भारतीय मानक

पहाड़ी क्षेत्र में भवन निर्माण के स्थल के चुनाव और विकास के मार्गदर्शी सिद्धान्त

भाग 1 शहरी केन्द्र का सूक्ष्म क्षेत्रीकरण

Indian Standard

SELECTION AND DEVELOPMENT OF SITE FOR BUILDING IN HILL AREAS — GUIDELINES

PART 1 MICROZONATION OF URBAN CENTRES

UDC 69.035.2 : 69.051 (026)

© BIS 1995

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

June 1995 **Price Group 2**

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Rock Mechanics Sectional Committee, had been approved by the Civil Engineering Division Council.

Physical planning and preparation of master plan for development of urban centres and multi-purpose projects require considerations of various natural hazards which lead to damage and collapse of structures resulting in injury and death along with loss of investments and reduction of socio-economic fabric of the inhabitants. Earthquakes, volcanic eruptions, river aeolian and glacial erosion, ground failures and other geological hazards, vagaries of rain fall, floods, cyclones, tornadoes and other atmospheric disturbances and procreated hazards resulting from mining and other excavations, unregulated and unplanned constructions, lack of awareness about natural hazards and oblivious of consequences of construction at sites vulnerable to ground failures, rock falls and avalanches, debris movements, inundations and other risks, cause damage to buildings in urban centres. In general these factors are not kept in view and haphazard growth of urban centres takes place which result in disasters on exposure to natural and procreated hazards.

Ground failures in hill sides in mountainous terrains and in other adverse rock and soil conditions, inundation of low-lying areas, along flood planes of rivers in alluvial terrains and coastal areas and on exposure to earthquakes and extreme hydrometeorological conditions give rise to large scale damage and destructions resulting in devastation of urban centres. The main objective of microzonation of urban centres is demarcation of following:

i) Areas which in the prevailing local geomorphological, geological and hydrological conditions are unstable and undergo ground failures inundation or water-logging;

ii) Areas which are potential sites for similar risks on exposure to earthquakes and other natural and procreated hazards; and

iii) Areas in which risks are negligible.

Thus planned land use with appropriate green belts, building complexes, transportation systems and life line structure sites is not likely to impose adverse effects on the environment. The strong ground motion amplification due to local conditions and proximity of active faults, nature, type of ground failures and their likely aerial extent and situation of inundations of specific land areas from external and internal sources have to be assesed used so that areas where housing and office complexes and commercial and industrial sectors constituting an urban centre can be sited.

To minimize damage of buildings in the prevailing local conditions, it is necessary to provide guidelines for microzonation of areas of existing and proposed urban centres, selection of sites for housing, commercial and industrial sectors within or close to an existing or planned urban centres and development of building sites to ensure safety on exposure to natural and precreated hazards. This code incorporates guidelines for preparation of microzonation maps of areas of existing and proposed urban centres. Such maps provide basic information for physical planning and preparation of land-use maps and master plans for siting of buildings and development of such sites in urban centres.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SELECTION AND DEVELOPMENT OF SITE FOR BUILDING IN HILL AREAS — GUIDELINES

PART 1 MICROZONATION OF URBAN CENTRES

1 SCOPE

This Standard provides guidelines for preparation of microzonation map of a region to be used for an urban centre or multi-purpose project site for regulating siting of housing and office complexes, commercial and industrial sectors, community services and other engineering structures to prevent damage from natural and procreated hazards resulting in ground failures and inundation of built up areas.

2 GENERAL

2.1 If natural and procreated hazards are not evaluated adequately while considering the suitability of the site for existing and future urban centres it may lead to large scale damage. Ground failure and inundation due to local conditions result in damage to buildings even if suitable construction practices have been adopted. Lack of structural safety of buildings in old and conjusted localities, from their inherent poor construction or dilapidated and weak conditions due to poor maintenance and repair add to the catastrophic effects often blocking access, hinder rescue and relief operations. Inundations fully or partially flooding buildings and household good and failures of foundations in adverse situations disrupts life lines in addition to damage to property and loss of life. Microzonation maps should delineate areas which are prone to ground failures of different types and the areas which could be inundated during monsoons and extreme hydrometeorogical conditions as well as unplanned drainage of domestic and industrial discharge of water.

2.2 The microzonation maps are required to be prepared on scales based on:

i) size of the urban centre,
ii) relief of the area,
iii) nature of surficial soil and rock strata, and
iv) drainage pattern and its density.

In regions of high relief in mountainous terrains with rock outcrops and surficial detritus, topographic map of 1 : 10 000 scale with contours at 2 m interval would be desirable. With gradual reduction in relief smaller scale maps up to 1 : 25 000 scale with contour intervals at 3 to 5m intervals may be used. For areas where such topographic maps are not available, they should be got prepared as they form the base maps for mappimg.

3 PRIMARY FACTORS TO BE CONSIDERED FOR MICROZONATION MAPS

3.1 The primary factors that govern the selection of parameters for microzonations depend on regional geology, hydrological conditions and local geology. The order, format and details in which these should be considered are governed by local conditions, the size of the urban centre and the type and purpose of the building complexes in various sectors of the urban centre. The hazards resulting from human activities due to mining and other excavations, constructions disturbing the hydrological regime, etc, often have adverse effects and cause damage, water logging and related hazards.

3.2 Regional Geology

It is necessary to consider overall geological setting and history of natural hazards in order to encompass all factors of significance and to account for specific conditions such as earthquakes and floods in the region. Such studies of regional geology should cover the area around the urban centre to evaluate the intensity of hazards which have a direct bearing on characteristics ground failures and inundation. Study of regional geology should include:

i) Identification of physiography including landforms and drainage, and geology of the region;
ii) Geologic history of the region;
iii) Description of geological formations rock masses and surficial deposits/soil;
iv) Description of geological and structural features including folds, faults and fractures and joint patterns;
v) Location and description of faults and shear zones in which movements are taking place or may generate earthquakes; and

vi) Hydrological conditions including the configurations of the ground water table of the region.

3.3 Local Geology

Informations on local geological and geomorphological conditions is required to ascertain the nature of ground failure expected at urban centres and evaluate the potential for such failures on exposure to earthquakes, inundation and other hazards. The data on local conditions is to be collected through review of literature, reports applicable to nearby engineering project sites, site inspection, field exploration and material sampling and testing. Data collected should include information on the following:

i) Geomorphology of the area showing surface slope characteristics, relative relief demarcating valley shape, areas of depression and inundations, various types of land forms, and drainage pattern and its density, location of natural springs, land-use and land-cover as well as rock outcrop areas;

ii) Type, extent, thickness, mode of deposition of formations and stability characteristics of rock mass and soil deposits;

iii) Hydrological conditions including water table underground seepage conditions, and permeability characteristics of surficial materials;

iv) Local geological and structural features including folds, faults, joint etc,

v) Inventory of effects of disasters - earthquakes and floods, that occured at or near the urban centres in the past; and

vi) Geotechnical data for evaluation of engineering characteristics for rock mass and surficial deposits.

3.4 Causative Factors of Land Hazard

The hazards to engineering structures of urban centre are caused due to a number of factors which may be classified into two major categories

i) Ground failures, and

ii) Floods and inundations.

3.4.1 Ground failures result mainly due to inherent instabililties, instabilities caused due to external forces and instability due to human activites.

3.4.1.1 The inherent instability is influenced by a number of factors as given below.

3.4.1.1.1 *Material characteristics*

It can be broadly classified into three categories:

i) Materials present in natural form,

ii) Materials disturbed due to ground failures, and

iii) Materials of reclaimed land and solid waste disposal dumps.

The materials present in the natural form includes rocks, river terraces, alluvial fans, flood plains, alluvial deposits, glacial deposits, etc. The strength parameters of the materials and the structural weaknesses in case of rocks should be considered in details for working out the stability. If the slopes have already been subjected to failures, the same may be identified and breaks in the ground profiles are demarcated. Such areas are highly hazardous for construction purposes.

3.4.1.1.2 *Geomorphology*

Geormophology of the area, a product of interaction of geology, climate and erosion is to be studied under:

i) slope characters, and

ii) relative relief for purposes of terrain evaluation.

The five categories of slope gradient — very gentle (0°–15°), gentle (15°–25°), moderately sleep (25 °– 30°), steep (35°–45°) and very steep (>45°) characterize the slopes. The relief or local relief shall indicate the nature of scarp faces, valley shape, depression zones, inundation areas, etc.

3.4.1.1.3 *Hydrological conditions*

It plays an important role as the pore water pressure affect shear strength of the material, while saturation increase the bulk weight of the mass. Hydrological conditions may be studied by evaluating:

i) surface run-off characters,

ii) water spread,

iii) marshy conditions,

iv) ground water table/phreatic level, and

v) springs and ground water seepages.

The surface run-off characters are influenced by the nature of the streams (perennial or seasonal). The normal water levels, seasonal flood levels and 100 years flood levels should be considered for locating the engineering constructions in the vicinity of water sources. The inlet and outlet levels of run-off water and the terrain features decide the water spread characters. Water logging may lead to marshy conditions, which in some situation may only be seasonal. If seepages are seen on the slopes, they may mobilize the slope materials and appropriate weightage has to be given while evaluating stability.

3.4.1.2 Instabilities caused by external forces may be broadly classified into five categories.

3.4.1.2.1 *Strong ground motions* — may be caused by earthquakes, blasting and rock burst.

3.4.1.2.2 *The extreme hydro-meteorological conditions* — may be caused by cloud bursts,

cyclones and tsunamies, and collapse of upstream water retaining structures.

3.4.1.2.3 The vicinity of lava eruptions may face problems due to lava eruptions and the associated debris flow.

3.4.1.2.4 The debris flow from collapse and bursting of debris dam in the upstream reaches should be considered in relevant cases. The debris charged with water may inundate the area all of a sudden in the event of bursting of debris dam. Such debris may consist of glacial-fill materials, rock debris on hill slopes, or landslides debris generated by ground failure on exposure to earthquakes or extreme hydro-meteorological conditions.

3.4.1.2.5 The avalanches and landslides debris within the area should be studied for detailed evaluation.

3.4.1.3 Instabilities due to human activities are caused due to lack of planning and faulty execution of works such as, mining and other excavations, unplanned urban development, constructions leading to interference with the existing drainage systems construction in floor plains or close to shore lines and constructions on weak or unstable foundations.

3.4.1.3.1 Open cast excavations including mining and road excavations should be properly planned taking into consideration the existing local conditions of that the cut slopes do not face stability problems. In adverse conditions the failure of cut slopes may mobilize natural slopes leading to unstable conditions.

3.4.1.3.2 Unplanned urban development may lead to excessive constructions in certain selected zones thereby causing instability of slopes, while leaving other potential areas suitable for constructions nearby.

3.4.1.3.3 The existing buildings if not provided with adequate and proper drainage facilities, may cause excessive saturation of the sub-surface formations creating adverse conditions. Moreover the construction of buildings should not obstruct the existing surface drainage courses. During extreme hydrometeorological conditions the floods may play havoc and inflict severe drainage of the constructions in the flood plains of the river.

3.4.1.3.4 Construction close to short lines and in the flood plains should take into consideration the sea waves and high tide levels/floor levels and the consequent spreading of water in the area. Back flows through drains inundating low lands has to be taken into consideration while planning the constructions.

3.4.1.3.5 The unstable foundations on the slopes may lead to unequal settlements and failures. Often constructions are done on disposal dumps which include solid waste disposal materials and filling by mined out material. The dump areas may have highly contagious materials with much of empty spaces. Moreover if organic materials are present in the dump, the decaying process over the years may lead to unequal settlements on the surface.

3.4.2 Floods and inundations are major hazards which should be evaluated from past history. They can be broadly classified into four categories:

i) Floods on rivers, that is, inland floods,
ii) Floods in deltaic areas,
iii) Sea waves due to cyclones, and
iv) Excessive precipitations due to cyclones and cloud bursts.

In all cases the maximum flood level has to be estabilished from the past history so that the constructions can be restricted above that level.

4 PROCEDURES

4.1 The topographic map of the area of urban centre on appropriate scale and contour interval as indicated in 2.2 shall be prepared. This shall form the base map for preparation of other maps. A slope map delineating area of very steep slope (>45°), steep slope (35°–45°), moderate slope (25°–35°), gentle slope (15°–25°) and very gentle slope (<15°) shall be prepared. The details of geology of the area showing rock outcrop and surficial deposits is prepared on the same scale. The land use and land cover map of the area, and the hydrological map shall be prepared showing the locations of perennial and seasonal streams as well as irrigation canals and open drains. The level of run-off of rivers during normal period of the year and monsoons and 100 years floods should also be shown on hydrological map along with ground water table contours.

4.2 Seismic hazard class based on peak ground acceleration (PGA) (refer Table 1) of the urban centre shall be determined and design earthquake evaluated for design of structures and stability analysis of rock mass/soil formation.

Table 1 Seismic Hazard Rating for Various Ranges of Estimated Peak Ground Acceleration (PGA)

Conditions	Seismic Hazard Class
PGA <0.10 g	I (Low)
0.10g <PGA < 0.25 g	II (Moderate)
PGA > 0.25 g but no active faults within 10 km distance from the urban centre	III (High)
PGA > 0.25 g active fault within the urban centre or within 10 km distance from the urban centre	IV (Extreme)

4.3 From a perusal of the geological map, the areas having more or less homogeneous lithology such as hard rock terrain, soft rock terrain, surficial materials categorized as terraces, fans, flood plains, laccustrian deposits, slide debris, etc, shall be demarcated. Superimposing the slope map and hydrological map, the stable areas are identified. In rocky terrain the areas having slope less than 25° are in general stable. In terrains of surficial deposits, the dry slopes less than 20° are generally stable. The remaining areas shall be studied in detail to work out the factor of safety in the prevailing local conditions for various slopes. The areas showing high water table and fully saturated soils shall be demarcated and studied for possible liquefaction and settlement on exposure to earthquakes.

4.4 In rocky terrain the valley faces having moderate or steeper slopes are evaluated for the type and extent of failures. The zones of rock falls, rock slides, creeps, and debris flow shall be identified and demarcated.

4.5 In glacial material the degree of saturation of the material shall be studied to see the extent of loss of strength and likely debris flow.

4.6 The terrace and fan deposits shall be studied and their stability under inherent conditions and on exposure to earthquakes and other hazards shall be estimated and delineated.

4.7 In reclaimed and as solid waste disposal areas, the long term effects due to settlements resulting from consolidations of soils and organic material be checked under *in-situ* conditions during various seasons of a year.

5 PRESENTATION

The microzonation maps portray areas likely to be inundated during 100 years floods in the existing streams within the area if any, and domestic and industrial water discharges and areas likely to be affected by ground failures indicating their nature and type, due to inherent instability and/or exposure to probable natural and procreated hazards in the urban centre. The areas for location of building complexes and green belts, and other open spaces, where the structures can undergo damage resulting from ground failures shall be demarcated. These informations may be presented in a single map or a series of maps depending on the complexity of the data to be shown in such maps. These maps will be accompanied by an explanatory text in the form of a report incorporating the methodology and procedures adopted for evaluating the nature and type of ground failures shall be demarcated on the map and the aerial extent of inundations in the urban centre under various condtitions.

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

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

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. CED 48 (5113).

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 : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern	: 1/14 C. I.T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	37 84 99, 37 85 61 37 86.26, 37 86 62
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern	: C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	632 92 95, 632 78 58 632 78 91, 632 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at Simco Printing Press, Delhi