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# Survey with Design & Development of Mathematical Modelling for Ash brick Production Hydraulic Machine

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**ABSTRACT:** This paper details the formulation of field data based model to analyze the impact of various machining field parameters on the productivity of the hydraulic operation. In order to establish relationship amongst input and responses of activity, the mathematical models of hydraulic machine operation needs to be developed. This article highlighta the detailed methodology of mathematical model formulation foe the productivity of the brck making hyadrulic machine operation. In all 29 independent variables are studied to analyzed their effect on the dependent variables productivity. The 29 independent variables are then grouped to form 5 dimensionless pi terms using the Buckinhams Pi theorem. Again, a model is developed using matrix analysis and the effect of the independent pi term on dependent pi term is established. Model derived by combining positive and negative pi terms, further analyzes the effect of the independent variables on the productivity. The model are validated to gauge the accuracy. Formulation of mathematical model and sensitivity analysis reveals that the environmental condition and badly designed sttol used for sitting while in working position in the workshop, majorly affects the productivity. Further, to improve productivity, it is necessary that the seating stool used should be properly designed by using ergonomics cosiderations. Other factors that affect productivity are BASECO of the operator and years in operation as well as anthropometric data of the operators. Now study is done on forty male hyadraulic machine operators working on manually pressing hyadruilic machine from more than last 12 to 14 years in north & central India. This operation is characterized by a static sitting posture, with forward inclination of head and trunk. Since the operators are sitting on stools without back support, ankle and knee angles are in uncomfortable position. The eyes are constrained towards visual control of work. While the hands are continuously directing the hydraulic material with the absorption of vibrations on working surface of hydraulic table.

**KEYWORDS:** Ash brick making hydraulic press, Environmental Parameter, Ergonimacally designed sitting arangement

### I. INTRODUCTION

The ash bricks hyadraulic machine operation involves activities for execution of different tasks in hydraulic. During hydraulic machine operation the operators perform each type of activity which forms a man- machine system (fig. i). In this man- machine system operators anthropometric data, posture, their skills, motivation, workstation environment and design, the working season influences their performance. Field database modeling is applied to any type of man-machine system. It is the relationship between input/ couse and output/ response variable. The operators productivity

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is studied in this paper. These operators are involved in manual press machine operation which causes stress and fatigue and hence the need was felt to investigate their productivity.

CAUSES	HYDRAULIC MACHINE OPERATOR	EFFECTS
P11 Anthropometry Data		Z1 Process Time
P12 Personal Data		
P15 Process Machine Design and its condions		

(Fig. i)

## II. APPOINTMENT OF OPERATORS

The operators under study were all male operators. They have an experience of working on hydraulic machines of more than 12 years. The survey method was used. Where a questionnaire with the help of ash bricks project already completed in BASECO in India.

## III. SYSTEM

This paper details the formulation of field Database modeling to analyze the impact of various field parameters in and around hydraulic machine operation on the productivity. There are few totally physical phenomena that cannot be represented by application of basic balances of mechanics. But such complex man-machine operated system can be arrived at mathematical model by adopting the theory of experimentation suggested by Mr. Obada Kayali guies. The model formulation is done by using the following methodology. (fig. ii)



(Fig. ii)

- . Identification of cause / input independent and responses / output dependent variables.
- . Identification of extraneous variables.

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- . Reduction of independent variables into dimensionless terms by adopting dimensional analysis method.
- . Data collection of hydraulic machine operators on existing process.
- . Formulation of Exponential form of model in field database management.
- . Formulation of Response curve model in field Database management
- . Model optimization.
- . Sensitivity analysis.

### III.1 Identification of Independent Variables

Any physical quantity that undergoes change can be said to be variables in general. If particular variables can be changed without affecting other variables then it is independent variables. Similarly if a particular variables changes its response of one or more variables then it is called dependent variables. The variables which changes its response over which we don't have control as regards what way those variables would vary w. r.t. time such variables are called as extraneous variables.

Causes or Independent Variables. 29 Independent variables are identified in the present phenomena. These are grouped in 5 PI terms by using Buckingham Pi II theorem. Following way:

- . II 1 = Anthropometric dimensions of operator.
- . II 2 = Environmental condition factors.
- . II 3 = Personal factors of operator.
- . II 4 = Workstation Design.
- . II 5 = Process machine design conditions.

### III.2 Responses or Dependent Variables

Dependent variables identified is productivity of hydraulic machine operators and analysis of effect of independent variables on productivity of operators is examine by mathematical model formulation tool. ( shown in table 1).

**Table 1.** Process variables ( dependent and independent)

Sr. No.	Variable Name	Symbol	Dimensional Parameters
A	Height of operator	A1	L (cm)
B	Weight of operator	A2	M (kg)
C	Sitting height	A3	L (cm)
D	Sitting eye height	A4	L (cm)
E	Elbow sitting Ht.	A5	L (cm)
F	Knee ht.	A6	L (cm)
G	Buttock knee height	A7	L (cm)
H	Popliteal height	A8	L (cm)
I	Elbow to elbow span	A9	L (cm)
J	Hip breadth sitting	A10	L (cm)
K	Inclination of head (alpha)	A11	0 (degree)
L	Inclination of eyeball (beta)	A12	0 (degree)
M	Inclination of back w. r. t. table (theta)	A13	0 (degree)
N	Age of operator	P1	T
O	Experience of operator	P2	T
P	Skill of operator	P3	T
Q	Health of operator	P4	Rating scale (1-10)
R	Enthusiasm of operator	P5	Rating scale (1-10)

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S	Habits of operator	P6	Rating scale (1-10)
T	Temperature of workstation	TW1	0 (centigrade)
U	Noise of workplace	NW1	decibels
V	Noise of workplace while working	NW2	decibels
W	Illumination of workplace	IW1	Lumens
X	Height of stool	H1	L (cm)
Y	Ht. of working table	H2	L (cm)
Z	Surface length of working table	H3	L (cm)
AA	Area of stool	H4	L (cm)
AB	Back support length	H5	L (cm)
AC	Position of press pad	H6	L (cm)
AD	Arm reach i.e. elbow to working table	H7	L (cm)
AE	Speed of operator	SO	T-1
AF	Length of leg	LL	L (cm)
AG	Angle of seat at any	D14	0 (degree)
AH	Size of dia area	Td	L (square)(cm)
AI	Length of push rod	Psrd	L (cm)
AJ	Axle size	Ax	L (cm)
AK	Diameter of motor belt	Lb	L (cm)
AL	Pully diameter. On machine head	Pmc	L (cm)
AM	Flywheel diameter	Fwh	L (cm)
AN	Pressing time / day	Pt	length./h
AO	Pressing length/ day	Ptl	length./h

### III.3 Reduction of Variables

As the number of independent variables are too large they are to be reduced to few by using dimensional analysis by applying Buckingham's Pi theorem. When this theorem is applied to a system having n independent variables and m primary dimensions, number of Pi terms are formed. Using three primary dimension terms L, M, T if the product of these Pi terms is taken then it will yield dimensionless pi terms. By using this approach the independent pi terms are formed. Table 2 will show independent pi terms.

**Table 2.** Independent variables following way

Sr. No.	Pi terms	Group for forming independent terms	Dimensional analysis
I	II 1	Anthropometric data of operator	$II\ 1 = (A1, A3, A4, A5, A9) / (A6, A7, A8, A10, LL)$
II	II 2	Persona data of operator	$II\ 2 = (P1, P3, P4) / (P2, P5, P6)$
III	II 3	Environmental conditions of workplace	$II\ 3 = (TW1, NW1) / (IW1, NW2)$
IV	II 4	Workstation data	$II\ 4 = [(h1, h5/h4), (h2, h3/h6)] / [SO/h7, LL), (A11, A12, A13)]$
V	II 5	Components of machine process and its conditions	$II\ 5 = [(L\ Belt), (Pmc), (H3)] / [(Td), (Psrd), (Ax), (Fwh)]$

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## IV. FORMULATION OF MODELS BASED ON OBSERVED DATA

Dependent variables Productivity is  $Z_3 = \text{Total length of Pressing work per day} / \text{press time per day during Experimentation}$  5 Independent  $\pi_i$  terms ( $\pi_1, \pi_2, \pi_3, \pi_4, \pi_5$ ) and one dependent  $\pi_i$  term ( $\pi_6$ ) are available for model formulation. Each dependent  $\pi_i$  term is the function of the available independent terms.

$$\pi_6 = f(\pi_1, \pi_2, \pi_3, \pi_4, \pi_5) \text{-----} \tag{1}$$

A Probable exact mathematical form for the dimensional equation of the phenomenon could be the relationships assumed to be of exponential form. So, the model representing the behavior of dependent  $\pi_i$  terms  $\pi_6$  with respect to various independent  $\pi_i$  terms can be obtained. The model representing the behaviour of dependent  $\pi_i$  term with respect to various independent  $\pi_i$  terms can be obtained as follows:

$$\pi_6 = K (\pi_1^{a_1} * \pi_2^{a_2} * \pi_3^{a_3} * \pi_4^{a_4} * \pi_5^{a_5}) \text{-----} \tag{2}$$

Therefore 5 unknown terms in the eq. 2 can said as Constant of Proportionality  $K$  & indices  $a_1, a_2, a_3, a_4, a_5$ .

By using classical experimentation of mathematical form of Curve fitting Constant.

$$Z = A + Bx + Cy + Dz$$

By taking log on both sides equation can be formulated.

Taking log on both sides of Equ. 2

$$\log \pi_6 = \log K + a_1 \log \pi_1 + a_2 \log \pi_2 + a_3 \log \pi_3 + a_4 \log \pi_4 + a_5 \log \pi_5 \text{-----} \tag{3}$$

We assume:

$$Z_1 = \log \pi_6, K = \log a_0, A = \log \pi_1, B = \log \pi_2, C = \log \pi_3, D = \log \pi_4, E = \log \pi_5$$

Putting the values in Equ. ( 4)

$$Z = K + a_1 * A + a_2 * B + a_3 * C + a_4 * D + a_5 * E \text{-----} \tag{4}$$

Equation (4) is a regression equation of  $Z$  on  $A, B, C, D, E$  in a dimensional co-ordinate system.

$$\text{Sum}(Z) = n * K + A_1$$

After substituting values in the above equ.5 one will get set 5 equ. These are solved by using matlab & values obtained are as shown in the below table 3.

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Table 3. Reduction of values of indices for output variables.

S. N.	Index values ( after process in matlab)	Productivity
1	a0	1
2	a1	0.55
3	a2	0.07
4	a3	-2.04
5	a4	0.36
6	a5	0.00

Putting values for indices & curve fitting constant for the equ. Of dependent Pi terms, exact model of productivity in Exponential form is obtained as shown in below equ. 5.

$$Z3 = I1I1 ( 0.55) * I2 (0.07) * I3 (-2.04) * I4 (0.36) * I5 ( 0.00) \text{-----} \quad (5)$$

### V. CONCLUSION

Referring equ 5, it is observed that the absolute index of al of II 1 term is highest i. e. II 1 = 0.55. This indicates that, the highest influence of the pi term I1 is on productivity. This is because the a1 index is positive, the relationship between the productivity I1 is direct. Meaning that if the values of I1 increases the productivity will increase. This pi term is related to anthropometric data of operator w. r. t. The stool on which he/ she is seating. The reasoning behind this can be that, if the height and other specifications of the stool werw designed ergonomically then that operator is at ease in sitting position while working. The other parameter i. e. II4 which is related to workstation design has a next high positive index. This also indicates that if the workstation data II4 value increases then it will help in increase of productivity. The third II3 term related to environmental factors shows negative index. This helps in decline of productivity because the operator is continuously working in hot and dry weather condition as in Hudkeshwar, Nagpur region. All the three pi terms shows us that the productivity of the operator could be increased if he/ she is working in ergonomica;;y designed workstation is better environmental condition (1). The other pi terms are very less influencing factors on productivity.

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### BIOGRAPHY

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