Industrial waste in highway construction

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Introduction

Civilization also produces waste products. Disposal issue of the waste products is a challenge. Some of these materials are not biodegradable and often leads to waste disposal crisis and environmental pollution. The present article seeks the possibilities of whether some of these waste products can be utilized as highway construction materials.

Traditionally soil, stone aggregates, sand, bitumen, cement etc. are used for road construction. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Concerned about this, the scientists are looking for alternative materials for highway construction, and industrial waste product is one such category. If these materials can be suitably utilized in highway construction, the pollution and disposal problems may be partly reduced.

The following table presents a partial list of industrial waste materials that may be used in highway construction:

Table-1: Possible usage of industrial waste products in highway construction

Waste product	Source	Possible usage
Fly ash	Thermal power station	Bulk fill, filler in bituminous mix, artificial aggregates [1]
Blast furnace slag	Steel industry	Base/ Sub-base material, Binder in soil stabilization (ground slag) [1]
Construction and demolition waste	Construction industry	Base/ Sub-base material, bulk-fill, recycling [2]
Colliery spoil	Coal mining	Bulk-fill [2]
Spent oil shale	Petrochemical industry	Bulk-fill [2]
Foundry sands	Foundry industry	Bulk-fill, filler for concrete, crack-relief layer [4]
Mill tailings	Mineral processing industry	Granular base/sub-base, aggregates in bituminous mix, bulk fill
Cement kiln dust	Cement industry	Stabilization of base, binder in bituminous mix [5]
Used engine oil	Automobile industry	Air entraining of concrete [6]
Marble dust	Marble industry	Filler in bituminous mix [7]
Waste tyres	Automobile industry	Rubber modfied bitumen, aggregate. [3]
Glass waste	Glass industry	Glass-fibre reinforcement, bulk fill [3]
Nonferrous slags	Mineral processing industry	Bulk-fill, aggregates in bituminous mix [3]
China clay	Bricks and tile industry	Bulk-fill, aggregates in bituminous mix [8]

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Material acceptability criteria

Roads are typically constructed from layers of compacted materials, and generally its strength decreases downwards. For conventional materials, a number of tests are conducted and their acceptability is decided based on the test results and the specifications. This ensures the desirable level of performance of the chosen material, in terms of its permeability, volume stability, strength, hardness, toughness, fatigue, durability, shape, viscosity, specific gravity, purity, safety, temperature susceptibility etc., whichever are applicable. There are a large number tests suggested by various guidelines/ specifications; presently the performance based tests are being emphasized, rather than the tests which estimate the individual physical properties.

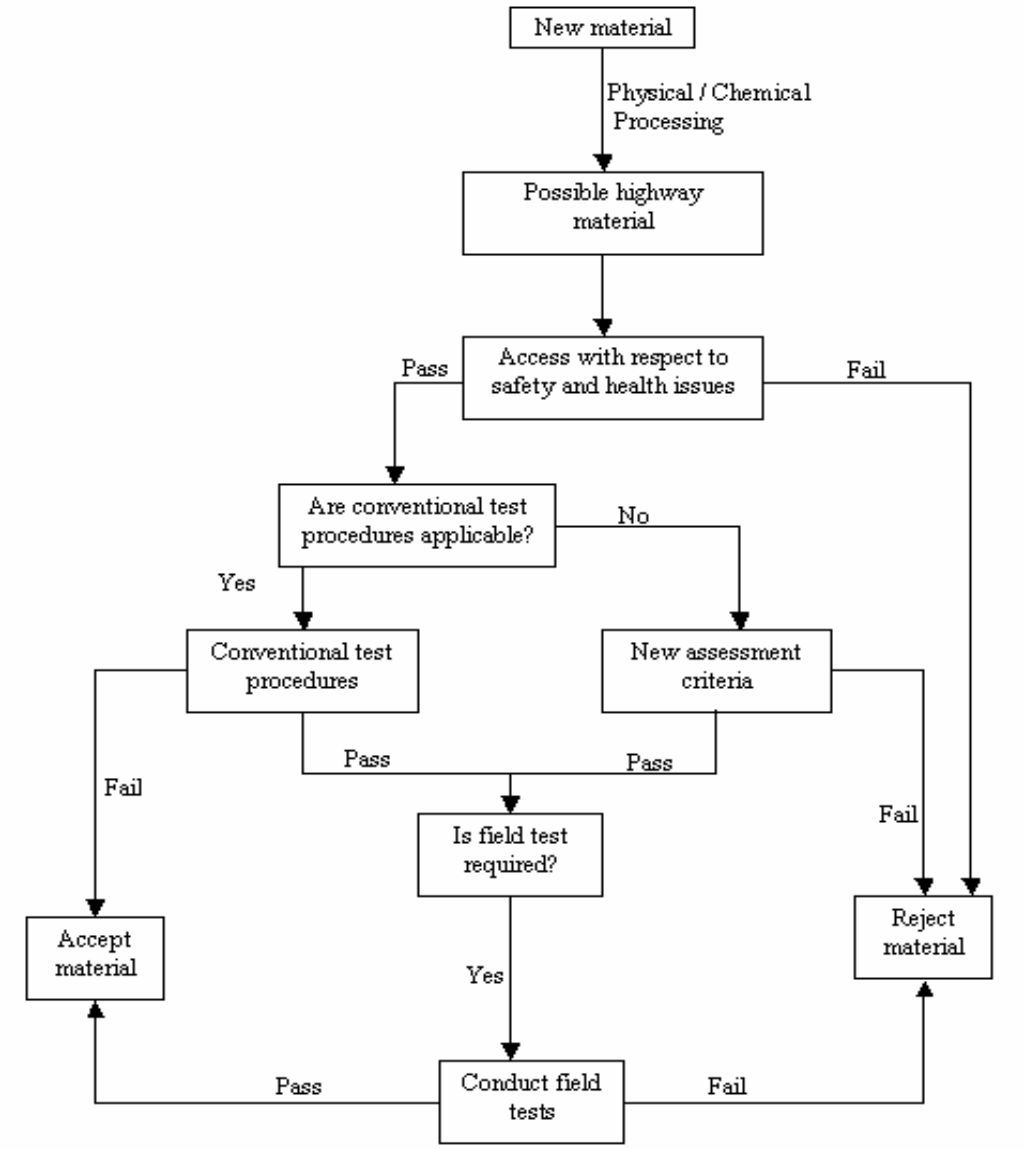

Figure-1 Evaluation industrial waste for suitability in highway construction

The tests and specifications, which are applicable for conventional materials, may be inappropriate for evaluation of non-conventional materials, such as industrial wastes. This is because the material properties, for example, particle sizes, grading and chemical structure, may differ substantially from those of the conventional materials. Thus for an appropriate assessment of these materials, new tests are to be devised and new acceptability criteria are to be formed. However, with the advent of performance based tests, it is expected that the performances of the conventional as well as new materials can be tested on a same set-up and be compared. Figure-1 presents a flow chart to evaluate the suitability of industrial waste for potential usage in highway construction. Health and safety considerations should be given due importance handing industrial waste materials [1, 9].

Suitability of industrial wastes as highway material

Limited information is available on suitability of individual industrial wastes for its utilization in highway construction. The following table (Table-2) summarizes the advantages and disadvantages of using specific industrial wastes in highway construction.

Table-2 Suitability of using industrial waste products in highway construction

Material	Advantages	Disadvantages
Fly ash	Lightweight, can be used as binder in stabilized base/ sub-base because of pozzolanic properties.	Lack of homogeneity, Presence of sulphates, slow strength development [2].
Metallic slag (a) Steel slag	Higher skid resistance	Unsuitable for concrete works and fill work beneath concrete slabs.
(b) Nonferrous slag	Light weight (phosphorus slag) [3]	May show inconsistent properties.
Construction and demolition waste	Being strong can be used as aggregates granular base.	May show Inconsistent properties.
Blast furnace slag	Used in production of cement, granular fill.	Ground water pollution due to Leachate in used as unbound aggregates [9]
Colliery spoil	-	Combustion of unburnt coal, Sulphate attack in case of concrete roads [2].
Spent oil shale	-	Burning of combustible materials.
Foundry sands	Substitute for fine aggregate in asphalt mixes.	Presence of heavy metals in non ferrous foundry origin, less affinity to bitumen [4].
Mill tailings	Some are pozzolanic in nature.	Presence of poisonous materials (e.g., cyanide from gold extraction).
Cement kiln dust	Can be used in soil stabilization because of its hardening property when exposed to moisture [5].	Corrosion of metals (used in concrete roads) in contact because of significant alkali percentage.
Used engine oil	Being very good air entertainer could be used in concrete works [6].	Requires well organized oil collection system [6].

Waste tyres	Enhances fatigue life	Requires special techniques for fine grinding and mixing with bitumen, sometimes segregation occurs.

Conclusion

It appears that some of the industrial waste materials may find a suitable usage in highway construction. However, environmental consequences of reuse of such materials needs to be thoroughly investigated.

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