Use of fishing sinkers along Kerala and Tamil Nadu coasts

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Abstract

Fishing sinkers form one of the most important components of fishing gear. Different materials such as baked clay, cement, stone, brick, iron, lead etc. are used as sinkers and they vary in size and shape. Of these, lead is considered to be the best material for making fishing sinkers and jigs. Even though lead has got all the properties suited for a sinker, it is globally recognized as a toxic substance for both humans and animals. It affects the nervous and reproductive system of mammals and birds. Many countries have banned the use of lead sinkers in certain regions or have imposed some regulations for their use. Due to fishing activities, lead sinkers running into several tons get deposited every year in the coastal waters. Currently there are many non-toxic alternatives made out of ceramic, recycled glass, cement, clay, natural granite, bismuth, tin, stainless steel and tungsten available for use as sinkers. However, in India studies on the types of sinkers available and their properties are generally lacking. This communication presents the results of a preliminary study of the fishing sinkers used along the southern coast of India. An account of the different sinkers used in various fishing gears is given. It was noted that the traditional fishermen are switching over to lead sinkers in an ever-increasing phase along the coast owing to its ready availability and ease of use. Apart from this, the boom in tourism in Kerala, where more recreational fishing activities are expected to take place, use of lead for jigs can add more lead into the environment.

Keywords: *Fishing, Sinker, Lead, Environment*

1. Introduction

Fishing sinker, an important component of a fishing gear serves different purposes in different gears. For instance, in gillnetting, sinkers together with floats give the net the desired shape. In trawls they are attached to the footrope to obtain the vertical gape. In bottom trawls and other dragged gears, sinkers serve to obtain firm contact with the bottom. In purse seine they provide the vertical stretch and can be used to adjust the sinking speed. However, very little information is available on the fishing sinkers and their use (Beech, 2004).

Sinkers have a long history too. Stones, clay, broken tiles, bricks, metallic pieces etc. were used as sinkers in ancient times and are supported by the findings from some ship wreckage sites (Galili *et al.*,

Sustain Fish (2006) B.M. Kurup & K. Ravindran (Eds.), School of Industrial Fisheries, Cochin University of Science & Technology, Cochin-682016, India

2002; Beech, 2004). This described different types of net sinkers that have been identified from archaeological sites in southeast Arabia. The first type of net sinkers was flat oval pebbles, notched roughly in the middle of their long sides (Uerpmann, 1992; Durante and Tosi, 1977). It occurs at a number of Omani coastal sites belonging to the Saruq of Bandar-Jissa-Facies, i.e. dating between 5500–3500 B.C. Prado (1990) in his compilation, 'Fisherman's Work Book' has given the details of few types of sinkers used in fishing gear and their properties like length, diameter of the hole and weight. There are different kinds of sinkers, *viz.*, of different material, shape and size. Predominantly locally available materials are used to manufacture net sinkers in various regions.

Sinkers are made in different shapes but are mostly spherical or barrel or ring-like in shape. Materials such as stone/granite, baked clay, brick, ceramic, cement, iron and lead are commonly used for making sinkers. Among these lead is generally considered to be the best material (Baranov, 1970). Even though lead has got all the properties suited for a sinker it is globally recognized as a toxic substance both for humans and animals. Fishing sinkers may be accidentally dropped into the water or may be lost if the hook or line becomes entangled and the line breaks or is cut. In view of the risks posed by lead exposure, regulations and initiatives are enforced to protect humans and the environment against the adverse effects of lead. The effects of lead sinkers are mainly concerned directly with wildlife and indirectly by the transfer of lead to biota, especially soil and sediment and plants and then to higher trophic levels.

The Canadian Wildlife Service estimates that 500 t of lead in the form of sinkers and jigs are lost in Canada annually and it amounts to approximately 14 % of total lead deposited in the environment (Scheuhammer *et al.*, 2003; Anon, 2004b). The Canadian Government has imposed restrictions on the use of any lead sinker or jig weighing less than 50 g, in national parks and wildlife areas since 1997. Many other countries like U.S.A. and U.K. have similar restrictions in force and are promoting use of non-lead sinker alternatives in their waters. Britain and USA had banned the use of lead fishing sinkers weighing less than 28.3 g and 14.2 g respectively in their waters (Scheuhammer and Norris, 1995; Una, 2004).

Ongoing research and assessment have revealed that lead poisoning from sinker or jig ingestion is an issue of serious concern with regard to the protection of certain wildlife. Water birds like loons and swans ingest lost sinkers mixed with gravel when they consume grit to aid digestion, or when they consume lost baitfish with hook, line, and

sinker still attached. Some birds mistake them for food items, such as seeds or shelled invertebrates. Eagles ingest lead by eating fish or birds that have themselves swallowed sinkers. Lead poisoning typically accounts for 20-30 % of adult loon mortality in habitats where fishing is prevalent. In addition to acute and lethal poisoning, birds with lead poisoning often have physical and behavioural changes such as loss of balance, gasping, tremors and impaired ability to fly. It becomes emaciated and often dies within tow to three weeks after eating the lead. The actual number of dead animals found represents only a small percentage of the total number of lead sinker poisoning cases suspected to be occurring. This is because dead animals are most often those found by chance, rather than through any systematic search-and-recovery process.

Metallic lead pellets deposited onto soils and aquatic sediments are not chemically or environmentally inert, although tens or hundreds of years may be required for total breakdown and dissolution of pellets. The rates of erosion, oxidation, and dissolution of metallic lead pellets in the environment depend on various physical and chemical factors. Aerobic, acidic conditions enhance the rate of pellet breakdown, whereas anaerobic, alkaline conditions decrease it. Physical factors such as high water flow rates, soils or sediments dominated by the presence of coarse sand or gravel, and frequent disturbance of contaminated soils all serve to enhance the rate of breakdown of lead pellet. Molecular lead from the breakdown of sinkers can get transferred to biota, especially to soil and sediment invertebrates and to terrestrial and aquatic plants, and thence to higher trophic levels. The leachable lead concentrations in soils or sediments associated with major fishing areas are often sufficiently high as to exceed lead criteria for hazardous waste, but data from such sites are generally lacking.

Persons consuming meat of affected birds or fish, especially children, are at risk from secondary lead ingestion from these poisoned birds or fish. It was found that the consumption of a single liver (often eaten in Spain) from any waterfowl from the lead polluted regions of in Europe may result in the direct uptake of 0.01-2.3 mg of lead in 40.4 % of cases. This is based on the percentage of 411 analyzed waterfowl having liver lead contents over 0.5 mg kg^{-1} wet weight, the maximum lead level in poultry offal that current EU regulations permit. All these point to the issue of lead pollution of the environment which needs to be checked at the first place. (Guitart *et al.*, 2002)

Whatever information available on the adverse effects of the use of sinkers is from the developed countries like USA, Canada, Britain etc. In India, neither such data nor basic information regarding the types of sinkers used in different fishing gears, materials used, size, shape, cost and availability are lacking. Hence an attempt is made to document different sinkers and their properties as a first step. This communication presents the results of a preliminary study under taken in India along the Kerala and the south Tamil Nadu coasts.

2. Materials and methods

A preliminary survey has been conducted along the coast of Kerala and Tamil Nadu during the period from June 2004 to January 2005 to study the fishing sinkers used along this region. A detailed questionnaire was prepared to collect data and samples from selected fishing centres. The selected centres include Enayam, Kadiapattinam, Muttom, Kanyakumari, Chinnamuttom, Manakkudi and Pallam along the Tamil Nadu coast and Vizhnjam, Valiyathurai, Marianad, Neendakara, Chelakkadu, Thottappally, Kattoor, Chellanum, Cochin, Kozhikkode, Mahe, Thalassery, Mopla Bay and Pallikkara along the Kerala coast. These centres have been grouped into three distinctive zones *viz.*; Northern Kerala coast, Southern Kerala coast and Southern Tamil Nadu coast. The data collected include the type and material of sinker used, their shape and size and the gears in which they are used. The availability profile and price distribution of sinkers were also studied. Samples of sinkers were collected from the shops and fishermen for further studies.

Sinking force of different sinkers was worked out by using the equation:

$S = W (1 - 1/r)$ where S is the sinking force in g., W is the weight of the material in g and r is the specific gravity.

3. Results and discussion

It was observed that the fishermen along the coast are using various types and sizes of sinkers made of different materials for their fishing gears. The requirement of an ideal material for making sinkers is that it should have specific gravity high enough to sink faster, it can be easily made in the required shape and size and can be easily available at low cost.

3.1 Classification of sinkers

Based on material used, mode of manufacture and shape, sinkers are variously classified (Fig. 1)

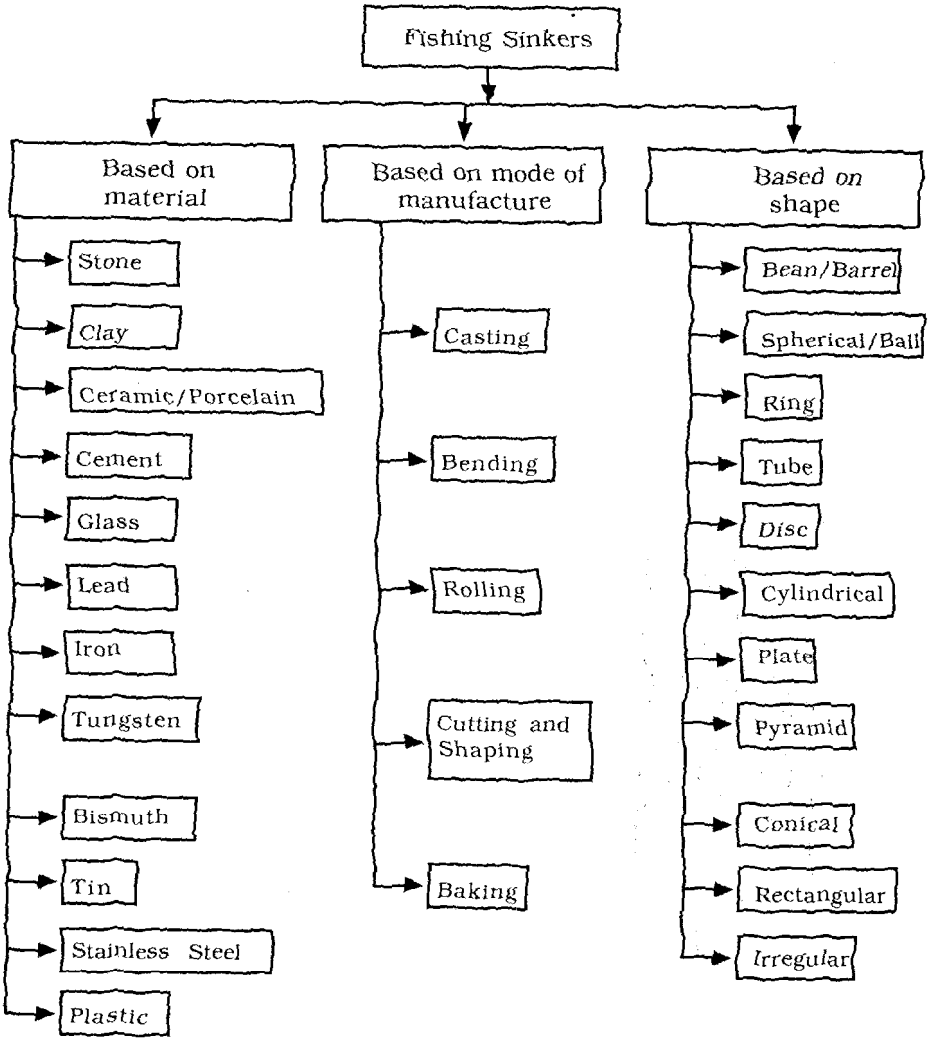

Fig. 1 Classification of fishing sinkers

3.1.1 Based on the type of material used the sinkers are classified as stone, clay, ceramic/ porcelain, cement, glass, lead, iron, tungsten, bismuth, tin, stainless steel and plastic sinkers.

The use of these sinkers was started in the ancient times and is still continued at many parts of the world. Usually stones are carved or cut into the required shape (Uerpmann, 1992; Durante and Tosi, 1977; Galili et al., 2002; Beech, 2004). Clay sinkers have a long history and are still in use. They come in different shapes but mostly are in either spherical or ring-like in shape. Porcelain/ceramic sinkers are gaining relevance these days due to the issues related to the

contamination of water bodies by the increased use of lead sinkers. Environmental Protection Agency (EPA) is currently promoting use of non-polluting alternatives like porcelain sinkers. Sinkers made up of cement are mostly disc shaped. These are extensively used in gill nets. Apart from this, large cement sinkers are used as mooring sinkers. Iron sinkers are used in many parts of the world, mainly as ground rope rings, cast iron sinkers *etc.* The main disadvantage of the iron sinkers is the issues related to rusting. Glass Sinkers are usually made in spherical shape using recycled glass pieces. The main drawback in using glass sinkers is the chances of breakage while handling the gear. Lead is the most common material used in making sinkers. They are available in numerous shapes and sizes suiting different needs.

Tungsten sinkers are superior to lead but are expensive than lead sinkers. (Anon, 2004a) Far denser than lead, tungsten has the best sink rate. It's the hardest metal used in making sinker. Tungsten is difficult to mould, imposing restrictions on casting in varied shapes. Sinkers made of tungsten alloys are used as a non-lead sinker alternative in developed countries. Bismuth is slightly less dense than lead and is brittle (Scheuhammer and Norris, 1995; Gibbs, 2004). Bismuth has low melting point and expands as it cools, in contrast to lead, and therefore must be poured only into high-quality milled moulds while making sinkers. Tin is less dense than lead and is soft, can be easily formed, reworked and reused for various fishing tasks. Tin, in the inorganic form, is generally much less toxic to aquatic organisms (crustaceans and fish) than lead (USEPA, 1994). Plastic sinkers are setting new trends in sinker production. Usually they are made up of high molecular weight polymers like Polypropylene, Polyvinychloride (PVC) or Acrylonitrile-Butadiene-Styrene (ABS). They are cheap and can be coloured to attract fish to the gear but add to pollution.

Based on mode of manufacture, sinkers are classified as cast, bent, rolled, cut and baked sinkers. In cast sinkers, sinkers are made by casting the material in different moulds to get the desired shape. Most of the lead sinkers and plastic sinkers are made by this method since it is easy to melt and cast into desired shape. In the case of sinkers made by bending, a metallic piece is bent like a ring or tube and fixed to the gear. These types of sinkers were used in ancient times (Galili *et al.*, 2002). In rolled type of sinkers a rod or strip of metal is rolled into a kind of coil or ring and is then attached to the gear. In some cases, the material to be used as a sinker is shaped or cut or machined into the desired size. In the sinker materials like stone, brick *etc.*, this was the common method adopted. Sinkers made by baking clay had been very common in historic times and have got a

promising future in environment conscious fishing activities. They come mostly in the shape of spheres/balls.

Based on shape, the sinkers are classified as bean/barrel shaped, spherical/ball, ring, tube, disc, cylindrical, plate, pyramid, conical, rectangular and irregular shaped. Important shapes in which the sinkers are available are shown in Fig. 2.

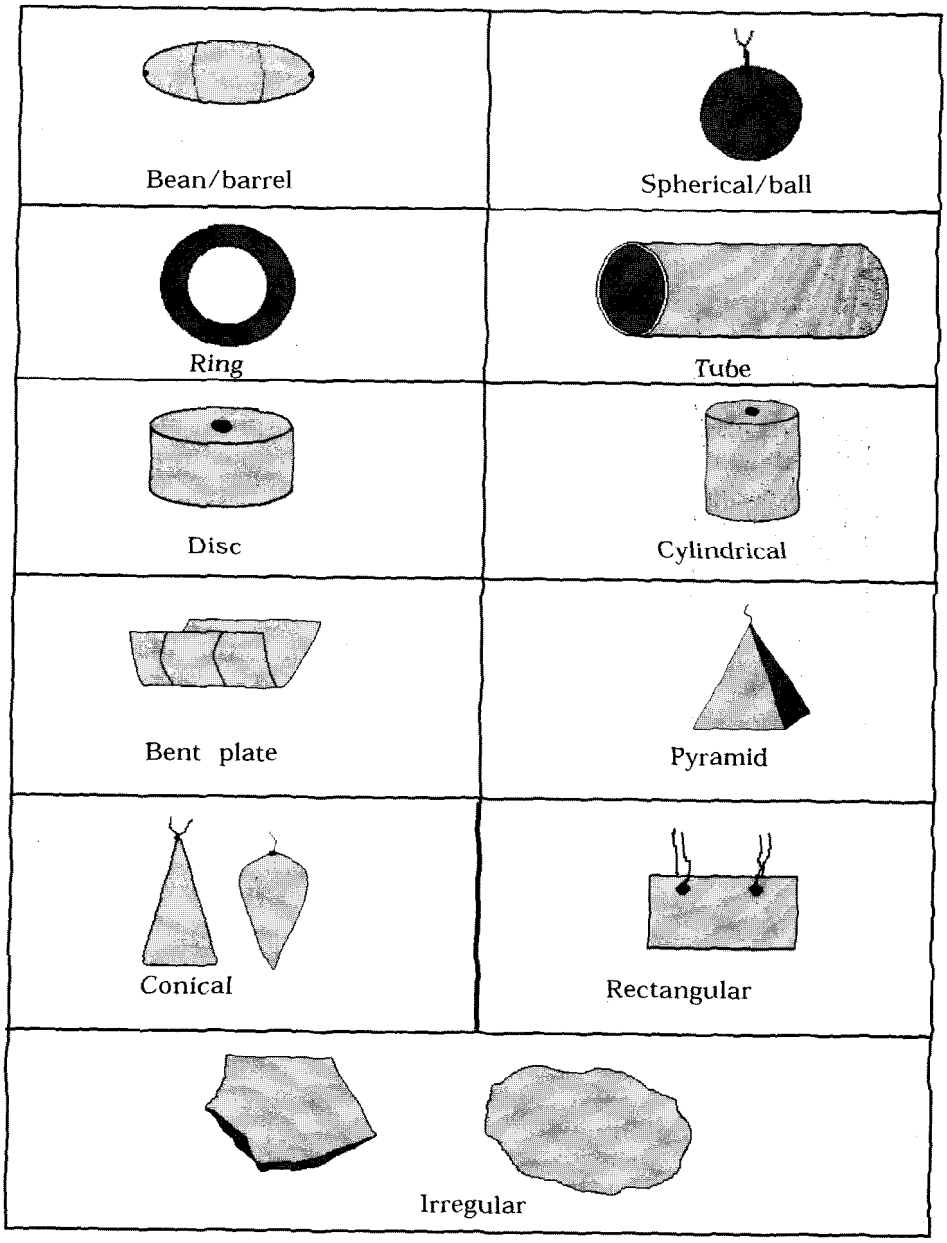

Fig. 2 Common shapes of sinkers

Bean/barrel shaped sinkers are the most common and extensively used sinkers. Lead and clay sinkers are usually made in bean or barrel shape. Spherical/ball shaped sinkers are also very common and are mostly made of cement and clay. Ring shaped sinkers are usually made up of iron and are rigged to the footrope of fishing nets. They are also very common in gill nets operated in rivers. Some times nuts are also used for this purpose. Tube Sinkers are shaped in the form of tubes. They are made up of metals like iron or lead. Disc shaped sinkers are usually made up of cement and are commonly used in gill nets. Cylindrical sinkers are mostly made of lead and clay. Sinkers in the form of bent plates made of lead are used in gill nets. Pyramidal sinkers are cast sinkers in the shape of a pyramid. Usually they weigh above 200 g. Conical sinkers are mostly made of lead and iron and are used in long lines and squid jigging. Rectangular shaped are mostly made of cement and brick. They are used in gill nets. Stone and brick sinkers are irregularly shaped and are more prevalent in the artisanal gill net fishing.

The shape and size of the sinker are very critical for successful operation of fishing gear and hence they are designed in such a way that the entangling of the sinker with the gear during operation shall be minimum.

3.2. Sinkers used in the study area

During the study it was found that sinkers of different material, shapes and sizes are available. Lead is very much prevalent throughout the area. A profile of sinkers used along the study area is given in Table 1

Throughout the region bean/barrel shaped sinkers are used in most of the fishing gears like gill nets, trawl nets, boat seines etc. They are usually made up of lead. It was observed that in the northern coast of Kerala, baked clay was also used to make barrel shaped sinkers having mean weight of 7 g, which is used only in gill nets. The sinkers made of lead are found to have a weight range of 10 – 250 g. Cylindrical sinkers are used in cast nets and are made up of lead. The weight ranged between 15 – 50 g. In the Chinnamuttom harbour, the foot-rope of some trawl nets are found to be rigged with cylindrical sinkers made of cast iron having a weight of approximately 300 g.

Conical sinkers are mainly used in hook and line operations. These are made of either lead or iron having a weight range of 50 – 500 g. Lead sinkers weighing up to 1.0 kg is attached at the distal end of troll lines (Hameed and Boopendranath, 2000). In trawl nets mostly lead and iron sinkers are used, while in purse seines and ring seines, lead is predominantly used. Sinkers other than lead and iron

such as clay, stone and cement are mostly used in gill nets. Thomas (2001) also reported the use of stone, cement and clay sinkers in gill nets of Kerala. Rectangular shaped cement sinkers were found in the Tamil Nadu coast, which are used in gill nets. They usually have two holes provided for rigging with the footrope. They have a weight range of 200-300 g. Spherical sinkers are more popular in the gill net sector. They are usually made of cement with a twine/rope fixed inside. They found to have a weight range of 100 – 400 g. But there is no strict standard followed in making them, as they are usually hand made by the fishermen. In the northern coast of Kerala, baked clay was also used to make spherical sinkers. The have a weight range of 20-50 g and are used in gill nets. In northern coast of Kerala, bent lead plates are fixed to the footrope of gill nets as sinkers. They come in varying sizes and dimensions. The fishermen select the suitable one according to their need. The data showed that lead is the most commonly used material for making sinkers. The high specific gravity, water repellency, easiness to shape (it can be machined, forged and cast) and easy availability make lead sinkers popular.

The types and usage pattern of sinkers were found to be almost similar in all the regions studied. This can be attributed to the migratory fishermen spread all along the coast who makes the scenario almost standard throughout the region. These fishermen are from the Kolachal belt of Tamil Nadu.

Table 1. Sinkers used along the study area

Material	Shape	Weight (g)	Fishing gears in which used	Areas where used	Cost (Rs kg^{-1})
	Bean/Barrel	10 – 20	Gill nets	A	50 – 90
		20 – 100	Gill nets, Trawl nets	A	
		100 – 200	Trawl nets, Boat Seines	A	
Lead	Cylindrical	15 – 25	Cast net	A	
	Conical	150 – 200	Long lines, Hand lines, Squid jigging	A	
	Bent plate	5 – 50	Gill nets	NK	
	Conical	100 – 500	Long lines	A	
Iron	Cylindrical	250	Trawl nets	ST	25 – 40
	Ring	10 – 20	Gill nets	A	
Clay	Bean/Barrel	5 – 10	Gill nets	NK	40 – 57
	Spherical	10 – 50	Gill nets	NK	20 – 40
Cement	Rectangular	100 – 200	Gill nets	SK, ST	10 – 30
	Spherical/Ball	100 – 250	Gill nets	A	
Stone	Irregular	100 – 500	Gill nets	A	NA

A – All over area studied NK – North Kerala NA – Not Applicable
SK – South Kerala ST – South Tamil Nadu

3.3. Properties of Sinkers

The general dimension of a typical sinker is depicted in Fig. 3

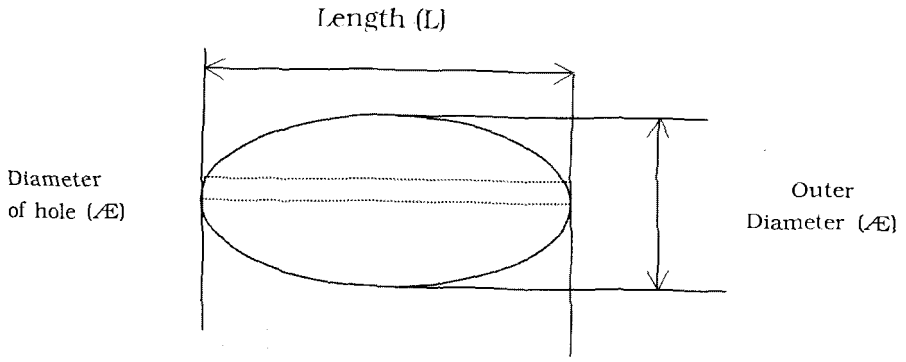

Fig. 3 Dimensions of a typical sinker

In general, the diameter of the hole for rope is found to follow the formula given below (Prado, 1990)

The diameter of the hole (Æ) = diameter of rope + 3 mm approx

The specific gravity has a very decisive role in determining the best sinker and is directly proportional to the sinking force.

Specific gravities of some materials used for making fishing sinkers is given in Table 2.

Table 2. Specific gravity of different sinker materials

Material	Specific gravity
Lead	11.3
Iron	7.8
Tungsten	19.62
Stone (Granite)	2.6
Brick	1.9
Porcelain	1.7
Clay	2.2
Cement	2.24 - 2.4
Glass	2.6

The sinking force and the physical dimensions of the common sinkers used are given in Table 3 - 6.

Table 3. Properties of lead sinkers

Bean/barrel shaped

Sl. No.	Weight (g)	Length (mm)	Dia at the Centre (mm)	Dia at the End (mm)	Dia of Hole (mm)	Sinking Force(g)	*Availability*
1	10	22	10	6	4	9.1	*Easily* available
2	20	20	15	10	6	18.2	Easily available
3	50	25	22	18	8	45.6	Easily available
4	100	35	25	17	8	91.2	Easily available
5	150	40	25	20	10	136.7	Easily available
6	200	40	30	22	10	182.3	Easily available
7	200	40	35	30	20	182.3	Easily available

Cylindrical shaped

Sl. No.	Weight (g)	Length (mm)	Dia (mm)	Dia of Hole (mm)	Sinking Force(g)	Availability
1	15	33	8	5	13.7	Easily available
2	25	45	8	5	22.8	Easily available

Conical shaped

Sl. No.	Weight (g)	Length (mm)	Dia (mm)	Dia of Hole (mm)	Sinking Force(g)	*Availability*
1	150	50	40	3	136.7	Limited
2	200	125	16	3	182.3	Limited

Bent plate type

Sl. No.	Weight (g)	Length (mm)	Breadth (mm)	Thickness (mm)	Sinking Force(g)	Availability
1	5	20	17	1	4.6	Very limited
2	10	35	20	1.5	9.1	Very limited
3	15	40	25	2	13.7	Very limited
4	20	60	25	2	18.2	Very limited
5	30	70	28	2	27.3	Very limited
6	50	70	40	2	45.6	Very limited

Table 4. Properties of iron sinkers

Conical shaped

Sl. No.	Weight (g)	Length (mm)	Dia (mm)	Dia of Hole (mm)	Sinking Force(g)	Availability
1	100	70	20	5	87.5	Easily available
2	500	100	35	6	437.5	Easily available

Cylindrical shaped

Sl. No.	Weight (g)	Length (mm)	Dia (mm)	Dia of Hole (mm)	Sinking Force(g)	Availability
1	250	50	40	20	218.8	Limited

Table 5. Properties of baked clay sinkers

Bean/barrel shaped

Sl. No.	Weight (g)	Length (mm)	Dia at the Centre (mm)	Dia at the End (mm)	Dia of Hole (mm)	Sinking Force(g)	Availability
1	7	50	12	5	7	3.8	Very limited

Spherical shaped

Sl. No.	Weight (g)	Dia (mm)	Dia of Hole (mm)	Sinking Force(g)	Availability
1	10	22	6	5.5	Very limited
2	50	35	7	27.3	Very limited

Table 6. Properties of cement sinkers

Rectangular shaped

Sl. No.	Weight (g)	Length (mm)	Breadth (mm)	Thickness (mm)	Sinking Force(g)	Availability
1	100	40	30	10	55.4	Made by fishermen
2	200	80	60	10	110.7	Made by fishermen

Spherical shaped

Sl. No.	Weight (g)	Dia (mm)	Sinking Force(g)	Availability
1	100	30	55.4	Made by fishermen
2	250	50	138.4	Made by fishermen

The sinking force of non-lead sinkers were compared with led sinkers of same weight. In the case of iron sinkers it was found that the sinking force was 3.83 % less than that of lead sinkers. Whereas,

sinkers made of cement and clay showed considerable lowering in the sinking force for the same mass of material. It was found to be 36.07% and 40.02 % respectively. Considering the reasonable sinking properties and low cost of iron makes it a good replacement for lead sinkers.

3. 4 Cost and availability of sinkers

In general, the cost of sinkers was found to vary slightly from one place to other. It ranged between Rs. 50 to 90 per kg for lead and Rs. 25 to 40 per kg for iron. The clay sinkers were available at the rate of Rs. 20 to 57 per kg. Lead and iron sinkers are easily available. Lead is produced by smelting spent electrodes of lead-acid storage batteries used in motor vehicles and electrical equipments. Crude methods are used in their production and no care is taken to prevent pollution of the environment. Iron sinkers are made by local black smith by casting iron in to desired shape. The cement sinkers are made by fishermen themselves. Use of clay sinkers is limited to north Kerala especially Kannur and Kozhikkode districts, these are mainly supplied by potters of Karnataka. The stone sinkers are very common in artisnal sector as they are made out of natural stones and granite. Big stones as such are used as mooring sinkers. The other type of sinkers made of ceramic/ porcelain, glass, tungsten, bismuth, tin, stainless steel and plastic were not available in this region.

3.5 Recent trends in use of sinkers

Predominantly locally available materials were used to make sinkers in various regions. However, the easy availability of lead sinkers in different sizes and shapes has made lead a widely used material replacing the commonly available materials like stone, clay/ brick etc. Apart from this, lead is preferred by fishermen over other materials due to its ease of use, reasonable cost, low rate of being damaged/lost in operation, corrosion resistance, easiness to shape (it can be machined, forged and cast) and high specific gravity. All along the region studied, this trend is much pronounced. This increased use of lead sinkers can add more lead to our environment. Apart from this, the up beat trend in the tourism sector in Kerala is expected to bring in more recreational activities which can also lead to more lead pollution as most of the sinkers and jigs used in recreational gears contain lead. It is advisable to impose some kind of restriction on use of lead sinkers and jigs especially in fresh water bodies.

Currently there are many new, non-toxic sinkers made out of bismuth, tin, stainless steel, tungsten, ceramic, recycled glass, natural granite, plastic etc. in countries like U.S.A., U.K., Canada and China. (USEPA, 1994). For instance, using tungsten, a sinker of about $1/3^{rd}$ the size of lead sinker of the same weight can be made (Anon, 1994). Sealing metallic lead with an inert material like plastic to prevent leaching of lead is a recent innovative and cost effective method of making sinkers (Anon, 2004a). While some of these

alternatives like tungsten are more expensive than lead products, government can provide some relief to fishermen through some subsidies for expensive non-lead sinkers.

The effect on the habitat and the health hazards on fishermen related to the use of lead sinkers needs to be further studied in detail. Exposure to lead can have a broad range of health effects depending on the amount of lead present and the length of exposure. Only 10 micrograms of lead per deciliter of blood can have toxic effects (O'Brien, 2002). Within the human body, lead damages the nervous system, circulatory and blood forming system, reproductive system, kidneys, gastro-intestinal tract. In India, studies concerning this issue are generally lacking. Therefore, further studies on the effect of lead sinkers on biota and documentation of information on the lead sinker induced problems are very essential. The possibility of using alternative materials such as tungsten, high-density plastic, stainless steel, ceramic *etc.* also has to be explored.

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