No. PL-50 (16)/71-SP *Dated the 8th May, 1975*

To

All State Govts. Administrations of Union Territories (Deptts. dealing with Roads)

Sub : Utilisation of Fly Ash in Road Construction

I am directed to say that the question of utilisation of Fly Ash in Road Construction has been engaging the attention of the Government of India for quite sometime and they set up a Technical Group also to go into it. Thereafter, the entire matter was considered by the Committee of Economic Secretaries. As a result certain instructions on the subject have been framed which are enclosed for immediate implementation by the State Governments.

2. I am to request that the contents of the enclosed instructions may kindly be given wide publicity among all officers of your Department engaged on National Highways/Centrally aided works for compliance. Similar instructions may be issued to the Staff engaged on road works in the State Sector also. In particular I am to draw your specific attention to paras 4 and 5 of the instructions at Annexure I, which need immediate action.

ANNEXURE I

Enclosures to Ministry's letter No. PL-50 (16)/71-SP *Dated the 8th May, 1975*

Instructions to State Governments regarding utilisation of Fly-ash in Road Construction.

Sub : Utilisation of fly ash in road construction

Fly ash is an industrial waste from thermal power stations using pulverised coal as boiler fuel. At present about 6-7 million tonnes of fly ash is produced annually in the country and this figure is expected to rise to over 12 million tonnes in the next ten years. Disposal of this huge quantity of fly ash which gets easily air borne and thus is a health hazard to the community, has gown into a pressing problem. On the other hand both laboratory and field studies have confirmed that this waster material can be used profitably in road construction by taking advantage of its pozzolanic action with lime leading to economy in cost.

2. Despite its known merits, utilisation of fly ash for road construction in this country has been very limited. This could be attributed to two main reasons, namely :—

(i) non-availability of fly ash of assured quality among other factors due to the mixing of fly ash with coarse bottom ash at the extraction stage in power plants, and

(ii) virtual absence of a marketing system assuring to the consumers supply of fly ash as per ISI specifications.

For overcoming these deficiencies simultaneous action is being taken to collect fly ash in an unmixed form and to market it with assurance about its quality. With these measures coming into operation, it is felt that there should be no difficulty in greater utilisation of fly ash for road works.

3. To propagate the use of fly ash on a wider scale, the Central Assessment Committee under this Ministry has finalised some specifications using this material:—

(i) lime-fly ash soil stabilisation;
(ii) lime-fly ash concrete;
(iii) lean cement-fly ash concrete; and
(iv) cement-fly ash concrete.

Brief notes giving essential features of these specifications as approved by the CAC are enclosed at appendix II to V. The CAC is taking further steps towards popularising these specifications. Indian Standards Institution has already laid down quality requirements of fly ash vide IS : 3812 (Part I) "Specification for Fly Ash for Use as Pozzolana" and IS : 3812 (Part II) "Specification for Fly Ash for Use as Admixture for Concrete" and IS : 3812 (Part III) "Specification for fly Ash for Use as Fine Aggregate for Mortar and Concrete." IS : 3812 (Part I) will apply to specification (iv) above, IS : 3812 (Part II) to specifications (ii) and (iii) above and IS : 3812 (Part III) to specification (i).

4. Out of the above specifications one that can be put into practice immediately is stabilisation of alluvial soil with lime and fly ash. This is akin to lime stabilisation except that a percentage of fly ash is incorporated along with lime. Laboratory studies and field trials have shown that this specification can be profitably employed for construction of sub-base on all classes of roads, and even as a base on lightly trafficked roads. As a positive step towards exploiting the benefits of this specification, it has been decided by the Committee of Economic Secretaries that for construction of sub-bases on National Highway Works, where these jobs fall within economic orbit of the thermal power stations, lime-fly ash stabilisation should be increasingly used in place of conventional granular materials like brick soling and over-size W.B.M. Proposals for National Highway works should in future be framed keeping this requirement in view. Similarly it has been decided that lime fly ash stabilisation should be used as much as feasible for the construction of sub-base/base courses on roads under the control of State Governments.

5. For actual application of the above specification on specific works, it will be necessary to determine mix proportions using local soil

and available lime/fly ash. This could be done through the State laboratory/Central Road Research Institute taking design factors into consideration.

APPENDIX II

ENCLOSURE TO ROADS WING'S LETTER NO. PL-50 (16)/71 DATED THE 8th MAY, 1975

RECOMMENDED PRACTICE FOR LIME FLY ASH STABILIZED SOIL AS SUB BASE IN PAVEMENT CONSTRUCTION

(As finalised by the Central Assessment Committee)

1. **Introduction:**

In many parts of the country fly ash is available as a waste product from the Thermal Power Plants. This recommended practice describes a method of utilising fly ash for stabilisation of soils with the help of lime so as to replace the soling or oversize metalling in sub-base course of the pavement.

2. **Description :**

This work consists of stabilising soil with a mixture of lime and fly ash for use as a sub-base course in road pavements.

3. **Design :**

The thickness of the sub-base should be designed as per Indian Roads Congress-37:1970 entitled "Guidelines for the Design of Flexible pavements". The C.B.R. value of the stabilized soil is to be determined in the laboratory for pavement design purposes. It has been observed that soils stabilized with lime fly ash mixture give a soaked laboratory C.B.R. value of 40-70 which should yield a field soaked C.B.R. value of 20-35. A typical mix proportion of such a mix is given in para 5.1.

4. **Materials :**

4.1. **Soil :** Normally soils with a Plasticity Index (PI) between 5 and 20 are suitable. This technique may also be applied to soils having PI value beyond these limits provided detailed investigations show that these will be suitable.

4.2. **Lime :** Normally lime used in the stabilization works should have a purity (Ca O plus Mg O content) of not less than 60% when tested in accordance with IS : 1514.

4.3. **Fly ash :** Fly ash should conform to I.S. 3812 (Part III)—1966.

4.4. **Water :** Water used for both mixing and curing the stabilized soil should be clean and free from injurious amount of deleterious matter. Potable water is generally considered satisfactory for mixing and curing lime fly ash stabilized soil.

5. **Mix Proportions:**

5.1. The mix proportion should be determind through laboratory tests meeting the strength requirements (see para 3 above). A typical mix proportion of soil, lime, fly ash is given below :

Soil :	—	85 parts by weight
Lime :	—	3 parts by weight (based on 80% purity of lime)
Fly ash:	—	12 parts by weight.

5.2. **Water :** The quantity of water should be as per the O.M.C. requirements determined on soil, lime fly ash misture by Proctor density method.

6. **Construction :**

Lime—Fly ash stabilized soil utilizes the same construction technique as used for lime or cement stabilisation. It is preferable that mixing is done by mechanical plants either of single pass or multiple pass type. Where such plants are not available, manual method may be adopted with rigorous control over quality of construction. In the manual method, the soil is pulverised by means of crowbars, pick axes, bullock-drawn ploughs etc. and deposited on the road bed in stacks of suitable size about 30 cm in height. Water in requisite quantities may be sprinkled on the soil for aiding pulverisation. The degree of pulverisation should be as given in the below table.

Sieve designation	Percent by wt. passing the seive.
25mm	100
4.75 mm	60

On the pulverised soil stacks, lime and fly ash in a thoroughly mixed form and in requisite quantities should be spread uniformly and mixed by cutting with spades till the whole mass is uniform. The mixed soil should then be spread over the prepared sub-grade to the required thickness and rolled. Before rolling the moisture content should be adjusted to be within +1% and −2% of O.M.C.

7. **Rolling:**

Rolling should be done with 8-10 tonne roller. Rolling is continued till the required density (100% of Lab. Proctor density) and a smooth surface is obtained without leaving any roller marks on the surface.

8. **Curing:**

The compacted surface should be cured for a minimum period of 7 days before the next layer is placed. Curing is done by sprinkling water over the surface 5 or 6 times a day. The surface should not be allowed to dry during the curing period. Curing by ponding should not be adopted.

APPENDIX III

(Enclosure to Roads Wing's letter No. PL-50 (16)/71 Dated the 8th May, 1975)

RECOMENDED PRACTICE FOR LIME-FLY ASH CONCRETE

(As finalised by the Central Assessment Committee)

1. **Introduction:**

The following is the recommended practice for lime-fly ash concrete which can be used in pavement as base/sub-base in flexible and rigid pavement construction. This is particularly useful as a base course in heavy rainfall areas or in black cotton soil areas when laid over lime stabilized black cotton soil.

2. **Description:**

This work consists of providing lime-fly ash concrete as sub-base or base course in flexible or rigid pavement construction.

3. **Design:**

3.1. **Thickness:** The thickness of the base/sub base for flexible pavements is to be designed as per C.B.R. method of design (Indian Roads Congress : 37-1970) "Guidelines for Design of Flexible Pavements", with the adoption of an equivalency factor of 1.25 to 1.5 depending on the discretion of the designer for lime fly-ash concrete and then if need be, checking the load factor of lime fly ash concrete slab through Meyerhof equation for ultimate load which would take care of both flexible and semi-rigid pavement design considerations. For sub-base under rigid pavements, the pavement is to be designed as per Indian Roads Congress : 58-1974. "Guidelines for the Design of Rigid Pavements for Highways". In any case the thickness of the layer should not be less than 10 cm.

4. **Materials:**

4.1. **Lime:** Lime used in these works should have a purity of not less than 60% when tested in accordance with IS : 1514.

4.2. **Fly ash:** Fly ash should conform to IS : 3812 (Part II)-1966.

4.3. **Coarse and Fine Aggregates :** Should conform to I.S. 383-1970.

4.4. **Water :** Water used for both mixing and curing the lime-fly ash concrete shall be clean and free from injurious amount of deleterious matter. Potable water is generally considered satisfactory.

5. **Strength and Mix Proportions:**

The 28 day compressive strength of lime-fly ash concrete should be in the range of 40-60 kg/cm^2. The actual mix to be used should be designed in the laboratory by trial and error.

Guidance about the suitable mix proportion to be used in preparation of Lime Fly ash concrete utilisin g good quality crushed stone, medium coarse sand and fly ash can be had from the following typical mix.

Typical Mix Proportion by weight :

Lime	—	1 Part (based on 80% purity of lime)
Fly ash	—	2 parts
Fine Agg.	—	2.7 parts
Coarse Agg.	—	6.3. parts
Water	—	11% by weight on dry mix.

6. **Construction:**

The construction technique for lime-fly ash concrete bases is similar to cement concrete construction in respect of batching, mixing and placement excepting compaction. The compaction of the mix is done by rolling with 8-10 tonne roller.

7. **Curing:**

The compacted surface should be cured for a minimum period of 7 days before the next layer is placed. Curing is done by sprinkling water 5 or 6 times a day, over the surface. The surface should not be allowed to dry during the curing period. Curing by ponding should not be adopted.

8. **Surfacing:**

Rigid pavement can be laid directly over the Lime Fly ash concrete bases. In case of flexible pavements, a minimum cover 10 cm thick consisting of either W.B.M. or any bitumen-bound layer should be provided before laying the wearing surface.

APPENDIX IV

(Enclosure to Roads Wing's letter No. PL-50 (16)/71 dated the 8th May, 1975).

RECOMMENDED PRACTICE FOR LEAN CEMENT-FLY ASH CONCRETE

(As finalised by the Central Assessment Committee)

1. **Introduction:**

Lean cement-fly ash concrete can be used in all constructions where lean cement concrete is used. It can be used as sub-base/base course in flexible and rigid pavement construction. Addition of fly ash in lean cement concrete mixes, decreases bleeding and segregation, improves plasticity and cohesiveness and permits easier placing and finishing of concrete.

2. **Description:**

This work consists of prov' ling lean cement-fly ash concrete as sub-base or base course in flexible or rigid pavement construction. With suitably designed mixes of such concrete, it is possible to achieve substantial saving in cement to the extent of 35-40 per cent compared to conventional lean concrete mixes.

3. **Design:**

3.1. **Thickness :** The layer thickness for flexible pavements is to be designed as per Indian Roads Congress:37-1970 "Guidelines for the design of Flexible Pavements", taking the equivalency factor of lean-cement fly ash concrete in terms of granular material such as W.B.M. in the range of 1.25 to 1.5, depending on the designer's discretion and then if need be, checking the load factor of the lean concrete slab through Meyerhof equation for ultimate load which would take care of both flexible and semi-rigid pavement design considerations. For sub-base under rigid pavements, the pavement is to be designed as per Indian Roads Congress:58-1974, "Guidelines for the design of Rigid Pavements for Highways". In any case, the thickness of the layer should not be less than 10 cm.

4. **Materials:**

4.1. **Cement :** Should conform to I.S. 269-1967.

4.2. **Fly ash :** Should conform to I.S. 3812 (Part II)-1966 "Specification for Fly ash, Part II for use as admixture for concrete".

4.3. **Coarse and Fine Aggregate :** Should conform to I.S. 383-1970.

4.4. **Water :** Water used for both mixing and curing should be clean and free from injurious amount of deleterious matter. Potable water is generally considered satisfactory.

5. **Strength and Mix Proportions:**

5.1. The 28 day compressive strength of lean cement-fly ash concrete should be in the range of 40-60 kg/cm^2. The actual mix to be used should be designed in the laboratory by trial and error.

Guidance about the suitable mix proportions to be used in preparation of lean cement-fly ash concrete utilising good quality crushed stone, medium coarse sand and fly ash can be had from the following typical mix.

Typical mix proportion by weight :

Cement	...	1 part
Sand	...	3.5 parts
Fly ash	...	3.5 n parts (where n = ratio of the specific gravities of fly ash and sand which usually ranges between 0.8 and 0.85)
coarse aggregate	...	14 parts

5.2. **Water requirements :** Because of higher specific surface of the fly ash, the water content required will be substantially more than ordinary Lean Cement Concrete, in order to keep the same workability. A water cement ratio of the order of 2.2 is usually found suitable.

6. **Construction:**

Lean cement fly ash concrete is required to be mixed in a concrete mixer and compacted by rolling with 8.10 tonne roller as is done in the case of Lean Cement Concrete.

7. **Curing:**

The compacted surface should be cured for a minimum period of 7 days before the next layer is placed. Curing is done by sprinkling water 5 or 6 times a day, over the surface. The surface should not be allowed to dry during the curing period.

8. **Surfacing:**

Rigid pavement can be laid directly over the lean cement-fly ash concrete bases. In case of flexible pavements, a minimum cover of 10 cm thick consisting of either W.B.M. or any bitumen-bound layer should be provided before laying the wearing surface.

APPENDIX V

Enclosure to Roads Wing's Letter No. PL-50 (16)/71, Dated the 8th May, 1975

RECOMMENDED PRACTICE FOR CEMENT FLY-ASH CONCRETE

(As finalised by the Central Assessment Committee)

1. **Introduction:**

Cement-Fly ash concrete consists of cement concrete in which upto 20% of cement is replaced by fly-ash. Cement fly-ash concrete can be used in all paving works where plain cement concrete is permissible. By adopting proper mix design method, more economical mixes can be produced with cement fly ash concrete as compared to plain cement concrete, for the same design strength.

2. **Design:**

2.1. **Thickness :** The thickness of cement-fly ash concrete slab should be designed as per Indian Roads Congress : 37-1970 "Guidelines for the design of Rigid Pavements for Highways".

2.2. **Mix-design :** The mix is to be designed on the basis of absolute volume method as per Indian Roads Congress : 44-1972 "Tentative guidelines for cement concrete mix design". While calculating water for the mix, ratio of water/(Cement + Fly ash) is to be taken instead of water/cement ratio.

3. **Materials:**

3.1. **Cement :** Should conform to I.S. 269-1967.

3.2. **Fly ash** : Should conform to I.S. 3812 (Part I)-1969.

3.3. **Coarse and Fine Aggregates** : Should conform to I.S. : 383-1970.

3.4. **Water** : Water used for both mixing and curing should be clean and free from injurious amount of deleterious matter. Potable water is generally considered satisfactory.

4. **Construction:**

Cement Fly ash concrete is identical in construction to cement concrete pavements, with the only difference that part of cement is replaced by fly ash at the batching stage.

6300.2

No. PL-50 (3)/76-SP *Dated the 8th March, 1976*

To

All Superintending Engineers/Chief Engineers in the Roads Directorate at headquarters.
All Engineer Liaison Officers/Regional Officers.

Sub : Utilisation of fly ash in road construction

Vide letter No. PL-50 (16)/71 dated the 8th May, 1975, instructions had been issued to all the State Governments for ensuring greater utilisation of fly ash in road construction. A copy of the letter was endorsed to all Officers of the rank of Superintending Engineer and above in the Roads Wing at headquarters and all Engineer Liaison Officers/Regional Officers for information and follow-up action.

2. In the letter refferred to, the State Govts, were advised that for construction of sub-bases on National Highways works, situated within an economic orbit of the thermal power stations, lime-fly ash stabilisation should be increasingly used in place of conventional granular materials like brick soling and over-size W.B.M., and that proposals for future N.H. works should be framed keeping this requirement in view. The economic application of fly-ash techniques will depend on the lead from nearest thermal power station and the cost of traditional construction materials, but it is expected that fly ash use will generally be advantageous within about 50-100 kms. of the power stations.

3. Director General (Road Development) has desired that all Chief Engineers/Superintending Engineers in the Roads Directorate may examine the on going as well as future road works in their zones to see to what extent fly ash stabilisation could be prescribed for sub-base construction. This should be done on a priority basis. As regard availability of fly-ash in different areas, a map of India showing the N.H. system and the approximate location of the thermal power stations is enclosed for reference.

6300.3

No. RW/RD/8/WB/77-OR *Dated the 17th March, 1983*

To

The Chief Engineers of all States, dealing with National Highways/Other Roads

Sub : Research Project R-2-Spectrum of Axle Loads on National Highways—Dissemination of Study Results

As the State PWDs are aware, the Ministry sponsored sometime back a project on the spectrum of axle loads on National Highways with the following objectives :

(i) To collect data about the frequency distribution of axle loads of commercial vehicles plying on different roads in different regions.
(ii) To rationalise the procedure of design of road-pavement based on collective data received from different regions.
(iii) To collect data about traffic intensity and its breakup.
(iv) To streamline the policy about weights and dimensions of vehicles.
(v) To evolve a suitable method for design of road crust based on axle load distribution in the region.

2. Earlier to this project there was hardly any data collected about axle loads distribution on commercial vehicles plying on different roads in different regions in the country. The pavement design procedure currently being followed is based on the number of commercial vehicles of more than 3 tonnes laden weight regardless of the axle load frequency distribution. The study on axle load distribution has now been completed in respect of important National Highways in the States of Haryana, Rajasthan, Uttar Pradesh, West Bengal, Maharashtra, Gujrat, Kerala and Tamil Nadu. A summary of the results of the study is enclosed for your information and further necessary action.