IS : 2974 (Part 5) - 1987
(Reaffirmed 1993)

Indian Standard

(Reaffirmed 1998)

CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF MACHINE FOUNDATIONS

PART 5 FOUNDATIONS FOR IMPACT MACHINES OTHER THAN HAMMER (FORGING AND STAMPING PRESS, PIG BREAKER, DROP CRUSHER AND JOLTER)

(First Revision)

Second Reprint FEBRUARY 1998

UDC 624.159.11

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 2

May 1988

Indian Standard

CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF MACHINE FOUNDATIONS

PART 5 FOUNDATIONS FOR IMPACT MACHINES OTHER THAN HAMMER (FORGING AND STAMPING PRESS, PIG BREAKER, DROP CRUSHER AND JOLTER)

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 5) (First Revision) was adopted by the Bureau of Indian Standards on 26 September 1987, after the draft finalized by the Foundation Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 The installation of machines and equipments such as forging, sheet metal and stamping presses, pig breakers and jolters involves careful design of their foundations taking into consideration the impact and related vibration characteristics of the load and the condition of the soil on which the foundation rests. While many of the special features relating to design and construction of such machine foundations will have to be as advised by the manufacturers of these machines, still most of the details will have to be according to the general principles of design. This standard lays down the general principles of planning and design of reinforced concrete foundations supporting impact causing machines and equipment other than the hammers.

0.3 This standard was first published in 1970. This revision has been prepared based on general experience gained in the implementation of this standard in the past 15 years. The principal modifications made in this revision are deletion of elevator and hoist tower structures (which do not fit into the scope of this code), and inclusion of provisions for the foundations for jolters.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 5) deals with design and construction of block type foundations of reinforced concrete for the installation of the following machines:

a) Forging, sheet metal and stamping presses,
b) Scrap breakers or pig breakers, and
c) Jolters.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 2974 (Part 1)-1982* shall apply.

*Code of practice for design and construction of machine foundations: Part 1 Foundation for reciprocating type machines (*second revision*).

3. NECESSARY DATA

3.1 The following information shall be obtained from the manufacturers of the machinery for guidance in design.

a) *Forging Sheet Metal and Stamping Presses*

1) Layout and outline drawing of the installation,
2) Details of anchor bolts and other embedded parts,
3) Pressure to be exerted by the press (p),
4) Stroke of the press (S),
5) Weight of the cross head (w_e),
6) Gross weight (w_p),
7) Weight of material to be forged (w_m),

8) Load-time relationship of the pulse realized during the action of the press (p versus t),
9) Dynamic force and moment in the case of eccentric presses (M), and
10) Height and cross section of steel columns.

b) *Pig and Scrap Breaker Installations*

1) As in (a) (1) above,
2) As in (a) (2) above,
3) Weight of ram and height of fall,
4) Weight of pig scrap, and
5) Constructional loads.

c) *Jolter*

1) As in (a) (1) above
2) As in (a) (2) above
3) Weight of jolting table with rated charge on it (w_t),
4) Weight of anvil (W_a),
5) Frequency of jolts (Blows/min),
6) Height of fall of the table or stroke (S), and
7) Maximum pressure of the steam/ compressed air (p).

3.2 Data of Ground and Site Conditions — The following soil data shall be known:

a) Soil profile and soil characteristics up to a depth at least 3 times the mean plan dimensions of the foundation (which can be taken as the square root of the expected area) or hard strata, whichever is less.
b) Soil investigation to the extent necessary in accordance with IS : 1892-1979* and for determination of dynamic properties of the soil in accordance with IS : 5249-1977†.
c) The relative position of the water table below ground at different times of the year.

4. DESIGN CRITERIA

4.1 General

4.1.1 To avoid transmission of vibration, no part of the machine foundation shall be allowed to have a rigid contact with parts of adjoining structures. For best isolation, a gap is recommended between parts of the machine foundation and adjacent structures.

4.1.2 In case it becomes necessary to support unimportant parts of a neighbouring structures, sensitive to vibration measures shall be taken to make a resilient connection using rubber, cork, falt or any other soft resilient material.

4.1.3 Overhanging cantilever supports for walkways shall be avoided as far as possible. Where unavoidable, they shall be designed to ensure adequate rigidity against vibrations.

4.2 Permissible Stresses

4.2.1 Full value of permissible stresses for steel and concrete as specified in IS : 456-1978* may be allowed if dynamic loads are considered in detail design by applying suitable dynamic and fatigue factors.

4.2.2 The approximate values of dynamic elastic modulus of concrete for different grades is given below:

Grade of Concrete	*Dynamic Elastic Modulus* kgf/cm²
M-20	300 000
M-25	340 000
M-30	370 000

4.2.3 *Soil* — The soil stress below the foundations under the combined static and dynamic loads shall not exceed 80 percent of the allowable stress under static loading determined in accordance with IS : 6403-1981†.

4.2.4 When seismic forces are considered in design, the allowable stresses in soil may be increased as specified in IS : 1893-1984‡.

4.3 General Provisions of Design

a) The centre of gravity of the machine as well as the foundation shall preferably lie on the same vertical line passing through the centroid of the base area.
b) The natural frequency of the foundation soil system (ω_n) shall not be a whole number multiple of the operating frequency of impact (ω_m). To avoid resonance, the following inequality relation is suggested:

$$0{\cdot}7 > \frac{\omega_n}{\omega_m} > 1{\cdot}5$$

4.4 Dynamic Analysis

4.4.1 *When the Duration of Impact is Negligible but the Effect of Repeated Blows (Periodicity of Blows) needs to be Considered* : The amplitude (A) of the foundation considered as a rigid body resting on a spring (represented by soil

*Code of practice for subsurface investigation for foundation (*first revision*).
†Method of test for determination of dynamic properties of soil (*first revision*).

*Code of practice for plain and reinforced concrete (*third revision*).
†Code of practice for determination of bearing capacity of shallow foundations (*first revision*).
‡Criteria for earthquake resistant design of structures (*third revision*).

springs or other underlayers as the case may be obtained from the relation:

$$A = \frac{I}{2\sqrt{km}\ \text{Sin}\ \pi\left(\frac{T_1}{T}\right)}$$

where I is the impact momentum, k is the stiffness of the subgrade of the foundation, m is the total mass of the machine foundation, T_1 is the periodicity of blows and T is the natural period.

As a measure of simplification, in cases where the impulse momentum is not specified, the amplitude of motion of the foundation body may be obtained from the following approximate relation:

$$A = \frac{W v}{2\,\omega_n\, W\,\text{Sin}\,\pi\left(\frac{T_1}{T}\right)}$$

where W is falling weight, v is terminal velocity and ω_n is natural frequency.

4.4.2 *When the Duration of Impact is Not Negligible, and the Effect of One Blow Alone need be Considered*: Following steps may be followed:

a) *Step 1* — Obtain the natural period (T) of the foundation-soil system as given in IS : 2974 (Part 1)-1982*.

b) *Step 2* — Obtain the dynamic magnification factor corresponding to the period ratio t_1/T, where t_1 is the duration of the blow. Fig. 1 gives values of η for three standard forms of pulse loading where η is dynamic magnification factor. For any other arbitrary loading, rigorous dynamic analysis needs to be carried out.

c) *Step 3* — The dynamic force F_d may be obtained from the relation:

$$F_d = \xi\eta\, P_d$$

Where ξ is the fatigue factor which may be taken as two for normal machinery and P_d is the peak dynamic force induced by the machine in each blow.

4.5 Forging and Stamping Presses

4.5.1 Forging sheet metal and stamping presses may be hydraulic, eccentric or friction type. The dynamic analysis of the foundation may be carried out as explained in **4.4**.

4.5.2 Alternatively, for stamping machines having anchor columns and resting on hard rock, in the absence of pressure time data the dynamic magnification factor may be obtained from the relation $\frac{V}{\sqrt{g\delta}}$ where $\delta = \frac{Wh}{EA}$; h and A being the height and area of cross

*Code of practice for design and construction of machine foundations : Part 1 Foundation for reciprocating type machines (*second revision*).

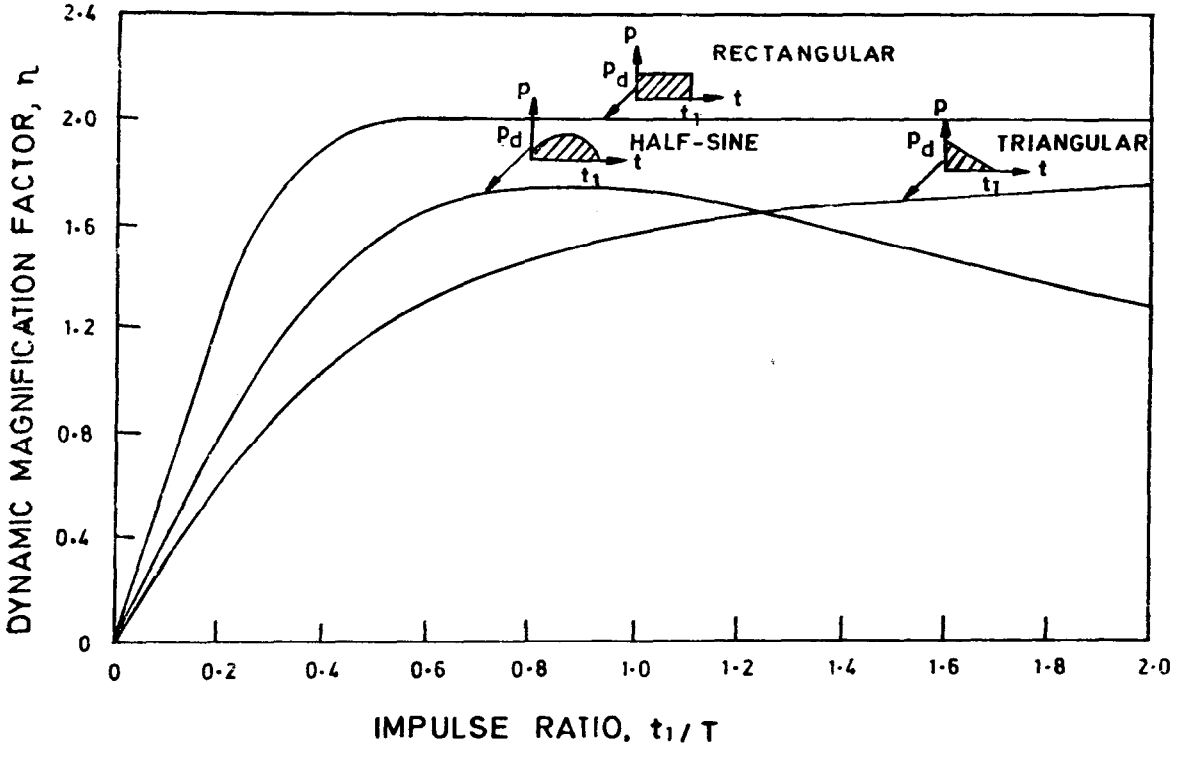

FIG. 1 DISPLACEMENT RESPONSE SPECTRA FOR THREE STANDARD PULSES

section of anchor columns, W is the weight of the machine without the cross head and V is the velocity at the middle of stroke (S) given by $2\pi f_m S$, f_m being the operating frequency of the moving cross head in cycles/sec. In the case of large eccentric presses, other forms of dynamic loads also occur. For design purposes, a dynamic moment equal to five times the normal torque and dynamic force equal to five times the centrifugal force, both acting at the centre of the fly wheel may be considered.

4.6 Pig Breakers or Scrap Breakers

4.6.1 Hammers inducing very high impact energy should be located, as far as possible, from other structures susceptible to vibration, namely laboratory buildings, shops, housing precision equipment and complete process lines, etc.

4.6.2 The foundation for crushing platform should preferably be designed as a hollow cylinder or hollow cup and made of RCC and filled with well compacted sand and scrap ingots to increase the crushing efficiency.

4.6.3 The crushing anvil may also be placed on RCC block in a rectangular or circular well. Block foundation under the anvil should be made of richer concrete and suitably reinforced to withstand the high impact energy.

4.6.4 Timber battens should be suspended on hinges from a metallic ring installed above the wall and tied to each other at places by a rope so that they can intercept the flying chips. Rubber lining may also be provided at the inner face for the same purpose.

4.7 Jolters

4.7.1 Block foundations supporting jolter tables often used in foundry-forge plants are designed following the procedure outlined in **4.4**. The moving weight in a jolter installation is the total weight of the jolter table together with the charge on it.

5. CONSTRUCTION DETAILS

5.1 The concrete for foundations and supporting structures should be controlled concrete and designed and placed in accordance with IS : 456-1978*. Concrete should be specified on the basis of 28 days cube strength and shall be of grade not less than *M*-20.

5.2 The concrete used should be of plastic consistency without excessive water. A slump of 5 to 8 cm is allowable. The same consistency should be maintained throughout the concreting.

5.3 Continuous concreting should be done as far as possible for the entire block leaving provisions for grouting.

5.4 If a construction joint is unavoidable, the plane of joint should be horizontal and measures should be taken to ensure perfect bond at the joint. Reinforcement should be continuous across the joint. Before placing the new layer of concrete, the previously laid surface should be roughened, thoroughly cleaned and washed by a jet of water and then covered by a layer of rich 1:2 cement grout 2-cm thick. Concrete should be placed not later than 2 hours after the grout is laid.

5.5 Grouting of the machine bed plate and the pockets of anchor bolts should be done in a continuous operation. The surfaces should be thoroughly cleaned prior to grouting. All exposed surfaces should be made rough so as to secure good bond with the fresh concrete. Cement grout with non-shrinkage additive should be used for purpose of grouting.

5.6 All units of foundation should be provided with reinforcements both ways and amount of reinforcement should be not less than 25 kg/m^3 of concrete.

5.7 The minimum diameter of bar should be 12 mm and the maximum spacing 200 mm in order to take care of shrinkage in concrete. Unless specified otherwise, the concrete cover for the protection of reinforcement should be a minimum of 75 mm thick at the bottom and 50 mm thick on the sides and top.

5.8 Foundation bolts should be properly anchored.

*Code of practice for plain and reinforced concrete (*third revision*).

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian Standard has been developed from Doc: No. CHD 025 (0251)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	323 76 17, 323 38 41
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola CALCUTTA 700054	337 84 99, 337 85 61 337 86 26, 337 91 20
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	832 92 95, 832 78 58 832 78 91, 832 78 92
Branches	: AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PATNA. PUNE. THIRUVANANTHAPURAM.	

Printed by Reprography Unit, BIS, New Delhi