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Need for guidelines to address environmental concerns in a ready mixed concrete plant

Sudhir Misra and Shweta Varsney

Increase in the use of concrete in construction has brought with it a rapid increase in the number of ready mixed concrete plants in the country. However, a comprehensive framework to address relevant issues relating to environmental protection and pollution control arising out ready mixed concrete plants is not yet in place. It should be noted that ready mixed concrete plants may discharge highly alkaline wastewater, emit fine particles into the atmosphere and be a source for noise pollution. This document provides information about relevant details from codes and specifications from outside India and compares the provisions with the extant Indian provisions. A framework for a better regulatory mechanism in the country in the form of Draft Indian Standard is also included as an Appendix.

Concrete is a vital construction material and at times the per capita consumption of concrete or cement is regarded as a measure of industrialization in an economy. Advancement in mechanization and construction technology in India has seen a rapid increase in the number of Ready Mixed Concrete (RMC) plants in the country, both in the organized and the unorganized sector. It is important that appropriate safeguards are put in place to ensure sustainable growth and make sure that the related environmental concerns (relating to water, air and land) are appropriately handled. Several documents in the world lay limits for different parameters which are representative of the impact that a RMC plant on the environment.[1-8]

On the contrary a study of the corresponding Indian Standard (IS 4926: 2003) shows there is need to strengthen some of the provisions therein in order to safeguard the environment and ensure sustainable growth.[9] In this context, it may also be noted that agencies such as the European Ready Mixed Concrete Organization and the National Ready Mixed Concrete Association (USA) have published reasonably comprehensive guidelines addressing several issues important from the point of view of minimizing the environmental impact of ready mixed concrete plants.[10,11]

Table 1. Effluent limits wastewater according to different regulations

Parameters	CPCB, India, General standards for discharge of environmental pollutants (India)		State of Tannessee, NPDES general permit for discharge of storm water runoff or process wastewater, associated with ready mixed concrete facilities (US)		Irish Concrete Federation (UK)	British Columbia Code of Practice for the Concrete and Concrete Products Industry (Canada)	Environmental Guidelines for the Concrete Batching Industry, Environment Protection Authority State Government of Victoria (Australia)
	Inland surface water	Public sewer	Process water	Storm water			
TSS	100	600	50	150	35	75	80
pH	5.5-9.0	5.5-9.0	6.0-9.0	6.5-9.0	The discharge should not cause the pH of the receiving waters to exceed 9	6.5-9.0	6.0-9.0
Total recoverable iron	3.0	3.0	5.0	5.0			
COD	250	-	-	120			

Units are in milligram per litre or otherwise stated; TSS- Total Suspended Solids; COD-Chemical Oxygen Demand; CPEB = Central Pollution Control Board; NPDES = National Pollutant Discharge Elimination System, USA

Table 2. Dust emission limits according to different regulations

CPCB, India (General emission standards, Part D)	Concentration of particulate matter should not exceed 150 mg/Nm^3
Irish Concrete Federation	For point emissions, the concentration of particulate matter in emissions to air should not exceed 50 mg/m^3. In effect this means that there should be no visible dust plume.
	For fugitive emissions, dust deposition from the activity beyond the site boundary should not exceed 350 mg/m^2/day monthly mean in accordance with TA Luft VDI Method 2119 (Bergerhoff Gauge).
British Columbia Code of Practice for the Concrete and Concrete Products Industry	The opacity of silo emissions discharged to the air must not exceed 10% averaged over 6 consecutive minutes.
Environmental Code of practice for concrete producing plants, Govt. of Alberta, 1996	The opacity from all air emission sources at the concrete producing plant shall not exceed 40 percent, averaged over a period of 6 consecutive minutes. The concentrations of particulates in the effluent stream from the concrete producing plant's cement and fly ash silos to the ambient air shall not exceed 0.20 grams per kilogram of effluent.
Emission Regulation for Ready Mix Concrete and Concrete Products Industries, Greater Vancouver Regional District	Discharges of Air Contaminants from Fabric Filter Systems must not exceed five (5) per cent Opacity, averaged over a 6-minute period measured at the point of discharge into the Air. Discharges of Fugitive Dust must not exceed 20 per cent Opacity, averaged over a 6-minute period measured at the point of discharge into the Air

An attempt has been in this document to briefly discuss some of the potential environmental concerns associated with RMC plants and propose a draft document that can be used as a basis for modification of IS 4926 or lay down a fresh standard, should a need for that be felt. It may be noted that at this stage, perhaps, the numbers suggested as limits are not as important as is the principle that there is a need to put in place a document of the nature contained in the Appendix.

Background

It may be noted that in India IS 4926 addresses more or less all issues relating to ready mixed concrete plants, including production and quality. On the other hand, several countries in the world where use of ready mixed concrete is more prevalent in fact have guidelines and standards specifically targeted to address environmental concerns such as water and air pollution. In the absence of such guidelines in India reference was made to

Table 3. Noise emission limits according to different regulations

<table>
<tr><td>Irish Concrete Federation</td><td>Activities on-site shall not give rise to noise levels off-site, at noise sensitive locations which exceed the following sound pressure limits by more than 2 dB(A).
Daytime (i.e. 08.00 hours to 20.00 hours)-L_{eq} 1 Hour 55 dB (A).
Night time (i.e. 20.00 hours to 08.00 hours) -L_{eq} 1 Hour 45 dB (A).
Where, "dB(A) L_{eq}" means the equivalent A-weighted sound pressure level measured in decibel</td></tr>
<tr><td>Environmental Guidelines for the Concrete Batching Industry, Environment Protection Authority State Government of Victoria</td><td>
<table>
<tr><td></td><td colspan="3">Noise Limits dB (A)</td></tr>
<tr><td>Land Use</td><td>M-F: 7am-6pm, Sat:7am-1pm</td><td>All Nights 10pm-7 am</td><td>All other times</td></tr>
<tr><td>Quiet rural areas</td><td>45</td><td>32</td><td>37</td></tr>
<tr><td>Mainly residential</td><td>50-54</td><td>39-43</td><td>44-48</td></tr>
<tr><td>Residential commercial and industrial</td><td>54-59</td><td>39-43</td><td>48-52</td></tr>
<tr><td>Commercial and industrial</td><td>56-59</td><td>47-52</td><td>58-52</td></tr>
<tr><td>Industrial</td><td>63-68</td><td>52-56</td><td>57-61</td></tr>
</table>
</td></tr>
<tr><td>Central Pollution Control Board, India</td><td>1. Ambient Air quality standards in respect of noise
<table>
<tr><td rowspan="2">Area code</td><td rowspan="2">Category of area/zone</td><td colspan="2">Limits in dB (A) L_{eq}</td></tr>
<tr><td>Day time (6 am- 10 pm)</td><td>Night time (10 pm-6 am)</td></tr>
<tr><td>A</td><td>Industrial area</td><td>75</td><td>70</td></tr>
<tr><td>B</td><td>Commercial Area</td><td>65</td><td>55</td></tr>
<tr><td>C</td><td>Residential area</td><td>55</td><td>45</td></tr>
<tr><td>D</td><td>Silence zone</td><td>50</td><td>40</td></tr>
</table>
• Day time shall mean from 6.00 a.m. to 10.00 p.m.
• Night time shall mean from 10.00 p.m. to 6.00 a.m.
• Silence zone is an area comprising not less than 100 meters around hospitals, educational institutes, courts, religious places or any other area which is declared as such by the competent authority.
2. General noise Standards : noise limit for Compactors (rollers), front loaders, concentrate mixer, cranes (movable), vibrators and saws (from at 7.5 meter in dB(A) at the manufacturing stage) is 75</td></tr>
</table>

relevant guidelines laid by the Central Pollution Control Board.[12] Tables 1, 2 and 3 compare the provisions relating to effluent limits in waste water, limits for dust emission and noise pollution, respectively, for ready mixed concrete plants.

Water and wastewater management in RMC plants

Water is extensively used in a ready mixed concrete plant – not only for mixing concrete, but also for washing the equipment including mixers and trucks, keeping the aggregate moist, and other general office consumption. Given the increased emphasis on water conservation, there is need for plants to have and implement an effective water management program for reduction of consumption of water, prevention of water pollution, reduction in waste water generated and its disposal in accordance with appropriate national and local regulations. The proposed guideline seeks to address some of the important issues related to (a) limits on quality parameters on effluent water, in terms of Total

Suspended Solids (TSS), pH, iron and Chemical Oxygen Demand (COD), and, (b) handling waste water

Dust emission

In ready mixed concrete plants, transfer and storage of materials (cement, sand and coarse aggregate) and the normal sweeping of the plant area lead to emission of dust that may be injurious to the health of plant personnel and others who may be living, working or traveling in nearby areas. It may also be noted that the location of the plant, direction of prevailing winds, could also play a significant role in determining the extent of damage arising from a certain emission level. Clearly, some of these issues can be effectively handled at the stage of planning while others are a matter of awareness, control and regulation while the plant is in operation. The document in the Appendix seeks to address some of the important issue that may be especially relevant from the point of view of ensuring that any emission of fines from the plant is kept within acceptable limits.

Controlling noise

Like most production units, a ready mixed concrete plant has its sources of noise, which could be disturbing (and, in fact, harmful in the long run). These include vehicular traffic of trucks delivering material to the plant and taking concrete out of the plant, operation of equipment such as conveyors and mixers. It should be noted that the Central Pollution Control Board gives 'permissible' noise limits for equipment such as compactors and other power equipment, and also the general ambient air quality standards for noise at different times of the day at different locations. It may not be considered necessary to make more specific guidelines for the ready mixed concrete plant as suggested in the Appendix, which also briefly discusses some of the measures that may be taken to contain noise pollution.

Managing waste concrete

Given the nature of concrete and the method of its production in a ready mixed concrete plant, it is clear a certain amount of waste concrete generation cannot be avoided. Concrete sticking to the mixer and other equipment, that return from the site for reasons such as non-compliance, and concrete produced in excess of that strictly required are some of the ways 'waste concrete' may be generated in a ready mixed concrete plant, and a clear plan for handling this concrete with a view to conserve natural resources should be in place. The proposed guideline in Appendix seeks to break-up the problem into smaller modules and lays down a methodology that may be followed. Making readiness of plants to be able to produce appropriate precast products, controlled used of hydration regulating admixtures, and installation of mechanical reclaimers to recover at least the coarse and fine aggregate are some of the recommendations made.

Some other issues

It is clear that concerns for environmental pollution and natural resource conservation cannot be addressed by simply laying down procedures and specific compliance but require a concerted effort on part of all those involved in the exercise, and steps need to be taken at all stages beginning with the planning of the plant, its layout and required facilities, maintenance operations, and sampling methods and frequency to check compliance with the required regulations. This requires a formal plan incorporating concern for the environment in day-to-day operations involving routine house-keeping activities, in-house training programme for personnel, etc. Some of these are also addressed in the proposed guidelines in the Appendix.

Concluding remarks

This document seeks to highlight some of the relevant issues relating to environmental protection and pollution control arising out ready mixed concrete plants. Poorly controlled concrete batching plants may discharge highly alkaline wastewater, dust and excess noise. In addition to comparing some of the relevant details from codes and specifications from outside India, the document also contains as an Appendix a draft that can be used to provide a framework for a better regulatory mechanism in the country. Through this article, the authors hope to initiate a debate on this important issue and the emergence of an appropriate regulatory framework while the number of RMC plants is still manageable.

References

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Appendix

Guidelines for handling environmental concerns in a ready mixed concrete plant (Draft)

1. Introduction

Concrete is a vital construction material and at times the per capita consumption of concrete or cement is regarded as a measure of industrialization in an economy. Advancement in mechanization and construction technology in India has seen a rapid increase in the number of Ready Mixed Concrete (RMC) plants in the country, both in the organized and unorganized sector. It is important that appropriate safeguards are put in place to ensure sustainable growth and make sure that the related environmental concerns are appropriately handled. This document addresses potential environmental concerns associated with the RMC plants.

2. Scope

This document provides guidelines to handle environmental concerns that are of special relevance to an RMC plant. It addresses issues related to the likely adverse impact on all the components of the environment – air, land and water.

3. Definitions

'Process water' means any water used in the concrete production process at the RMC plant, or, water that otherwise comes into contact with cement, fresh concrete, sand and grit particles, as well as hydrocarbon sources, including water used for dust suppression and cleaning plant area or any vehicle, mixers or other equipment.

'Storm water' means contaminated or uncontaminated runoff including surface runoff and drainage from within the boundaries of the plant.

'Point sources of dust emission' means dust emission from cement silos, vents or filter stacks to atmosphere.

'Fugitive sources of dust emission' includes dust emission during transfer of sand and aggregate, truck loading, mixer loading and wind erosion from sand and aggregate piles.

'Sludge' means sand, gravel and cementitious materials deposited at the bottom of settling basin.

'Waste concrete' means, any concrete which is produced in the operations of the RMC plant but is not used in the construction work at the site.

4. Water and wastewater management

The plant should have and implement an effective water management program for reduction of consumption of water, prevention of water pollution, reduction in waste water generated and it's disposal in accordance with appropriate national and local regulations. The water management program records should include, breakdown of total water used from different water sources e.g. water sourced from the local water supply, on site bore or recycled, initiatives taken to reduce water use and water management policies at the plant.

4.1. Effluent limits for waste water discharges

The maximum permissible limits for Total Suspended Solids (TSS), pH, iron and Chemical Oxygen Demand (COD) in the water discharged as waste or allowed to percolate into the groundwater are given in Table 1.

Table 1. Maximum effluent limits for waste water discharge

Parameter	Proposed Effluent Limitation
TSS	75.0 mg/l
pH	Less than 9.0
Iron	3.0 mg/l
COD	120 mg/l

Notes:

1. TSS is of concern because a number of the raw materials at ready mix facilities are stored outside and are exposed to storm water.
2. pH Limitations are needed because cement mixture is basic in nature and discharges high pH water
3. Iron is included as a parameter to be monitored because slag, a byproduct of steel manufacturing, is used as a mineral admixture in concrete production.
4. Chemical Oxygen Demand (COD) indicates the presence of spilled oils and fuels, from vehicles and equipment, and also of organic matter, which may be found in concrete admixtures.

4.2. Handling waste water

4.2.1. The plant operations should not discharge process wastewater, storm water, or mixed process water, to any surface or subsurface stream, watercourse, or drainage channel or a low lying area, unless its compliance with the required effluent limits is ensured.

4.2.2. Steps should be taken by the plant to stress recycling of water where-ever possible.

4.2.3. It is advisable to separate drainage systems for contaminated and clean stormwater (runoff from roof). Segregating the storm water runoff between process areas and aggregate storage sites and vehicle parking lots will help to minimize the amount of storm water runoff that needs to be managed. Clean storm water can be discharged directly from the plant site.

4.2.4. All areas in the plant which are potential sources of wastewater (runoff) should be paved and provided with appropriate bunds to enable the wastewater and contaminated storm water from the entire site to be directed to an on-site settling pond, or series of ponds.

4.2.5. The plant should, at least, have an appropriately designed settling tank which acts as a collection point for process waste water and allows it to be held for a sufficient period for the contaminants to settle out as well as allowing any additionally required treatment, such as treatment to adjust the pH, etc. to take place. Additional basins in series may be needed in order to adequately treat water prior to reuse it or release to the environment.

4.2.6. Storage area and settling tanks should be designed and constructed in a manner that minimizes subsurface leakage and should be of adequate size to cater for unexpected short term rainfall.

4.2.7. A mechanical filter or filter press can also be used to separate suspended particles. An example of a mechanical filter is a 100 micron size cloth filter through which discharge water is pumped. Cloth filters require cleaning on regular intervals to remain effective.

4.2.8. Coagulants and flocculants could also be used if very fine particles continue to remain in suspension. The coagulants or flocculants should be non toxic / bio-degradable to avoid any further requirement of treatment to neutralize them. The injection system for coagulants and flocculants and maintenance should be handled only by trained personnel.

4.2.9. The settlement tanks should be periodically cleaned and the sludge removed to a designated area of the site having controlled drainage facilities for drying.

4.2.10. Concrete trucks and other equipments, including the mixers, should be washed out to prevent the

concrete from hardening within. This washout may occur at the job site, plant site, or at any other site. Such washout should not be discharged directly into any drainage system, surface or ground water. Washout material or slurry should not be placed on public property, along roadsides, in roadside ditches, on river banks, or into rivers.

4.2.11. Flow control devices (metering or spring-loaded valves) should be installed on water hoses and limit allowable wash time or water volumes.

4.2.12. For reducing pH levels to allowed limits, a diluted acid solution or carbon dioxide gas may be injected in the settling tank in a controlled manner.

4.2.13. After adequate treatment, water may be reused as may be deemed fit.

5. Dust emission

The plant should have an appropriate dust management plan covering all areas of the operation including access ways, concrete plant and associated activities. Such a plan take into account local climatic conditions, prevailing wind directions, average daily temperatures and seasonal precipitation. Inclusion of natural or artificial wind barriers such as trees, fences and land forms to help control the emission of dust from the plant should be considered. Point source emissions may be controlled with available pollution control equipment such as baghouses, fabric filters or scrubbers. Fugitive dust sources, such as plant site traffic or aggregate stockpiles, are more dispersed and need different treatment to reduce dust emission.

5.1. Emission limits

Maximum limit on discharges of air contaminants from Fabric Filter Systems or point sources may be limited to 10 per cent opacity, averaged over a 6-minute period measured at the point of discharge into the air. Maximum limit for discharges of fugitive dust may be limited to 30 per cent opacity, averaged over a 6-minute period measured at the point of discharge into the air.

5.2. Controlling dust emissions from silos

5.2.1. All materials capable of generating dust (cement, pulverized fuel ash, etc.) should be stored in sealed, dust-tight storage silos. A particulate control system such as fabric filters should be implemented for the collection, control and suppression of dust emissions during loading and unloading of the silo.

5.2.2. Adequate access should be made to the filters to allow for regular inspection and maintenance.

5.2.3. Cement should be delivered in sealed vehicles equipped for pneumatic transfer from the vehicle to the cement storage silo. Silos should be equipped with a high level sensor alarm and an automatic delivery shutdown switch to prevent overfilling.

5.2.4. Silo conveying systems should be monitored daily for visible emissions and action should be taken immediately for any visible emission.

5.2.5. If the particulate control system or effluent system of an establishment becomes inoperative for any reason, appropriate remedial action should be immediately initiated.

5.3. Controlling dust emission by proper handling or transfer of aggregates and other raw materials into or within the plant

5.3.1. Sand and aggregates should be delivered in a dampened state, using covered trucks. If the materials have dried out during transit they should be re-wetted before being dumped into the storage bunker.

5.3.2. Sand and aggregates should be stored in a hopper or bunker which shields the materials from winds or stockpiles should be watered to minimize the generation of fugitive dust.

5.3.3. Number of transfer points for raw materials and material drop heights should be minimized.

5.3.4. Any raw material spills should be cleaned up by dry sweeping. Water should not be used in the process of cleaning up spills except where the area drains to an effective wastewater collection point.

5.3.5. Weigh bins and hoppers should be properly shielded on three sides and roof where a front end loader is used.

5.3.6. Scrapers should be provided at the turning points of all conveyors to prevent dust collection on the belt surface

5.3.7. Shielding, cover or partial enclose should be provided for transfer points and conveyors.

5.4. Controlling dust emissions from plant site traffic

5.4.1. All process areas and traffic areas within the plant must be paved and kept clean. All regular paths of vehicle traffic should be paved with a hard surface that can be cleaned by dry methods to minimize dust and runoff to nearby properties and storm water systems.

5.4.2. Dust and/or mud should be cleaned from the outer surfaces and wheels of concrete trucks and other vehicles after loading before exit from the plant.

5.4.3. If water sprays or dust suppression agents are used to reduce dust, it should be ensured that the use of water is minimized.

5.4.4. Use of dry cleanup and wind barrier equipment may be preferred, and a water spray system for dust prevention should be used only as a last resort as it generates storm wastewater, which again requires treatment as outlined above.

5.5. Controlling exhaust emission from engines at the plant

5.5.1. As mixer trucks wait in the yard, idling time of engines should be minimized to reduce exhaust emissions and save fuel.

5.5.2. Maintaining correct engine-operating temperatures also helps in reducing exhaust emissions and prolongs equipment and vehicle life.

5.5.3. All vehicles should be well maintained and regularly serviced to minimize exhaust emission. A regular preventive maintenance program will keep equipment and vehicle engines running at optimal performance.

5.5.4. Equipment and vehicle pollution control devices should be inspected during regular intervals in conjunction with preventative maintenance inspections.

6. Controlling noise

6.1. Limiting values

General Standards Part E of the Central Pollution Control Board give noise limit for compactors, front loaders, concentrate mixer, crane, vibrators and saws, as 75 dB (A) at 7.5 meter at the manufacturing stage, which can be adopted for RMC plant equipment also. In the case of RMC plants, noise levels should be monitored at the plant boundaries. Also, ambient air quality standards for noise, as given by CPCB (Table 2) may be adopted for use by the RMC plants also.

Table 2. Ambient air quality standards for noise

Area code	Category of area / zone	Limits in dB (A) L_{eq}	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Notes:

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutes, courts, religious places or any other area which is declared as such by the competent authority.
4. The sensitivity to noise is usually greater at night-time than it is during the day, by about 10dB (A), hence there are differences between night and day time allowable noise levels.

6.2. Suggested measures

Plants should ensure that they operate with minimum noise and that the requirements of sound pollution are complied with. Use of sound barriers should be considered wherever considered necessary. Some of the other measures that may help in this regard are mentioned below.

- Quieter equipment should be selected and installed. Silencers should be used wherever required.
- Noisy equipment such as motors, compressors, pumps and mixers should be enclosed to reduce noise levels, installed away from sensitive areas and located behind artificial or natural sound barriers or sound absorbers for example, gravel stockpiles, screens or constructed barriers.
- Hooters should be used for emergencies only. Sirens should face away from residences. Audible tones and impulsive noise at sensitive locations at night should be avoided, irrespective of the noise level.
- Traffic entrance and exit points should be away from noise sensitive areas.
- An adequate buffer should be kept between the plant and neighbors.

- Special attention should be paid to limiting, as far as practical, the level of noise generated by the delivery vehicles. This includes ensuring the efficiency of silencers and the careful maintenance of engines.
- Material drop heights should be minimized.

7. Monitoring and reporting

The frequency of sampling for compliance for water and air pollution shall be determined taking into account the size of the plant. but it should be ensured that the sampling and analysis of samples (the process water, stormwater runoff, air) is carried out at least once a month. As far as noise pollution is concerned, observations should be taken on a daily basis at the different locations along the boundary of the plant, and appropriate records maintained. When monitoring shows non-compliance in any manner, steps should be initiated to immediately inform the authorities and take corrective action at the plant. (*A form may be included in this standard for reporting such non-compliance*).

8. Managing waste concrete

Waste concrete should be reused or recycled to the extent possible to help in pollution prevention and conservation of natural sources. Such measures also reduce the need of land for dumping waste concrete. Thus, the objective of waste concrete management is to (1) reduce the amount of leftover concrete, (2) recycle or reuse the leftover concrete, and, (3) appropriately dispose of the leftover material.

8.1. Re–using returned concrete before it has set

The plant should have a mechanism to immediately assess if concrete not used at a site and returned to the plant can be used at another site so that the concrete truck can be diverted to that site, provided there is no compromise on quality. It is desirable that a plant is equipped with infrastructure to produce precast products can be prepared. In this manner any concrete returned from a site, can still be gainfully used. Appropriate records of the quality of the concrete so used should be maintained to ensure quality of the precast products. Waste concrete can also be used for lower end applications such as laying paved areas, etc.

8.2. Concrete stabilization using chemical admixtures

Plants should have the capability and readiness for application of chemicals, such as hydration stabilization admixtures (HSA), through which the setting of concrete can be delayed and then reactivated for use. In consultation with experts, the plant may use appropriate amounts of HSA. Plants should be equipped with the capability to carry out tests and ensure that such addition is not deleterious to the properties of concrete.

8.3. Mechanical reclaimer

A 'reclaimer' may be used to separate coarse and fine aggregates from the waste concrete. Such reclaimed aggregates should be stacked separately and may be used in concrete with approval from the users. They may also be used as clean fill material or as a road base material. The remaining 'slurry' may be collected in a settlement tank to recycle waste water from it and the remaining part (i.e. sludge) should be disposed of suitably, as discussed in Section 4.2.9.

8.4. Converting waste concrete to recycled aggregate

Returned concrete, before hardening, can be placed in a designated area within the plant site and allowed to harden. This concrete can then be broken up, crushed, screened and processed for use as 'recycled' aggregate in concrete or otherwise appropriately used.

8.5. Waste concrete management program monitoring and reporting

The concrete product manufacturer should have an effective waste management policy and program, and keep on record an annual report on waste management, including, methods being used for handling waste concrete, quantity of waste concrete generated, quantity of waste concrete recycled and materials recovered, quantity of waste disposed of to landfill, information on disposal locations and initiatives taken to reduce waste generation and improve recovery/recycling of waste.

9. Fuel, oil and admixture storage

The objective is to prevent pollution of surrounding surface and ground water from accidental spillage of fuel, oil or admixtures from storage tanks whether above or below ground. Appropriate contingency plans and detailed protective measures should be provided for dealing with the environmental implications of accidental spillage during delivery, storage and subsequent use of these materials.

Underground storage tanks should be designed and maintained to prevent leakage into the surrounding soil or ground water. Normally an impermeable base and walled area or bund should be provided for the above ground storage of fuel, oil and admixtures in bulk, with a minimum capacity well in excess of the likely volume

of storage of chemicals. It should have an impermeable surface and should be under cover, preferably indoors. The area defined for this storage should be located away from regions of heavy traffic and from any natural water course.

All storage tanks and drums containing fuel, oil or admixtures should be clearly labeled and properly sealed. Periodic inspections must be carried out in the storage areas.

Plant should have preparation of an emergency response procedure to address any accident on site. There should be safety system to prevent overfilling of tanks. Spill kits or suitable absorbent material should be maintained on site. All equipment and vehicles should be properly maintained, preventing oil leaks and grease deposits.

10. Good housekeeping

One of the easiest and least expensive ways to reduce wastes is keeping the plant site clean. The site should be regularly swept to remove dust buildup and cleaning all spillages or deposits of materials on immediately. Dry clean-up methods should be used whenever practical such as sweeping, dust collection vacuum, wiping etc. Care should be taken that waste or garbage is not dumped in open areas or along roadsides. Appropriate placards and signs calling upon the plant staff to keep the area clean should be prominently displayed in the plant area.

11. Employee's training and communication with community

Pollution prevention efforts can only be successful only if all employees are committed to the cause of minimizing wastes. All employees should receive training to promote awareness of their responsibility to the environment, understand the importance of minimizing consumption and reuse or recycling of natural resources such as water, aggregates, and, encouraged to give a high priority to site care and good housekeeping.

The plant should have an effective system of addressing complaints, all of which should be recorded. The record should include the name and address of the complainant, time and date of the incident, the outcome of the resulting investigation, solutions implemented and the names of personnel involved. Immediate actions should be taken to resolve the problem and a complainant should be informed about the outcome.

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