR/CDOT study.
Farrar (1991)	CME 75	92-97		1-2	[1]35-40	Four series of tests on one rig, Mormon Island, known rod area,[1] rate was 35-40 bpm with spacer ring used on the anvil.
GRL, ASCE Seattle (1994) [9]	CME 75	81	81	6-7	51	Seattle ASCE Demonstration Project.
GRL, ASCE Seattle (1994) [9]		74	73	6	58	59 blows of data, ram efficiency is low, possibly problem with the guide tube.

Table 1.—Summary of SPT energy measurements on the CME automatic hammer (continued)

Reporter	Drill rig	Average Eri -% EF2 method	Average Eri -% EFV method	Standard deviation - range[1] %	Rate blows per minute	Comments
GRL, ASCE Seattle (1994) [9]		74	73	6	58	59 blows of data, ram efficiency is low, possibly problem with the guide tube.
GRL, Oregon DOT (1995) [9]	CME 750	95	82	3 EFV 19 EF2	49	Rig 86-991, 11 series.
GRL, Oregon DOT (1995) [9]	CME 750	93	78	3 EFV 7 EF2	54	Rig 90-893, 10 series.
GRL, Oregon DOT (1995) [9]	CME 750	118	78	5 EFV 5 EF2	56	Rig 93-99, 7 series, high EF2 values not explained.
GRL, Oregon DOT (1995) [9]	CME 850	102	82	5 EFV 11 EF2	56	Rig - CME lease, high EF2 values not explained.
Lamb (1997) [9]			86-66		55->58	Three drills tested.
GRL, Wyoming DOT (1998)		75	81		59	Rig 821, 95 percent velocity efficiency.
GRL, Wyoming DOT (1998)		76	81		58	Rig 823, 96 percent velocity efficiency.
GRL, Wyoming DOT (1998)		76	78		52	Rig 4001, 95 percent velocity efficiency.
GRL, Los Angeles USACE, (1998) [16]		75	81	2.1 EFV 2.5 EF2	50-55	This report, averaged values from 7 series of measurements in table 2, with rate between 50 and 55 bpm.

[1] The values of standard deviation in this column are ranges between different trials or series of tests.

The energy transfer of SPT hammers is especially important in liquefaction evaluation of soils. In 1997, the ASTM developed a practice for determination of normalized penetration resistance of sands [2]. In this practice, the effects of hammer systems are discussed. Automatic hammers are very desirable from the standpoint of energy transfer reproducibility. The practice states that for hammers used in these investigations, energy can be measured during the investigation, or an assumed value can be used if there is reliable data from others and the hammer is operated correctly.

Proper Hammer Operation

The CME factory operating instructions and instructions for adjusting the hammer speed are given in the appendix. CME has designed the automatic hammer with a viewing slot so that the drop height of the hammer can be easily checked. The CME automatic hammer is designed to operate at a speed of 50 to 55 bpm. The chain-cam motor is hydraulic, and there are flow control settings to adjust the blow count rate. All drills are adjusted at the factory to provide the recommended rate. However, with time, these settings may change and should be checked.

The rate of the hammer depends on the engine revolutions per minute (rpm). This is because the chain cam system is driven by a hydraulic motor. The power of the motor depends on the hydraulic fluid pressure in the drill system, and the hydraulic supply pressure varies with engine rpm. The hammer will not operate correctly at idle speed. Typically, the hammer is adjusted to operate at a set throttle detent speed of 1,500 to 2,000 rpm, or full throttle.

The flow control setting is accomplished according to the instructions in the appendix. The viewing slot allows for observation of the drop height. The hammer is equipped with an anvil that projects into the guide tube 11.75 inches. The viewing slot is about 39 to 43 inches above the base of the guide tube (refer to figure 1 in the appendix). When the hammer is operated at about 50 to 55 bpm, the base of the hammer will be visible at a height of 41½ inches above the base of the guide tube. If hammer rates are set too high, the falling hammer will impact the returning cam prior to anvil impact and may damage the equipment. This occurs when the rate is set near or above 60 bpm.

Therefore, *the easy way to check for proper operation is to look at the viewing slot and count the blow count rate during testing*. The base of the hammer should be about 41½ inches above the base of the guide tube.

It is important that the drill operator understand what throttle speed is to be used during testing. Field observations have shown that when the hammer is operated at idle speed or at a speed slower than that for proper flow control, the drop height is significantly reduced. Therefore, *during testing, if the operator fails to engage throttle detent speed, the SPT test will be invalid unless the rate is recorded*.

Operation at slower speeds.—ASTM procedures for testing of liquefaction state that the rate of blows should range from 20-40 bpm [2]. If it is desired to operate the hammer at 40 bpm, the energy will be reduced. Another approach is to add a spacer ring to the anvil. Based on the properties of this hammer system, the spacer ring will allow for a 30-inch hammer drop. Based on theoretical calculations, the height of the spacer ring should be about 3 inches at 40 bpm. Our study, to follow, shows that at 40 bpm, the ring may need to be only 2 inches. When a spacer ring is to be used, the viewing slot must be cut and lowered 3 inches so that the hammer can be observed, assuring proper operation.

The effect of blow count rate on SPT liquefaction data in sands is not known. In a clean sand of high permeability, there could be almost no difference between the N value for a hammer of 30-inch drop performed at 50 and 20 bpm. The rate effect is more likely a problem for dirty sands. In our data to follow, the rate effect on the drop height is significant when a spacer ring is not used to maintain the 30-inch drop height.

Maintenance.—As with any hammer system, the hammer should be maintained to ensure that it operates correctly. The guide sleeve and chain should be cleaned and lubricated periodically to ensure that the hammer is dropping freely. You can measure the hammer efficiency by measuring the velocity at impact with radar or a displacement transducer. Our measurements indicate that the hammer drops at 95 to 97 percent efficiency in a clean guide tube. In some cases, where we have measured low drill rod energy, the hammer velocity is slower than normal, pointing to a situation such as a rusted or dirty guide tube interior.

Other Operation Considerations

The hammer assembly weighs about 230 lbs. This assembly weight is significantly greater than rope and cathead operated hammers which weigh from 75 to 100 lbs [10]. When testing very soft soils, the hammer assembly may sink under the weight of the assembly. The SPT data in soft, fine-grained soils may differ significantly between the automatic and rope-cathead hammers, so it is important to report the assembly mass on the drill log [12]. The hydraulic cylinder that controls vertical movement of the assembly is a one-way piston, made only to lift the assembly. If the assembly sinks quickly, the A valve may be used to catch the hammer (see appendix).

In hard driving conditions, the assembly may cause secondary impacts to the anvil shoulder. In these conditions, valve C (hammer restricted fall) should be used.

Summary of Energy Measurements

In the mid 1980s, after collection of EF2 drill rod energy data in the U.S. and other countries, H. Bolton Seed et al. recommended that SPT N values be corrected to N_{60} for liquefaction analysis [1]. The correction takes the form of:

$$N_{60} = N_m * (ER_i / 60) \qquad \textbf{EQN (1)}$$

Where:

N_m = measured N value
ER_i = drill rod energy ratio, expressed as a percent, of maximum theoretical energy for the system used

The EF2 data form the basis of the 60 percent recommendation. Seed assumed that safety hammers deliver ER_i of 60 percent. Table 1 shows the EF2 data that were collected prior to 1992. In this table, EF2 ER_i, ranges from 83 percent to over 100 percent, and the data that are considered reliable generally average around 85 to 95 percent.

In the 1990s, accelerometers began to find use in SPT energy measurement, and a new method called the EFV method was developed. Table 1 summarizes EF2 and EFV data that have been collected since 1992. The first EFV data were collected by Goble in 1989. Virtually all the new EFV data for the CME automatic hammer have been collected using equipment provided by Goble, Rausche, Likins and Associates, Inc. (GRL). This company has adapted their pile driving analysis equipment for SPT energy measurements.

Review of the new GRL data in table 1 indicates the new EFV data for the CME hammer range from 74 to 86 percent. EFV data, where the hammer is operated at a correct rate, generally range from 80 to 85 percent. There is also an appreciable difference between EF2 and EFV data. In some cases, EFV data are higher than EF2 data, while in other cases, EFV is lower than EF2. There is a very wide variability in the reported EF2 data. The reasons for the variability are not well explained [9, 13]. Due to limited funding, GRL measurements have not been well documented. That is, they have been on a project to project basis. GRL does not adjust EF2 data for short rod lengths, and this could explain some of the lower EF2 data. GRL believes that, due to reflections in the stress waves near the transducers, EF2 data are not always reliable. Also, they believe that older, pre-1990 EF2 data could be biased toward the high side (90-95 percent) because of errors with piezoelectric load cells. It is well accepted that EFV measurements, if collected correctly, are more fundamentally correct than EF2 measurements because true, one-dimensional wave equation conditions are not met in SPT drill rod.

Measuring ER_i is more difficult with the CME automatic hammer than with most hammers. This is because the hammer anvil aspect ratio is such that a very fast rise and fall time and a very large, sharp peak in force and velocity can develop in the drill rods [8]. This rapidly peaking large force results in very severe loading conditions for both accelerometers and strain transducers. Additional studies are planned to try to explain the lower energy levels being measured with GRL equipment.

An engineer who must decide on how to apply this energy data has some difficult decisions to make. EF2 data were originally reported as high as 90 percent. According to equation (1) above, CME automatic hammer N values would be lower than rope and cathead safety hammer data by a factor of 90/60 = 1.5 using EF2 data. Using new EFV data, a correction of 80/60 = 1.3 would be applied.

Reclamation had the opportunity to test the difference in hammer systems at Jackson Lake Dam. Dynamic compaction ground improvement was performed in two phases. SPT drilling of the first phase was with a rope and cathead safety hammer, while in the second phase, CME automatic hammers were used. Over 4,000 SPT N values were analyzed [14]. The results indicate that N values from the CME automatic hammers differed by a factor of approximately 1.8. The factor was surprisingly constant through a wide range of soil types, from gravel to clay. This larger factor could also be attributed to other effects, such as drilling method and systematic disturbance, amount of gravels, prestress effects, etc. But the data show there is a significant difference in SPT N values between the automatic hammer and safety hammer. Physical comparison data published in many sources also show much larger differences in N values collected with automatic and safety hammers than those predicted by EFV energy measurements [12]. The differences are much larger than could be explained by a 20 percent energy difference (i.e., a factor of 80/60 = 1.3) implied by the GRL data.

Even with the larger differences shown in some of the field data, the engineer who is using the new EFV data will likely err toward conservatism and would likely apply the factor of 1.3. This low correction factor gives little incentive to using automatic hammers on a project if low conservative N values requiring costly ground modifications would result.

Even though GRL data appear to be erratic and possibly lower than the older EF2 data, GRL is the only active SPT energy measurement contractor in the U.S. The Army Corps of Engineers had questions regarding past drilling at Whittier Narrows Dam. We decided we would use the GRL equipment to study the rate effects of the CME automatic hammer.

Rate Effect Study

The Los Angeles District of the Army Corps of Engineers had questions regarding CME hammer operations during their liquefaction investigation at Whittier Narrows Dam. The CME automatic hammer was used exclusively, and in most of the investigation, the same hammer and operator were used. Drop height and rate effect studies where performed to evaluate the CME hammer.

In a series of field studies on a CME 75HT drill, the rate of the hammer was varied, and the drop height was measured through the viewing window. Drop height was also monitored on the second hammer in a second round of drilling. The results of this study are summarized in figure 2. When the hammer rate was slowed to about 40 bpm, the drop height was reduced to 28 inches. This reduction in drop height equates to a theoretical reduction in input energy of 7 percent.

Next, a field study and energy measurements were performed by GRL [15]. Measurements were performed in three drill holes. The results of this study are shown in table 2 and figure 3. Test depths ranged from 4.5 to 35.5 feet. GRL reports EF2 data without correction for short rod length. In order to compare EFV data, which are equivalent to a nominal hammer energy, it is necessary to correct the EF2 data by the K2 factor described in the old ASTM D 4633 standard. This is because the hammer input energy is prematurely terminated by the reflected tensile wave in short drill rods. This effect can easily be seen in table 2 in the column "Average EF2." The shorter the rod length, the lower the value of EF2. Once rod length is about 40 feet, the full energy content can be delivered.

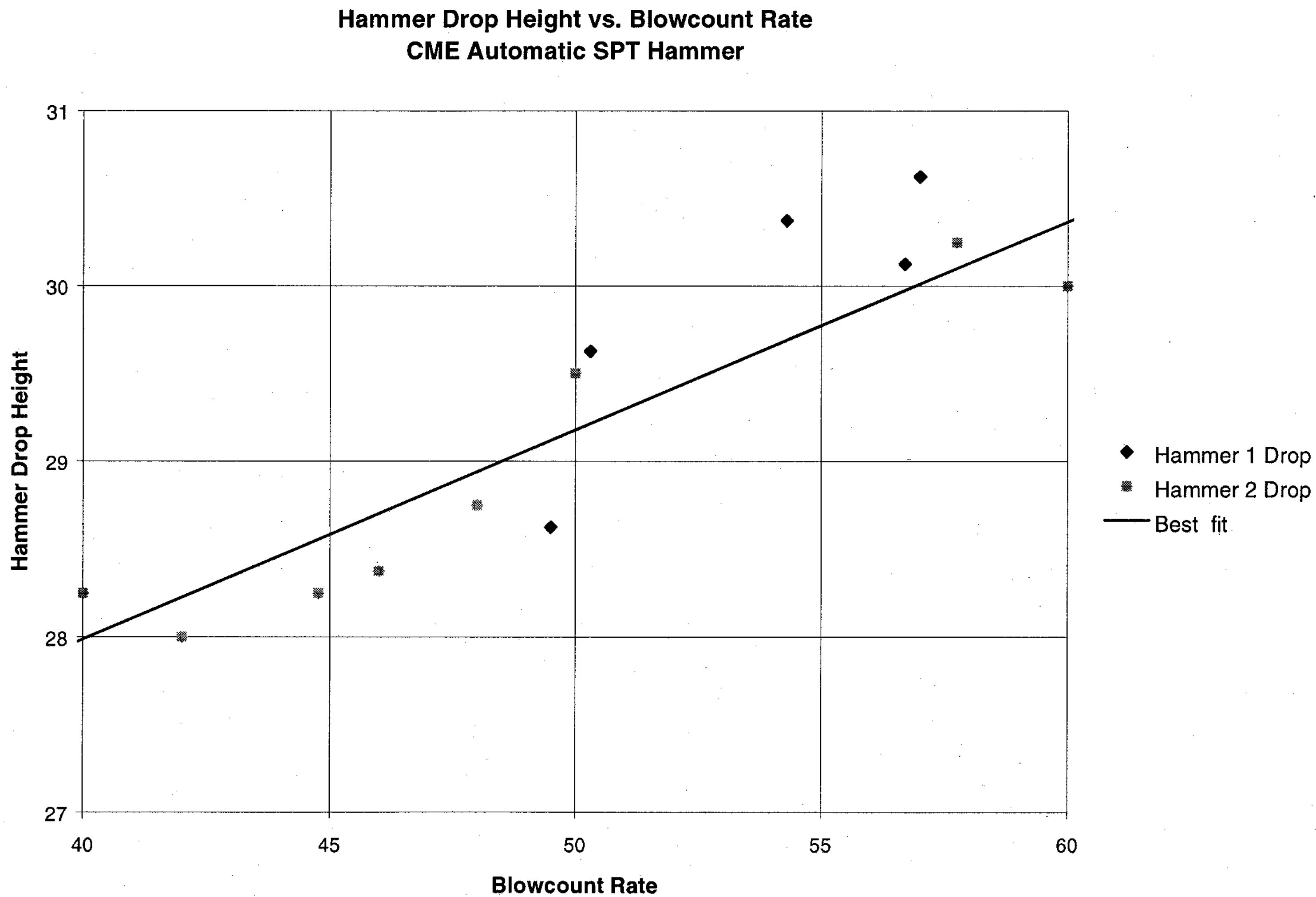

Figure 2.—Summary of CME hammer drop height and rate measurements (Whittier Narrows Dam investigation).

To correct for short rod length, we first estimated the rod length during the test (table 2). Then, we calculated the estimated wave travel time:

wave travel time, $t = 2l'/c$

Where:

l' = length of rods, distance from transducer to bottom of rods
c = stress wave velocity in steel, 16,800 ft/sec

For our new standard in ASTM, the short rod factor is now called the K1 factor, and we have developed tables of K1 for different rod sizes/lengths. The K1 factor for AW rods used in this study is shown in table 2. We took the average EF2 energy and multiplied it by the K1 factor to get a nominal energy.

Table 2 and figure 3 summarize the results of the rate study. Rates from 30 to 58 bpm were measured. When the rate of the hammer is slowed to around 30 bpm, drill rod energy drops 10 to 15 percent. These data agree fairly well with the drop height data summarized in figure 1. The drop height study indicates that a reduction to 40 bpm resulted in a drop height of 28 inches, equivalent to about 7 percent energy. Assuming a linear relationship, further reduction to 30 bpm results in an energy loss of 14 percent, which would equate to a drop height reduction to 26 inches. A drop height of 26 inches may well be the minimum with this hammer system and may reflect the distance between the chain cam sprockets.

Using figure 3 and the drop height data, one could estimate the energy delivery of the CME hammer if the blow count rate is recorded.

For the nominal energy of the Los Angeles study, which is summarized in the last row of table 1, we averaged seven series of data at rates ranging from 50-57 bpm. EFV ER_i averaged 81 percent while K2 corrected EF2 ER_i averaged 75 percent. The difference in EF2 and EFV data again has not been explained. It is not known why, in this case, the EF2 data are lower than EFV data. Additional controlled research is needed to explain these differences.

The assumed drill rod energy for the CME hammer, when operated at 50 to 55 bpm, should be on the order of ER_i = 85 to 95 percent based on most of the measurements made to date. The value used in design depends on the analysis being performed. For the Whittier study, EF2 data were even lower, at 75 percent.

Conclusions

In this report, energy measurements for the CME automatic hammer are reviewed. Operational guidelines of the CME automatic hammer are given to avoid operation at incorrect speeds. Finally, the effects of slowing the blow rate are measured. The following conclusions can be drawn from this study:

Table 2.—Summary of rate measurements of CME automatic hammer - Whittier Narrows Investigation

Drill hole No.	Test depth (ft)	SPT N value (bpf)	Blow count rate (bpm)	Average EFV (%)	Max EFV (%)	Min EFV (%)	Average EF2 (%)	Assumed rod length (ft)	Wave travel time (msec)	K1 factor	Average EF2 K1 corrected (%)	Max EF2 (%)	Min EF2 (%)
WD-14.1	5.5	12	29.7	64	67	61	0	12	1.43	1.35	0	0	0
WD-14.1	10.5	18	31.2	66	68	65	57	17	2.02	1.17	67	58	56
WD-14.1	15.5	14	30.9	71	72	70	58	22	2.62	1.09	63	59	57
WD-14.1	20.5	23	32.1	71	73	69	63	27	3.21	1.05	66	64	62
WD-14.1	25.5	12	31.1	70	71	69	64	32	3.81	1.03	66	65	64
WD-14.1	30.5	7	30.2	70	71	70	68	37	4.40	1.03	70	68	67
WD-14.1	35.5	27	32	72	73	72	68	42	5.00	1.02	69	69	68
WD-13.1	5.5	17	33.5	73	75	71	47	12	1.43	1.35	63	47	46
WD-13.1	10.5	8	32.5	67	67	66	58	17	2.02	1.17	68	59	57
WD-13.1	15.5	23	36.3	74	75	72	63	22	2.62	1.09	69	64	62
WD-13.1	20.5	36	38.6	75	77	72	69	27	3.21	1.05	72	70	66
WD-13.1	25.5	29	41.8	78	82	75	67	32	3.81	1.03	69	69	66
WD-13.1	30.5	12	40.7	75	86	71	66	37	4.40	1.02	67	66	65
WD-13.1	35.5	33	40.7	76	88	61	73	42	5.00	1	73	74	70
WD-12.1	5.5	8	57	84	87	81	55	12	1.43	1.35	74	55	54
WD-12.1	10.5	6	57.4	73	81	66	66	17	2.02	1.17	77	67	65
WD-12.1	15.5	10	56.4	81	90	55	67	22	2.62	1.09	73	68	67
WD-12.1	20.5	25	56.4	82	90	75	73	27	3.21	1.05	77	75	72
WD-12.1	25.5	27	52.9	85	92	77	71	32	3.81	1.03	73	73	70
WD-12.1	30.5	48	50.2	78	85	68	71	37	4.40	1.02	72	73	69
WD-12.1	35.5	63	56.5	81	93	73	77	42	5.00	1	77	80	75

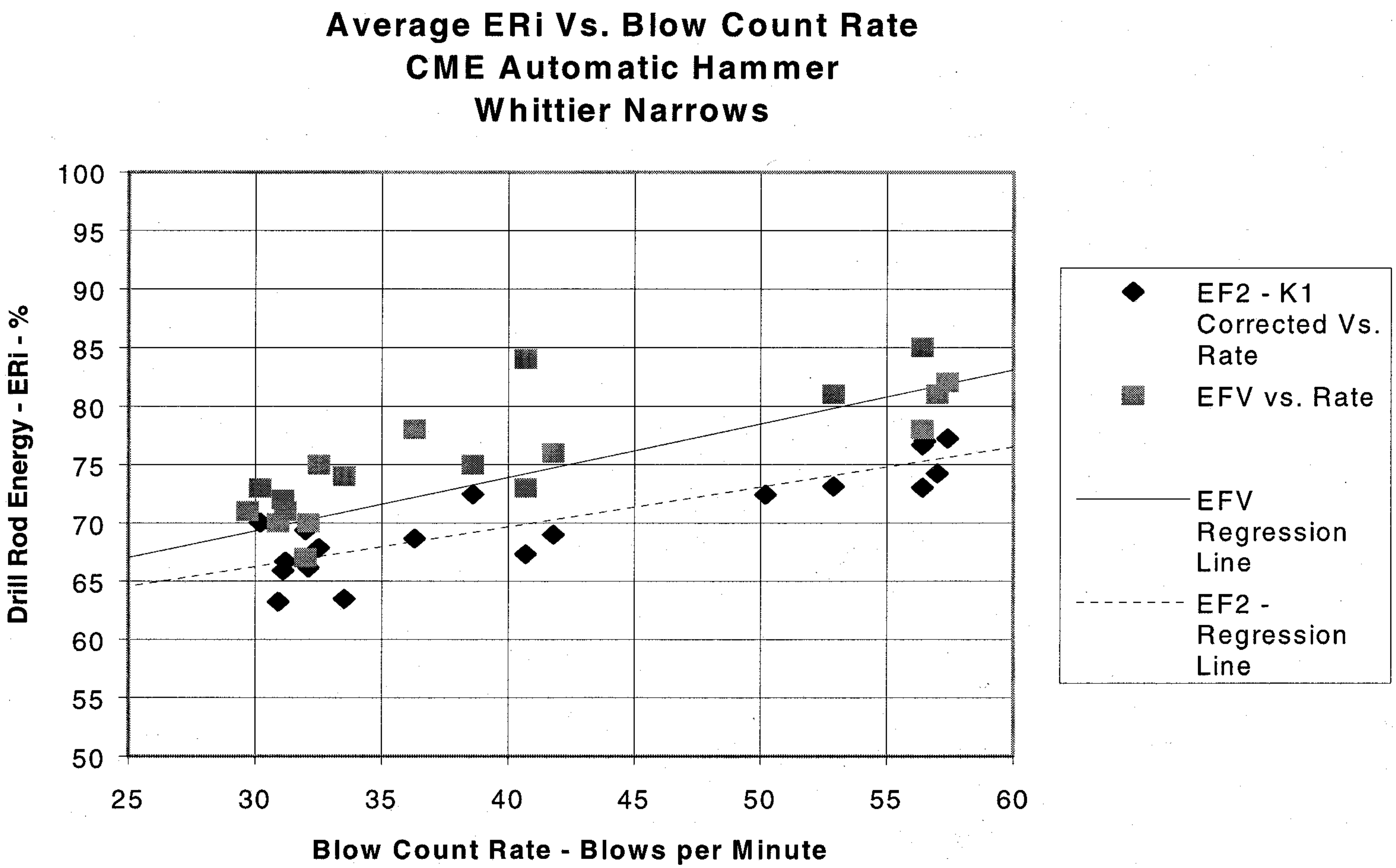

Figure 3.—Summary of drill rod energy and rate data (Whittier Narrows Dam investigation).

- The CME automatic hammer delivers more energy than typical rope-cathead safety hammer systems. The hammer is much more consistent in energy delivery than manually operated hammers. The use of this automatic hammer is highly desirable, but it must be checked to assure it is operating correctly.

- The hammer is designed to operate at 50-55 bpm. The speed is controlled by the hydraulics of the drill and, therefore, the flow control valves must be adjusted correctly and the drop height should be checked to assure proper operation. The operator should be sure that proper engine speed is reached during testing. The hammer is simple to check—simply count the rate and check the position of the hammer in the viewing slot. The hammer speed and drop height should be reported on the drill logs.

- Numerous investigators have measured drill rod energy on the CME automatic hammer. Prior to the 1990s, the measurements were made according to ASTM D 4633 using the force squared (EF2) method. These measurements indicated that the hammer, when operated at the correct speed, would deliver 90 to 95 percent ER_i. In the 1990s, accelerometers came into use, and the product of force and velocity (EFV) was measured. The recent EFV ER_i data range from 80 to 85 percent. Reported EF2 data are more variable, and there are differences of as high has 10 percent ER_i between EF2 and EFV data. The reason for these differences have not been explained. The new EFV data appear about 10 percent lower than the older EF2 data. Limited field comparisons between CME automatic and safety hammers indicate larger differences in actual blow counts than would be expected using the EFV or even older EF2 data.

- Given the new EFV data and any uncertainties with the older EF2 data, the recommended drill rod energy for the CME automatic hammer operated at the correct speed of 50 to 55 bpm is 85 to 95 percent. This assumed energy could be used for liquefaction investigations in accordance with ASTM D 6066, method B, and thus alleviate the need for project-specific energy measurements. If there is uncertainty, smaller energy corrections could be used.

- Studying the rate of the CME automatic hammer and measuring the energy indicates that when the hammer is operated at 30 bpm, drill rod energy loss was almost 15 percent. Using the information in this report, an observer could estimate energy delivery of the CME automatic hammer from information on the speed and drop height.

- Additional studies are needed. There needs to be a systematic study of the various energy measurement equipment available. This study should be performed under the most extreme loading conditions. The CME hammer provides a good test for response under extreme loading. It would also be helpful to look at additional field studies, comparing safety hammer data and CME automatic hammer data. Some data exist in the literature but were not reviewed for this report.

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Appendix

Operation Instructions for the CME Automatic Hammer

CENTRAL MINE EQUIPMENT COMPANY

OPERATING INSTRUCTIONS FOR THE CME

AUTOMATIC PENETRATION TEST HAMMER

There are five (5)* hydraulic control valves that are used to operate and regulate the automatic hammer:

Valve A (valve spool) - Is used to hydraulically raise the hammer guide tube (with hammer inside).

Valve B (ball valve) - Is used to lower the hammer guide tube over the anvil. Valve B is normally closed for the driving operation. (AUTO HAMMER FREE FALL)

Valve C (ball valve) - Is normally opened for the driving operation. (AUTO HAMMER RESTRICTED FALL)

Valve D (valve spool) - Is used to start and stop the driving operation.

Valve E (ball valve) - Is used to preheat the hydraulic oil during cold weather operation. Valve E is closed for the driving operation. (AUTO HAMMER BY PASS VALVE)

Valve F (flow control) - Is used to adjust the fall height of the hammer. (AUTO HAMMER SPEED CONTROL)

To operate the hammer at approximately 50 blows/minute use the following:

1. Close valves "B" and "C".
2. Thread the anvil to the top of the sampling rod.
3. Remove retaining pin that locks hammer in place.
4. Open valve "A" to raise the bottom of the guide tube to an elevation higher than the top of the anvil.
5. Rotate the guide tube to a position above the anvil.
6. Lower the guide tube over the anvil by opening valve "B".

CAUTION

KEEP HANDS AWAY
FROM THE HAMMER
GUIDE TUBE OPENING
AND THE ANVIL

7. The guide tube with hammer inside should come to rest on the anvil shoulder.

* On some drills the auto hammer by pass (valve E) is not included. See operating controls page 3.
Valves A and D are usually together on the same valve spool.

CENTRAL MINE EQUIPMENT COMPANY

OPERATING INSTRUCTIONS FOR THE CME

AUTOMATIC PENETRATION TEST HAMMER

8. Close valve "B" and open valve "C".

9. Mark the drill rods to observe and measure the blow count.

10. Open valve "D" to start the hammer action.

11. Open flow control valve "F" completely (turn knob counter-clockwise). Adjust engine RPM so hammer fall height is more than 30 inches (approximately 2000 engine RPM). Turn flow control valve knob clockwise to lower fall height to 30 inches.

12. Watch the distance that the anvil is being driven for each blow.

13. If the driving distance is or becomes less than 1/4 (0.25) inches per blow, close both valve "B" and valve "C" and manually regulate the downward movement of the guide tube by "cracking" valve "C" as required.

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INSTRUCTIONS FOR SETTING HYDRAULIC HAMMER
FLOW CONTROL 55197

1. Loosen set screw, and remove adjustment knob, C-clip, lock knob and shims from stems on Valve B. Turn stem on Valve B in (clockwise) until C-clip groove is 1/4" from valve. (SEE FIGURE 2 & 3)

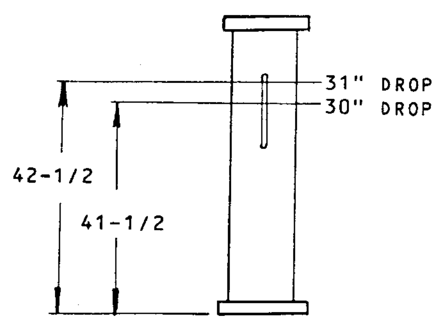
2. Loosen jam nut on Valve A and turn stem in (clockwise) until C-clip touches the top of the jam nut. (SEE FIGURE 2)

3. Turn knob on Valve C (clockwise) to close. (SEE FIGURE 2)

4. Set hammer up over anvil and open ball valve so hammer rests on anvil.

5. Mark hammer viewing slot 41-1/2" and 42-1/2" up from bottom of hammer housing. (SEE FIGURE 1)

FIGURE 1



6. With engine at idle engage hammer motor. While watching weight throw height bring engine speed up slowly until bottom of weight reaches 42-1/2" mark.

"CAUTION"

Running engine too fast will cause motor to over-throw weight and damage chain. DO NOT allow hammer to throw weight higher than the 42-1/2" mark.

CENTRAL MINE EQUIPMENT COMPANY

7. With hammer running turn stem A out (counter clockwise) until weight throw height decreases to 42". Then lock jam nut.

8. Turn stem B out until weight throw height decreases to 41-1/2".

9. Reinstall lock knob and adjusting knob, being careful not to rotate stem B. Check clearance between lock knob and valve. (SEE FIGURE 4) Remove and install maximum number of shims that fit freely in space. <u>NOTE:</u> If clearance is less than one shim no shims are required.

10. Run engines RPM's up slowly to full throttle. If throw reaches 42" stop and contact Central Mine Equipment's Engineering Department.

FIGURE 2

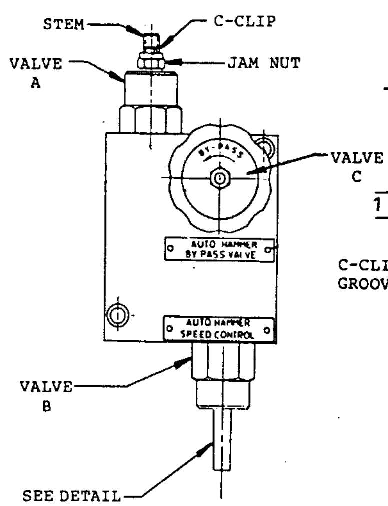


FIGURE 3

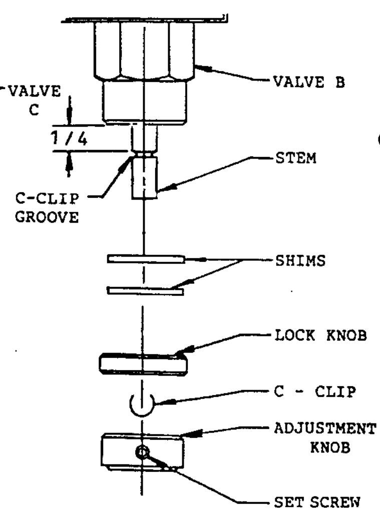


FIGURE 4