

भारतीय मानक

भवनों तथा सड़कों के लिये चूना-पोजोलाना मिश्रण कंकरीट  
तैयार व उपयोग करना — रीति संहिता

( पहला पुनरीक्षण )

*Indian Standard*

PREPARATION AND USE OF  
LIME-POZZOLANA MIXTURE CONCRETE  
IN BUILDINGS AND ROADS — CODE  
OF PRACTICE

*( First Revision )*

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

## FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Building Lime and Lime Products Sectional committee had been approved by the Civil Engineering Division Council.

Lime-pozzolana mixture concrete is found to have many desirable properties advantageous for use in road and building construction. The values of drying shrinkage of lime-pozzolana mixture concrete have been observed to vary from 0.019 to 0.040 percent which compares favourably with values of 0.024 to 0.038 percent and 0.043 to 0.058 percent respectively for plain cement and pozzolana cement concrete of 1 : 5 and 1 : 6 nominal mix proportions. The drying shrinkage values of lean cement concrete of mix proportions 1 : 16 and 1 : 20 are of the order of 0.06 to 0.09 percent. From these, it is seen that lime-pozzolana mixture concrete undergoes only negligible volume change after setting and initial shrinkage.

Well compacted lime-pozzolana mixture concrete is also found to be less permissible because it is more cohesive and plastic in nature than cement concrete of equivalent strength. The bond strength between lime-pozzolana mixture concrete and cement concrete is found to be of the order of 1.5 to 2.0 MPa when the time interval between laying of two layers in road and other pavement work is not more than one hour. Because of this characteristic, it is found that lime pozzolana mixture concrete can be advantageously employed as a bonded underlay under thin cement concrete surfacing to obtain a composite, economical rigid pavement wherein the shear stresses developed at the inter-face of the two layers are taken care of by the bond strength developed between the two layers.

This standard was first published in 1970. This revision has been prepared with a view to incorporate the modifications and improvements found necessary in the light of experience gained during the use of this standard. In addition to giving reference to the latest Indian Standards, this revision also incorporates the details of lime-pozzolana mixture concrete made with quick setting lime-pozzolana mixture according to IS 10772 : 1983 'Specification for quick setting lime-pozzolana mixture'.

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*

# PREPARATION AND USE OF LIME-POZZOLANA MIXTURE CONCRETE IN BUILDINGS AND ROADS — CODE OF PRACTICE

( *First Revision* )

## 1 SCOPE

This code covers the preparation and use of lime-pozzolana mixture concrete, using lime-pozzolana mixture conforming to IS 4098 : 1983 and IS 10772 : 1983 in building, road and runway construction works, such as levelling course in foundation, footing under masonry walls and columns, ordinary base concrete under floor, filling haunches over masonry arch, roof finish, fabrication of building blocks, paving blocks, road bases and bonded underlays.

## 2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

## 3 TERMINOLOGY

For the purpose of this standard, the definitions as given in IS 4305 : 1967 and IS 6508 : 1988 shall apply.

## 4 MATERIALS

### 4.1 Lime-pozzolana Mixture

Lime-pozzolana mixture shall conform to IS 4098 : 1983.

### 4.2 Quick Setting Lime-pozzolana Mixture

Quick setting lime-pozzola mixture shall conform to IS 10772 : 1983.

### 4.3 Coarse Aggregates

**4.3.1** Coarse aggregate for use in lime-pozzolana mixture concrete shall be either natural stone aggregate conforming to IS 383 : 1970 or broken brick ( burnt clay ) aggregate conforming to IS 3068 : 1986 depending upon the situation of use.

**4.3.2** Guidance about the type of aggregate to be used in lime-pozzolana mixture concrete may be obtained from Table 1.

### 4.4 Fine Aggregate

Fine aggregate for use in lime-pozzolana mixture concrete shall conform to IS 383 : 1970 or

IS 3182 : 1986. Aggregate conforming to IS 2686 : 1977 and having the required grading for fine aggregate as laid down in IS 383 : 1970 may also be used.

### 4.5 Water

Water used for both mixing and curing lime-pozzolana mixture concrete shall be clean and free from injurious amount of deleterious matter. Potable water is generally considered satisfactory for mixing and curing lime-pozzolana mixture concrete.

## 5 DESIGN CONSIDERATION

### 5.1 General

Lime-pozzolana mixture concrete may be used in building and road works for the following situations:

- a) As a levelling course for foundation and for plain concrete footings for masonry walls and columns;
- b) Ordinary base concrete under floors;
- c) For filling haunches over masonry arch work;
- d) Roof finish;
- e) Road and airfield bases and bonded underlays in composite rigid pavement (*see Note*); and
- f) For making solid building and paving blocks including tiles.

**NOTE**—Such pavement may be composed of two layers of overlay and underlay bonded together, whereas the overlay is of normal paving cement concrete, the underlay may be of lime-pozzolana concrete or cement concrete or leaner mix.

**5.2** For satisfactory use and proper selection of right mix for lime pozzolana mixture concrete detailed information with regard to the following will be necessary:

- a) *For Use in Foundation* — Nature of soil and characteristics of ground at or near the surface, sub-soil water level and load transmitted to the foundation;

**Table 1 Recommended Mixes with Lime-Pozzolana Mixture Conforming to IS 4098 : 1983 and IS 10772 : 1983**  
( Clauses 4.3.2, 5.2.1, 5.3, 5.6, 8.2.1, 8.3.1, 8.4.2, 8.5.1, 8.6.1 and 8.7 )

SI No.	Situation	Grade of Lime-Pozzolana Mixture	Coarse Aggregate	Mix by Mass			Mix by Volume			28 Days Strength, Min	
				Lime-Pozzolana Mixture (5)	Fine Aggregate (6)	Coarse Aggregate (7)	Lime-Pozzolana Mixture (8)	Fine Aggregate (9)	Coarse Aggregate (10)	Compressive MPa (11)	Flexural MPa (12)
1.	Levelling course under foundations, footings under masonry walls and columns, ordinary base concrete under floors, filling of haunches over masonry arches and roof finish	LP-20	Crushed stone	1	4	8	1	2.25	4.5	1	0.2
			Brick aggregate	1	3	6	1	1.75	4.0	1	0.2
		LP-7	Crushed stone	1	3	6	1	1.75	3.5	1	0.2
			Brick aggregate	1	2.5	5	1	1.5	3.0	1	0.2
		Type 1	Crushed stone	1	8	16	1	4.5	9	1	0.2
			Brick aggregate	1	6.8	12	1	4.0	8	1	0.2
		Type 2	Crushed stone	1	5.2	10	1	3.0	6	1	0.2
			Brick aggregate	1	4.2	8	1	2.5	5	1	0.2
		Type 3	Crushed stone	1	3.4	7	1	2.0	4	1	0.2
			Brick aggregate	1	2.5	5	1	1.5	3	1	0.2
2.	Road bases air-field bases and improved base concrete under floor	LP-40	Crushed stone	1	2.33	5	1	1.25	3.0	4	0.6
		LP-20	do	1	1.33	3	1	1.25	1.75	4	0.6
		Type 1	do	1	3.72	6.66	1	2.0	4	4	0.6
		Type 2	do	1	2.66	2.60	1	1.5	3	4	0.6
		LP-40	do	1	2	4	1	1.12	2.25	7	0.9
3.	Bonded under lays, building blocks and paving blocks	LP-20	do	1	1	2	1	0.50	1.12	7	0.9
		Type 1	do	1	1	3.60	1	1.0	2.0	7	0.9
		Type 2	do	1	1	2.64	1	0.5	1.5	7	0.9
		LP-40	do	1	2	4	1	1.12	2.25	7	0.9

## NOTES

1 The aggregate grading for the lime-pozzolana concrete should, in the absence of special mix design procedure generally conform to the grading given in IS 383 : 1970.

2 The volumetric proportioning is based on the assumption that a 36 kg bag of LP mixture would be 0.0425 m<sup>3</sup> by volume.

3 For water requirement, the compaction factor should be kept 0.85 ± 0.02 for all the mixes.

- b) *For Use Under Floor Finishes* — Characteristics of ground sub-soil water level, type of floor finish provided and load on the floor;
- c) *For Road Bases and Bonded Underlays, in Composite Rigid Pavement* — Characteristics of subgrade, wheel load for which the slab thickness is designed and the flow of traffic data.

**5.2.1** Lime-pozzolana mixture concrete in foundation for building shall be used only where the strength requirements are not likely to exceed those specified for different situations of work as given in Table 1.

**5.2.2** When properly prepared and laid, lime-pozzolana mixture concrete applied as roof finish serves as an efficient water-tight material and does not usually need any further finishing treatment thereon.

### 5.3 Mix Proportions

Guidance about the mix proportions to be used in the preparation of lime-pozzolana mixture concrete for different situations of use may be obtained from Table 1.

### 5.4 Workability

Because of very good water retention properties of lime-pozzolana mortars, the workability of lime-pozzolana mixture concrete will be found satisfactory with normal conditioning of concrete. The lime-pozzolana mixture concrete mixes generally appear to be dry, but are found workable during compaction. Lime-pozzolana mixture concrete with slumps as low as 15 mm have been found to be satisfactory in practice for a wide range of use. It is desirable to arrive at suitable mix proportions of lime-pozzolana concrete taking into account the details of requirements of work and facilities for compaction available.

### 5.5 Rate of Hardening and Setting Time

The hardening of lime-pozzolana mixture concrete will depend on the lime reactivity of the pozzolana and in general be slower than that of cement concrete but will be satisfactory for most of the normal uses to which it is put in building and road works. Higher the lime reactivity of the pozzolana the quicker will be the rate of setting and hardening of the lime-pozzolana mixture concrete. In case of structural lime-pozzolana mixture concrete subjected to loads, such as in foundations, the work of superstructure shall not be started earlier than a period of seven days after concrete has been laid and consolidated. This condition is however not applicable in case of composite rigid pavement construction.

### 5.6 Strength Requirement

The strength of lime-pozzolana mixture concrete will depend on the type of lime-pozzolana mixture used, water/binder ratio and binder/aggregate ratio. The minimum compressive and flexural strength requirements for different situations of work as applicable to different buildings and roads, using type of lime-pozzolana mixture as specified in IS 4098 : 1983 and quick setting lime pozzolana mixture as specified in IS 10772 : 1983 are given in Table 1.

### 5.7 Durability

Properly prepared, compacted and laid lime-pozzolana mixture concrete is durable under normal exposures. Such concrete possesses considerable resistance to sulphate attack and can be used in foundations, and in areas where the soil contains considerable amount of soluble sulphate and sub-soil water table is high.

## 6 STRENGTH CHARACTERISTICS

**6.1** Lime-pozzolana mixture concrete possesses compressive and flexural strengths comparable to those of lean cement concretes. For determination of compressive and flexural strength of lime-pozzolana mixture concrete, the methods applicable for lime concrete, given in IS 2541 : 1974 may be used. The tests shall be made at 28 days.

**6.2** Lime-pozzolana mixture concrete has reasonably high flexural and ultimate strain-taking capacity. In view of these properties, it can be used with advantage to lay road bases or bonded underlays, foundations and, floor concretes, etc. Compared to crushed stone bases, lime-pozzolana mixture concrete base course spread the load over a much larger area due to its flexural rigidity in the same manner as a rigid base does, thus reducing the stress on the subgrade and inducing smaller deflection.

**6.3** The bond strength between lime-pozzolana mixture concrete and cement concrete is of the order of 1.5 to 2.0 MPa, when the time interval between laying the two layers is not more than one hour.

## 7 PREPARATION OF LIME-POZZOLANA MIXTURE CONCRETE

### 7.1 Coarse Aggregate

Aggregate shall be washed clean and saturated surface dry aggregate shall be used in the preparation of concrete.

### 7.2 Mixing

**7.2.1** For mixing small quantities of lime-pozzolana mixture concrete, hand mixing or hand-operated small mixture may be adopted, whereas for big jobs mechanical mixer may be employed.

### 7.2.2 Hand Mixing

**7.2.2.1** Mixing shall be done on a clean, water-tight platform of sufficient size to provide sample mixing area. The platform shall have tight close joints so that there is no leakage of water or mortar through them and the mixing tool does not strike the joints while in operation.

**7.2.2.2** The coarse aggregate shall first be stacked on an even surface on the platform. The required quantity of fine aggregate and the lime pozzolana mixture shall then be dry mixed by a shovel separately. This mixture shall be evenly spread over the coarse aggregate and the whole thoroughly mixed. The required quantity of water shall be applied with a sprinkler over the top surface and mixing shall be done by turning it over several times, until all the particles of aggregates are covered with mortar and concrete of uniform appearance and consistency is obtained.

### 7.2.3 Machine Mixing

Saturated surface dry coarse aggregate shall first be fed into the mixer. The quantities of sand and lime-pozzolana mixture shall then be added to the mixer. Part of the water shall thereafter be added and the contents mixed. The remaining quantity of water shall then be finally added and the contents mixed well. The total time of mixing shall not be less than 2 minutes, and should be sufficient to ensure uniform mixing.

## 8 LAYING

### 8.1 General

Only that much quantity of concrete shall be mixed which can be laid in position within two hours after mixing. The concrete shall preferably be placed in position immediately after mixing has been completed. Laying and compaction of concrete shall be completed within four hours of adding water.

### 8.2 Lime-pozzolana Mixture Concrete in Foundations and Under Floors

**8.2.1** The bed of ground where concrete is to be laid shall be properly wetted and rammed before concreting is started. Guidance about the mix proportions to be used may be obtained from Table 1.

**8.2.2** The concrete shall be laid carefully in position (not thrown from a height) while quite fresh, in layers not exceeding 150 mm in thickness when consolidated. Care shall be taken while placing the concrete that segregation of aggregate particles and mortar does not take place. Each layer shall be thoroughly rammed and consolidated before succeeding layer is placed. During laying and consolidation, concrete shall be kept free from mixing with leaves,

straw, twigs, dirt and other deleterious matter. Alternatively, heavy duty plate, or surface vibrators may be used for uniform and good compaction.

**8.2.3** Heavy rammers shall be used and ramming shall be continued until a skin of mortar covers the surface and completely hides the aggregate (iron rammers weighing 4.50 to 5.50 kg and not more than 30 000 mm<sup>2</sup> in area are generally found satisfactory). Square rammers are helpful for compaction of edges. No water shall be added during ramming. Where joints in the same layer are unavoidable, the end of each layer shall be sloped at an angle of 30° and made rough to ensure proper bond with new concrete. The surface of each completed layer shall be watered, roughened and cleaned by wire brushing or any other suitable means before the next layer is laid over it. Where vertical joints occur in an upper and a lower layer they shall be at least 600 mm apart horizontally.

**8.2.4** The mixing and ramming shall go on continuously when once started, relief parties being provided to avoid stoppage. This may be achieved by arranging workmen in one or more lines across the width of the concrete, with a lateral space of not more than 450 mm per man. Sufficient labour and materials shall be employed to make up the concrete foundations, layer by layer, simultaneously throughout the whole building when this is not practicable, unfinished layers of concrete shall break joints as described in 8.2.3.

**8.2.5** For large areas, where the thickness of the foundation concrete to be laid and compacted is 150 mm or more, a needle vibrator shall be used to compact the mass of concrete till wet mortar just appears at the top surface of the layer to be compacted.

NOTE — Generally concrete laid in 200 mm thick layers gives thoroughly compacted layer of 150 mm thickness.

### 8.2.6 Curing

**8.2.6.1** After laying and compaction has been completed, lime-pozzolana mixture concrete shall be cured for the first 48 h by covering it with wet hessian and for a further period of not less than 10 day by spreading wet sand or gunny bags and watering frequently in moderate quantities.

**8.2.6.2** In case of concrete in foundations, no brickwork or masonry shall be laid on concrete for a period of at least seven days after laying or till such period the engineer-in-charge feels it necessary.

### 8.3 Lime-pozzolana Concrete in Haunches of Arches

**8.3.1** The concrete of suitable mix proportions,

the guidance of which may be obtained from Serial No. 1, Table 1, shall be laid to the required thickness and level in layers not exceeding 100 mm in thickness. Compaction and ramming shall be continued till wet mortar just appears at the top surface if the layer is to be consolidated.

### 8.3.2 Curing

The surface shall be continuously cured for not less than a total of 21 days as described in 8.2.6.

## 8.4 Lime-pozzolana Mixture Concrete in Roof Finish

**8.4.1** Lime-pozzolana mixture concrete apart from its use as a structural material in several situations in building construction is also used for roof finish and serves as an effective waterproofing medium.

**8.4.2** The concrete of suitable mix proportions as given at Serial No. 1, Table 1, shall be used in roof finish.

### 8.4.3 Laying

**8.4.3.1** For sufficient planning, design and laying of the water-tight finish, the basic information, design considerations and preparation of roof surface shall be as given in IS 3067 : 1988.

**8.4.3.2** The concrete shall be laid to the required thickness and levels not exceeding 100 mm in thickness.

**8.4.3.3** If the roof is flat, the slope required for drainage may be given in lime-pozzolana concrete layer, but the minimum compacted thickness (*see 8.4.3.4*) of the concrete layer shall nowhere be less than 7.5 cm.

**8.4.3.4** After the lime-pozzolana mixture concrete is laid, it shall be initially rammed with a rammer weighing not more than 2 kg and the finish brought to the required evenness and slope. Further compaction shall be done by workers who will sit close together, beat the surface lightly with wooden *THAPPIES* (light wooden rammer) in rhythm and move forward gradually.

**8.4.4** Curing shall be done in accordance with the procedure given in 8.3.2.

### 8.4.5 Treatment of Junction Between Roof Finish and Parapets

The details of treatment of junction between roof finish and parapets should follow the requirements for lime concrete waterproofed finish given in IS 3036 : 1980.

### 8.4.6 Finish

**8.4.6.1** In extreme climates where there is a considerable expansion and contraction, two

layers of tiles may be put on the top of the lime-pozzolana concrete. The tiles should be jointed with an impervious mortar for such a finish, maintenance will be confined to the top most finish only.

**8.4.6.2** The protection against water penetration for the roof finish is enhanced by efficient drainage of surface water. For this purpose, slope of the terrace with lime-pozzolana concrete and tiles finish shall not be less than 1 in 60 and the slope in the case of plain lime-pozzolana concrete finish shall not be less than 1 in 50.

**8.4.6.3** For every 40 m<sup>2</sup> of roof area, one 100-mm diameter rainwater pipe shall be provided.

## 8.5 Lime-pozzolana Mixture Concrete in Laying Road and Airfield Bases and Improved Base Concrete Under Floor

**8.5.1** Lime-pozzolana mixture concrete of suitable mix proportions, the guidance of which may be obtained from Serial No. 2, Table 1, shall be used for laying road bases and improved base concrete under floor.

**8.5.2** The formwork of the same height as the thickness of the base or sub-base to be laid shall be fixed upon the subgrade. The levels of the formwork and subgrade shall be examined so that a uniform required thickness shall be laid with tolerance of  $\pm 6$  mm.

**8.5.3** Compaction shall be done in the conventional manner using either needle and screed vibrator or 8-10 tonne roller, depending upon the condition of the project.

**8.5.4** Suitable contraction joints shall be provided at intervals of 5 to 8 metres.

**8.5.5** Curing shall be done in accordance with the procedure given in 8.3.2.

## 8.6 Lime-pozzolana Mixture Concrete in Laying Bonded Underlays

**8.6.1** Lime-pozzolana mixture concrete shall be used for laying composite rigid pavement, using it as bonded underlay under comparatively thin cement concrete surfacing (overlay). For the lime-pozzolana mixture concrete underlay, guidance about the mix proportions may be obtained from Serial No. 3, Table 1.

**8.6.2** Weigh-batching of material is preferred in such constructions. However, volume batching may be permitted if adequate precaution is adopted. In case of weigh-batching a swing-type weigh-batcher with two buckets to weigh the materials of lime-pozzolana concrete for the underlay and of cement concrete for the overlay may be installed at the construction site.

**8.6.3 Concrete Mixer**

Two concrete mixers of capacity 0.20 to 0.25 m<sup>3</sup> shall be run for separate mixing of the lime-pozzolana concrete and cement concrete, as the two materials shall be laid simultaneously.

**8.6.4 Lime-pozzolana mixture concrete underlay** up to a compacted thickness of 150 mm shall be compacted and finished by a screed vibrator notched at the ends (*see Note*) whereas for thickness of more than 150 mm needle vibrator shall also be used.

NOTE — Notched screed vibrator is the one in which the wooden board of the vibrator shall be cut at both ends in such a way that the bottom of wooden board is at the level of the finished underlay and that the boards slides freely on the formwork.

**8.6.5 Method of Construction**

Lime-pozzolana mixture concrete shall be prepared in one of the mixers and laid up to the required thickness by giving sufficient surcharge of this material at the top so that complete compaction by the notched screed vibrator shall

be achieved. As laying of the underlay up to about 10 m is completed, the manufacture of concrete may be started with the second mixer. The laying of concrete overlay shall then be commenced from the starting end, which shall be compacted and finally finished by an ordinary vibrating screed. The process of laying, compacting and finishing of underlay and the process of overlaying with concrete shall be so synchronized that a time lag of not more than one hour occurs between the two operations.

**8.6.6** All the conventional requirements of cement concrete road construction in respect of laying, finishing, provision of joints, etc. shall be followed.

**8.7 Lime-pozzolana Mixture Concrete in Making Solid Building and Paving Blocks**

Lime-pozzolana mixture concrete shall be used for making solid building and paving blocks. Guidance about the mix proportions may be obtained from Serial No. (iii), Table 1, IS 3115 : 1978, IS 10049 : 1981 and IS 10359 : 1982.

**ANNEX A**

( Clause 2 )

**LIST OF REFERRED INDIAN STANDARDS**

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
383 : 1970	Specification for coarse and fine aggregate from natural sources for concrete ( <i>second revision</i> )	3115 : 1978	Specification for lime based blocks
2541 : 1977	Code of practice for preparation and use of lime-concrete ( <i>first revision</i> )	3182 : 1986	Specification for broken brick (burnt clay) fine aggregates for use in lime-mortar ( <i>first revision</i> )
2686 : 1977	Specification for cinder as fine aggregates for use in lime-concrete ( <i>first revision</i> )	4098 : 1983	Specification for lime-pozzolana mixture ( <i>first revision</i> )
3036 : 1980	Code of practice for laying lime-concrete for a waterproofed roof finish ( <i>first revision</i> )	4305 : 1967	Glossary of terms relating to pozzolana
3067 : 1988	Code of practice for general design details and preparatory work for damp-proofing and water-proofing of building ( <i>first revision</i> )	6508 : 1988	Glossary of terms relating to building lime-pozzolana ( <i>first revision</i> )
3068 : 1986	Specification for broken brick (burnt clay) coarse aggregates for use in lime-concrete ( <i>first revision</i> )	10049 : 1981	Code of practice for manufacture of lime based blocks
		10359 : 1982	Code of practice for manufacture and use of lime-pozzolana concrete blocks for paving
		10772 : 1983	Specification for quick setting lime-pozzolana mixture



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## 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 445-446, Sector 35-C, CHANDIGARH 160036

{ 53 38 43, 53 16 40  
53 23 84

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

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