Emergency Sanitation in Tsunami affected Andaman and Nicobar Islands of India

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Abstract

Sanitation is one of the biggest issues during the case of an emergency. It is also the most challenging as most of the populations have been practicing open defecation before the disaster. The relatively low population density and wide-open areas on coast minimized the risk due to open defecation. The displacement of affected population to camps away from the coast has altered the conditions considerably and there is certainly a need for safe excreta disposal especially where population is large. Women find it all the more difficult as the usual areas are no longer accessible or are too far from the camps and the need for privacy was expressed by every woman interviewed.

Agencies including PWD have taken up construction of latrines of varied designs all across the affected areas. There was however a general concern as the facilities provided are either not being used or not being maintained well. The toilets were filled up very early because of faulty design. This has lead to most unhygienic conditions near the camps and was also the major cause for ground water contamination. This paper has been an attempt by the author by providing a safe and secure pour flush toilet (Rural Pan) with appropriate considerations for less soil infiltration one of the reasons for early fill up.

Introduction

Floating in splendid isolation, east of Indian mainland is the archipelago of 572 emerald islands, islets and rocks known as Andaman and Nicobar islands. Known as 'Kala Pani' (the penal settlement) in yore days of British suzerainty these beautiful islands were attraction of tourists, visitors, anthropologists, sociologists, natural scientists and others. Unique fauna, lush forests, white sandy beaches and exquisite coral were some of the natural attractions. The severity of tsunamis on 26th December 2004 has left the whole island in a big shock. The life became a stand still and the devastating effect of nature has left very less for the visitors.

The Tsunami

Despite their coral reefs, most Andaman Islands themselves are not of coral origin. Instead they are the peaks of a drowned mountain range. The islands lie parallel to a geographical fault line to east, crossing the Andaman Sea from north to south. The line marks two tectonic plates rubbing against each other; the eastern plate an extension of the huge Eurasian plate is stationary, while the Indian plate to the west is moving north to northeast at the rate of a few centimeters a year, carrying the Andaman islands with it. This slow and steady motion is still pushing up the Himalayan Mountains and causes earthquakes and volcanic activities in and around the islands. India's only active volcanoes are sitting directly on the fault line.

On the fateful morning of 26th December 2004, an earthquake of magnitude 9.0 on ritcher scale rocked the whole Andaman & Nicobar Islands including coastal areas of Tamilnadu, Kerala, Andhra Pradesh of India and Indonesia and Sri Lanka. The epicenter of this earthquake was 255 km SSE of Banda Aceh, Northern Sumatra in Indonesia. The devastating tsunami was a direct consequence of this earthquake, which caused movement of the seafloor all along the length of rupture, displacing a huge volume of water and generating the tsunami wave. The vertical uplift was as much as several metres. In the open ocean tsunami waves move very rapidly, 300-500km/hour (about the speed of a jet airliner). As the wave approached the coast it slowed down and grew in height to many metres high when it strikes the coast. When these waves reached the coastal areas the devastating affect of nature was at its climax. Buildings, Boats and all man made structures were severely affected. There was a severe loss of life and property in all the coastal areas. This resulted in people shifting to relief camps and finally to temporary shelters.

Government's initiation

The GOI situation report 35 states that situation in Nicobar islands comprising Car Nicobar, Great Nicobar, Komorta, Katchal and a string of smaller islands was particularly bad. This is also reflected in the numbers and populations in relief centers established by the government subsequent to Tsunami.

S.No	**Districts/Islands**	**No of relief camps**	**Nos in the Camps**
1.	Car Nicobar	85	15500
2.	Great Nicobar	14	4328
3.	Komorta	4	1476
4.	Katchal	3	3228
5.	Nancowry	2	934
6.	Teressa	9	3296
	Total	**169**	**43373**

Source: GOI situation report 35

<u>Needs for safe Sanitation in new Environment:</u>

In relief camps open pit latrines and trench latrines were constructed by government and some NGO's. This has resulted the living conditions very miserable. Inadequate water supply with deteriorated water quality, poor hygiene and sanitary conditions associated with unsafe disposal of faeces, waste water and solid waste put a big demand for a safe and secure sanitation in temporary shelters. Hence the first priority for temporary shelters became the safe and secure disposal of human excreta.

Excreta Disposal

Excreta disposal is undoubtedly one of the key elements of any emergency sanitation programme. Unsafe disposal of human excreta is the main route to transmission of excreta related diseases. This may lead to contamination of ground and water sources, and can provide breeding sites for flies and mosquitoes. Diseases like diarrhea, cholera, typhoid, dysentery and many more responsible for high mortality and morbidity rate in developing countries are all spread through faecal–oral or skin penetration. Children under five years of age are most at risk from communicable diseases since their immune systems have not developed.

Selection criteria for excreta disposal:

Following criteria's were considered for appropriate excreta disposal interventions in temporary shelters.

a) Socio culture aspects: Consultations were made with tribal leaders, Captains and other associated people in the affected islands. Most of the affected population was not using any kind of toilets prior to tsunami. Hence it was decided to provide a simple kind of toilet, which can be easily used by the tribal/ non-tribal people and easy to maintain & operate. Factors regarding the usage of toilet by children were also kept in consideration. Similarly at some islands people showed interest for individual family toilets where as in other islands the people were interested for community toilets.

b) Available Space: *The* tsunami has left with no other option to provide the toilets at high land areas rather than low-lying areas. After the tsunami all the affected islands have sunk down by more than one meter. This has resulted the low-lying areas submerged in sea when there is high tide. The examples of it were the markets of Campbell bay and Kamorta islands which were all submerged during high tides. High land areas mainly on hillsides were available for temporary shelters with limited space available.

c) Ground Conditions: The ground conditions have a particular impact on latrines that rely on soil infiltration. Almost at all islands it was found that soil is silty clay loam, which has a very less infiltration rate. This was one of the important criteria, which have to be taken into consideration while designing the pit. From the data given by Reed and Dean it was found that the soil filtration rate would be around 8 liters /sq. metre/ day.

d) Water Availability: Availability of water in the vicinity of temporary shelters was a big issue. It was decided by the Public Works Department (PWD) that water would be pumped to these high land areas from surface reservoirs. Simultaneously it was also decided that the rainwater harvesting might be the other option near the temporary shelters. Similarly the toilets were also designed as per Sphere standards, which say the toilets will be at least 30 m away from any ground water source and not more than 50 m from dwellings.

e) Design life: The temporary shelters, which were designed by Ministry of Home Affairs, Government of India, were meant for two years. Hence the design period for toilet pits would also be two years.

f) Availability of local materials and transportation means: In all the islands logistics is extremely difficult. Except coconut trees nothing is produced or grown in these islands. This has resulted the dependency of these islands totally on mainland. The only sources of mode of transportation are ships, which come once or twice a week. With almost all the jetties broken and damaged the loading and unloading of relief and construction materials from ship to island is a nightmare. Small boats and paltoons are other supporting means from big ship to island. This has resulted the increased time and cost of materials because of additional labour.

g) Time constraint: Time is especially important in the immediate stage of an emergency when the aim is to provide facilities rapidly in order to minimize the spread of excreta related diseases in the affected area. Looking to above conditions there was unusual time taken to procure the equipments and materials due to severe scarcity of local resources. This has resulted in delay of attaining the targets in stipulated time.

h) ***Choice of toilet:***

The final choice was based on ground conditions. Since toilets were provided on up hillside and water table was not one of the issues hence it was decided to have an off set leach pit. Depending upon the needs of the people a decision was to be made on community or family latrines at different places.

i) ***Choice of Pan/WC***

One of the organizations called Gramalaya in coordination with Water Aid India has developed one unique kind of polypropylene pan especially suited for rural areas where there is severe scarcity of water. This is also called rural pan has a steep slope (28 degree) towards defecation hole (3 inches). Due to this only 2 liters of water per person is used for flushing. It is very easy to install in rural areas with little masons help. The specific poly material does not stick any human excreta hence cleaning and maintenance of this pan is very easy. In these Easy flush toilets the minimal use of water for flushing associated with its low cost, bulk packing and transportation option with no losses through breakage and easy availability in the remotest areas were the deciding factors to have these kinds of toilets in these islands. The pan was attached with a P trap/ S bend that will work as a water seal and shall ensure fewer nuisances of odour and flies. Attached with this bend is a PVC pipe of about one metre length taking all discharge from pan to a pit. Pit was provided close to the toilet room so that additional lengths of pipes are avoided. With additional pipes more coupling joining materials are required and chances of blocking and bursting of pipes would be higher in the water scarce area.

j) Effective pit volume: Effective pit volume is one of the major factors in designs of toilets in emergencies. In absence of a proper design the pits are filled very soon and may be a big nuisance after that. The important factors, which were considered before designing the pits, were

k) Soil infiltration rate: Here the soil was silty clay loam (Black Cotton Soil) which has a very less infiltration rate (8 litres/square metre/day) hence additional depth were provided after finding out the infiltration rates of soils directly in the field by using a open steel cylinder filled with plain water.

l) Number of users: When pits were designed for a single family it was taken as 6 and when they were designed for communities it was taken as 12 this was as per MHA (Ministry of Home Affairs, GOI) plan. This is also in accordance as per Sphere, which says maximum number people using one toilet, is 20.
m) <u>Design period</u>: Here the Government of India said that people would be shifted to permanent shelters within 1-2 years. Hence the design years was taken as 2 for these temporary shelters.

n) Free board: A free board of 0.5 meter was always provided above the effective pit volume. This has ensured the safety against splashing and other nuisances.

o) Water Table: In case of emergencies when we provide a pit then the base of pit is minimum 1.5 m above the ground water table (Sphere). Here since temporary shelters were provided on hilly areas and water table was much deeper (10-25 m) hence it minimizes any chances of ground water contamination.

p) Pit Depth / Pit Volume:

1) When people's choice was family toilets then a single circular pit was provided. Circular pits, which have a benefit of natural arching effect keeps, the structure in equilibrium has less chances of collapse than a rectangular pit. Effective pit volume was calculated as follows. V= N*S*D, Here V= Effective pit volume in cubic meters N= Number of users (here it was 6), S= Solids accumulation rate (0.04 cum/person/yr) (Since water was used for anal washing hence it was taken as 0.04 cum per person per year. This is as per "Suggested maximum sludge accumulation rate" given by Franceys et.al, 1992) D= Number of design years (here it is 2) , V = 6 * 0.04 * 2 = 0.48 cum, This is the effective volume of the pit required for 6 people for 2 years. If we provide a pit of diameter 1 m then effective depth of pit was calculated by this formula. V= Pie * R* R* H Where V = Volume, R= Radius and H= Effective depth of pit, Hence H= V/ pie * R * R, H= 0.48 * 7 / 22 * 0.5 * 0.5 = 0.61 m This would be the effective depth of pit, while excavating the pit additional depth in the form of free board of 0.5 m was always left from top. Hence total depth of pit was 0.61m + 0.5m = 1.11 m say 1.2 m hence a pit of 1 m diameter and 1.2 m depth was provided for a family of 6 people using for 2 years. Looking to less infiltration rate of soils at almost all places additional depths of pits were also provided.

Alternatively: Depth of pit was also calculated by this method.

Pit wall surface area (sq.m) = daily wastewater flow (litres) / soil infiltration rate, Daily wastewater flow would be 6 * 2 = 12 litres (6 people using 2 litres of water peruse) Soil infiltration rate = 8 litres /sq m / day Here soil is silty clay loam hence its infiltration rate is 8 litres /sq m/day given by Reed & Dean, 1994. It can also be roughly calculated in the field by steel cylinder method. Hence pit wall surface area = 12/8 = 1.5 sq m, Choosing a pit diameter of 1m, Calculating the depth of pit required to dispose of all the liquids, Depth of pit required = pit wall surface area / (pie * diameter), Depth of pit = 1.5 * 7 / 22 * 1 = 0.48 say 0.5 m, Adding 0.5 as free board. Total depth of pit needed to excavate would be 0.5 m +0.5m i.e. 1.0 m which is less than the above method so for higher factor of safety taking the dimensions of pit as calculated above. Taking a pit of dimensions of minimum 1m diameter and 1.2 metre of depth.

2) When people's choice was for the communities in that case a single block of toilet was made for 6 units as per MHA. Number of users per unit was also increased to 12 as per MHA plan. Here the pit was a combined rectangular trench.

Effective pit volume required V = N * S * D, V = (12 *6) * 0.04 * 2 = 5.76 cum

Since GI sheet were available in the length of 3 m by 0.8 m and total length of each block was 5.4 m as per MHA plan hence provided a rectangular trench pit of 5.4 m by 0.8 m.

Hence depth of pit = 5.76 / 5.4 * 0.8 = 1.35 m, in addition a free board of 0.5 m was also provided from top. The total depth of pit to be excavated was 1.35m + 0.5 m = 1.85 m.

In addition to this additional depth of pit was also excavated after finding out the infiltration rate of soils at the field site itself.

Alternatively:

When pit depth calculated by the second method it came as 1.45 m + 0.5 m as free board i.e. 1.95 m say 2.0 m, Hence provided a rectangular pit of 5.4 m * 0.8m * 2.0m

3) Lining of pits and water seal:

Lining of pit was infact the most difficult task as availability of the material for lining was extremely difficult in these remote islands.

a) For single circular pits since honeycombing was not possible because of material and time constraint hence wooden logs were placed all around the pit wall to safeguard against the collapse of structure inside the pit. The tops of pits were raised and it was water sealed by GI sheet so that no outside water or runoff gets inside it and no inside waste comes outside it.

b) In case of rectangular trench pits where availability of materials was a big issue wooden log of pit depth were placed all around the pit wall. Secondly GI sheets, which were available, were provided and covered from top of the pit to the middle of the pit. This kind of shoring will protect the pit to collapse inside it and also the lower part of pit, which is not covered by GI sheet, will be used for leaching. The top of the pit was raised above the ground surface and covered by GI sheet to ensure from mixing with surface and rainwater.

c) Where availability of materials was not a constraint in that case hollow blocks of cement were provided to cover the whole of the inside wall of the pit. Ample space was left in between the hollow blocks to have leaching through the wall also. On site covering slab was casted with 10 mm steel bars.

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