

# ***Ballast Castings & Carbon Coated Ballasts***

## *Use of SAILSetc ballast castings*

### **General**

Most of these notes deal with One Metre and Marblehead ballasts which are cast in machined aluminium moulds. Much of the information will apply to our 6 Metre and A Class ballast castings too. The section at the end headed **6M and A Ballasts** deals with the differences.

### **Earlier SAILSetc designs (1990 - 1998)**

The shape is based on Young's designs for low drag solid bodies. They have been used with success for many years and, in the absence of better knowledge, remain a good choice of ballast shape.

### **Plan for ballast designs (2002)**

A Marine Modelling plan, MAR3007, available from SAILSetc, shows shapes suitable for all classes of model yachts. Two ballasts are shown with a round cross section. One ballast is shown with a flattened cross section and a winged platform. This is more suitable for 6 Metre and A Class designs. All are based on a section shape by Eppler and suitable for the Reynolds numbers typical for rc yachts. Several scaled versions are shown and a method of scaling each to other sizes is shown. This permits patterns for ballasts in the range 1 to 22 kgs to be made.

### **Current SAILSetc designs for 1M, M & 10R**

During the early part of 1998 a new ballast shape was designed for use on our One Metre designs. The shape was decided after looking at existing wind tunnel data and using it to minimise the frictional drag of the whole yacht at low speeds. The smaller diameter lowers the centre of gravity and this, along with the lower frictional drag, promotes performance at higher speeds too. We felt the new ballast was partly responsible for the success of the One Metre IKON and we were keen to use the same philosophy for the Marblehead ballast we supply. A new mould was made just in time to have a new ballast on the modified PARADOX 'RAD' which subsequently won the Marblehead World Championship in July 1998.

The Ten Rater ballast is a wide bodied version of the Marblehead ballast.

One Metre ballast, natural cast state, 2.4 kgs

Item 200-024

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Marblehead ballast, natural cast state, 3.6 kgs	Item 200-036
Ten Rater ballast, natural cast state, 4.2 kgs	Item 200-041

The new designs are fully compatible with current SAILSetc fin mouldings - see Slot Size

### Slot Size & Position

One Metre	8 wide x 14 deep x 97 long between 105 and 202 mm from forward tip 45 mm forward to 52 mm aft of lcg
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Marblehead/Ten Rater	8 wide x 18 deep x 100 long between 130 and 230 mm from forward tip 43 mm forward to 57 mm aft of lcg
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The slot is rectangular and is positioned approximately at the longitudinal centre of gravity of the ballast. This accommodates our normal arrangement of fin and ballast which is designed to minimise fin twist and deflection. These slot sizes will accommodate most other fin sizes.

### Casting

Each ballast has a 4 mm diameter brass rod running down its centre. This serves to strengthen and stiffen the fine ends of the ballast and protect them from damage. It also reinforces the ballast where it will be drilled to take the attachment bolt or studding in the middle of the slot. The restricted pouring hole size in the mould leads to occasional voids in the casting directly under the pouring hole. Fill these with a lead shot and resin mix before finishing.

### Replacement of an existing ballast

If the old ballast is **readily removable** in one piece the first step is to locate its longitudinal centre of gravity. Do this by making a noose in a piece of thick cord and using it to suspend the ballast. When you have found the balance point mark the position of the piece of cord. This is directly above the longitudinal centre of gravity.

If the old ballast is **'permanently' fitted** to the fin, take the precaution of drawing round the profile of the fin and ballast before removing the existing one. Use a new hacksaw blade and turpentine or turps substitute to lubricate when cutting. A bandsaw makes the job very quick and simple and it is worth finding someone who has one you can use. Cut the ballast off in as few chunks as possible and retain them. Re-assemble them into their original shape with adhesive tape and find their combined longitudinal centre of gravity using the method described above.

Now note the distance this longitudinal centre of gravity falls forward of, or behind, a near vertical line drawn on the fin.

When the new ballast is faired to shape and weight, repeat the test to find its longitudinal centre of gravity and arrange to fix the new ballast in the same position relative to the vertical line.

If the fin will not fit into the slot in the desired position you will need to enlarge the slot. If this seems likely you should allow for this when adjusting the total weight and, when this is done, re-check the longitudinal centre of gravity.

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## **Trim to weight & fair**

The natural cast state of the ballast castings leaves a grainy surface which can be smoothed initially with 100 grade grit if little weight is to be removed. Move on to 240 and finally 400 grade (use wet and dispose of waste into the dustbin rather than down the drain). Larger amounts of weight are best removed with a Surform. We use the convex blade held in the hand and drawn towards the body to cut the material rather than use the proper holding tool. Remove an amount all over in proportion to the local diameter. Then carry on abrading as above.

## **Maximising stability - minimising drag**

Before bonding or casting the ballast onto the fin you should pack any free space in the slot with lead and re-adjust the total weight and position of centre of gravity as needed. We add bronze powder to bonding resin to make it denser.

## **Alignment of ballast and fin**

It may seem 'normal' to have the centreline of the ballast parallel to the waterline. Another way is to drop the aft end of the ballast by a few mm to arrange for the ballast to be aligned with the water flow when the hull trims down by the bow in normal sailing trim. We have found that 2 to 3 degrees of 'nose up' is best for all round performance. You may find that the mast needs moving aft, or raking aft, more than usual in order to restore balance.

## **Transverse alignment of ballast and fin - make a jig**

It is especially important that the axis of symmetry of the fin and ballast are aligned. So, it is well worth spending some time making a simple jig to hold the ballast and fin in the desired relative position so that they can be glued together with confidence that they will not be mis-aligned. It is usually quicker and cheaper to do the job properly once. See Jig Plan 2 for details

## **Permanently fixing the ballast**

When you are confident you have positioned the centre of gravity and aligned the centreline of the ballast relative to the fin correctly you are ready to bond the two together. Abrade the bottom of the fin and mask off the part which will be above the slot with adhesive tape. Mix sufficient epoxy resin and hardener and thicken it with colloidal silica. Pour it into the slot and add the fin. Wipe off any excess resin and allow to cure. Fill any voids in the surface of the ballast with the excess resin.

## **Removable ballasts**

Proceed as for a fixed ballast but carefully taper and smooth the lower end of the fin finishing with 600 grade abrasive.

*It is best to have drilled the hole for the studding at the bottom of the fin before this stage – block it with Plasticene (modelling clay) to avoid filling with resin but leave a witness mark so that the position of the hole to be drilled in the lead slot is clear after removal of the fin.*

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Give at least four coats of wax to the lower end before casting it into the ballast slot (same way as for a fixed ballast). Wait until the epoxy is well cured before attempting to remove the fin. Do this by holding the fin and ballast over a padded surface and 'knocking' the ballast off by striking vertically downwards with a block of timber in front of and behind the fin. Patience! Clean the wax off the fin with solvent.

### **Attachment of ballast to fin using studding**

We use a piece of 3 mm stainless steel studding bonded into the bottom of the fin at the thickest point on the section. At least 50 mm should penetrate the fin and the retaining insert, INS-030, should be positioned in a 'key hole' in the fin to help take the tension. Make the studding long enough to extend to within 2 or 3 mm of the base of the ballast. Bond the studding and insert in place with epoxy resin and hardener thickened to make a paste.

### **Drilling the ballast for the studding**

Now carefully mark out and drill the ballast with a 2.5 mm diameter hole to match the position of the studding. If a witness mark for the hole in the fin was left it will be clear where to drill. Enlarge the hole to 3.5 mm diameter. Counterbore the bottom of the hole in the ballast to 6.5 mm diameter and to a depth of only 10 mm to take the ballast retaining 'nut' which is supplied as part of INS-030. A better solution is to counterbore the bottom of the hole in the ballast to 8.5 mm diameter and to a depth of 15 mm to accept the special brass seating we use on our ballasts, item INS-SEAT. Bond the seating into the ballast with epoxy paste.

Take care not to over tighten the nut when attaching the ballast.

### **Painting**

Abrade the surface all over with 400 grade abrasive but do not be concerned about low spots at this stage. Wipe with methylated spirit or acetone to remove any grease. Suspend the ballast from the attachment hole (if it is a removable ballast) or place it on a piece of timber which fits into the slot. Spray the ballast lightly all over with grey cellulose primer spray. This will identify the places where the surface needs to be filled. Use polyester car body filler (ISOPON, P38 etc) and leave to cure well before abrading to avoid clogging the abrasive paper. Abrade all over with 400 grade abrasive to achieve a good quality surface. Spray with grey primer to add 3 to 6 more coats. When dry rub down using 600 grade and 800 grade abrasives. We leave sprayed ballasts in primer finish as it is far easier to rub down to get a good finish and to add more to cover any scratches.

### **IOM & 10 Rater CF Coated Ballast Instructions for fitting to fin.**

- 1 The coated ballast is supplied without the slot cut for the fin. The carbon coating covers the whole ballast but the cavity which is cast in the lead remains unfilled except for polyurethane foam. This enables you to cut the slot to the correct size and shape and in the correct position. See the 'Slot size & position' section above for details.

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- 2 Mark the shape of the required cut out in the top of the ballast. Take care to ensure it is in the correct place. The top of the ballast is identified by the location of a 1.6 mm diameter hole on the join line.
- 3 Drill a series of small holes through the carbon coating just inside the line to be cut. Join them together by inserting the drill at an angle. Use a small hacksaw blade with the end broken off to cut the carbon material free. Alternatively use a Dremel grinder or similar tool to cut the slot.

*WEAR A MASK WHEN WORKING WITH CARBON. EXCEPT WHEN USING ELECTRIC TOOLS YOU CAN REDUCE DUST BY KEEPING THE MATERIAL WET. UNLESS IT HAS A GOOD QUALITY MICROFILTER DO NOT USE A VACUUM CLEANER TO REMOVE DUST AS THE NORMAL FILTER WILL NOT REMOVE FINE FIBRES.*

- 4 When the slot is cut and filed to the correct shape, cut away the polyurethane foam inside to permit a good gluing joint between the lead and the fin.
- 5 Complete any work required on the fin and weigh it accurately. Weigh the coated ballast. Estimate the weight of glue used to fit the fin to the ballast. Glue/resin has a density near to water so each cubic centimetre will weigh one gram. You can measure the amount of glue that will be required by using a syringe to fill the ballast cavity with water and deducting the volume of the fin which will be pushed into the cavity. If it is a One Metre ballast you should calculate the amount of additional weight that needs to be added to bring up NEARLY to the maximum permitted by the class rules, say 2490 grams.
- 6 Any additional weight that needs to be added should be in the form of sheet lead cut to fit into the ballast cavity. If the fin is a heavy one it is possible that some lead will need to be removed from the ballast before attaching it to the fin. Do this by drilling material out of the centre of the ballast.
- 7 Hold any sheet lead in place in the slot with cyanoacrylate glue. Devise some way of holding the fin and ballast in correct alignment while they are glued together. Mask the bottom of the fin just above the portion which will fit into the fin with adhesive tape and thoroughly abrade the fin below the tape. Clean off the dust. Mask the top of the ballast too around the slot.
- 8 Mix sufficient epoxy resin and thicken it with colloidal silica until it is thick enough not to sag. Place some of the resin mix into the ballast cavity and wet the bottom of the fin with the mix to ensure good bonding. Push the fin into the ballast cavity and clean off any excess before it hardens. Check alignment and hold in place while the resin hardens.

## **6M and A ballasts**

The special shape of these demands the use of a harder alloy to avoid the thinner parts being easily damaged. The material is worked in much the same way as pure lead. The larger surface area and sand casting technique means a rougher finish and greater weight variation than for the other ballasts.

Rather than bond these ballasts to a fin using a slot we rely on a piece of 8 mm stainless steel rod bonded into the bottom of the fin and passing into a single vertical hole through the deepest section of the ballast. A 6 mm pan head bolt (recessed into the ballast) attaches the ballast on

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the lower end of the rod. The load of the ballast is transferred through the fin to the top using 6 mm studding. A washer and nut placed on the top of the studding serves to attach the fin to the hull. This set of items is sold as INS-080.

Two locating studs of 3 or 4 mm stainless steel rod, one fore and one aft, stop the ballast from twisting on the fin. These should penetrate the lower end of the fin by at least 20 mm and into the ballast by 10 mm. They should not be permanently bonded into either fin or ballast.

end

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