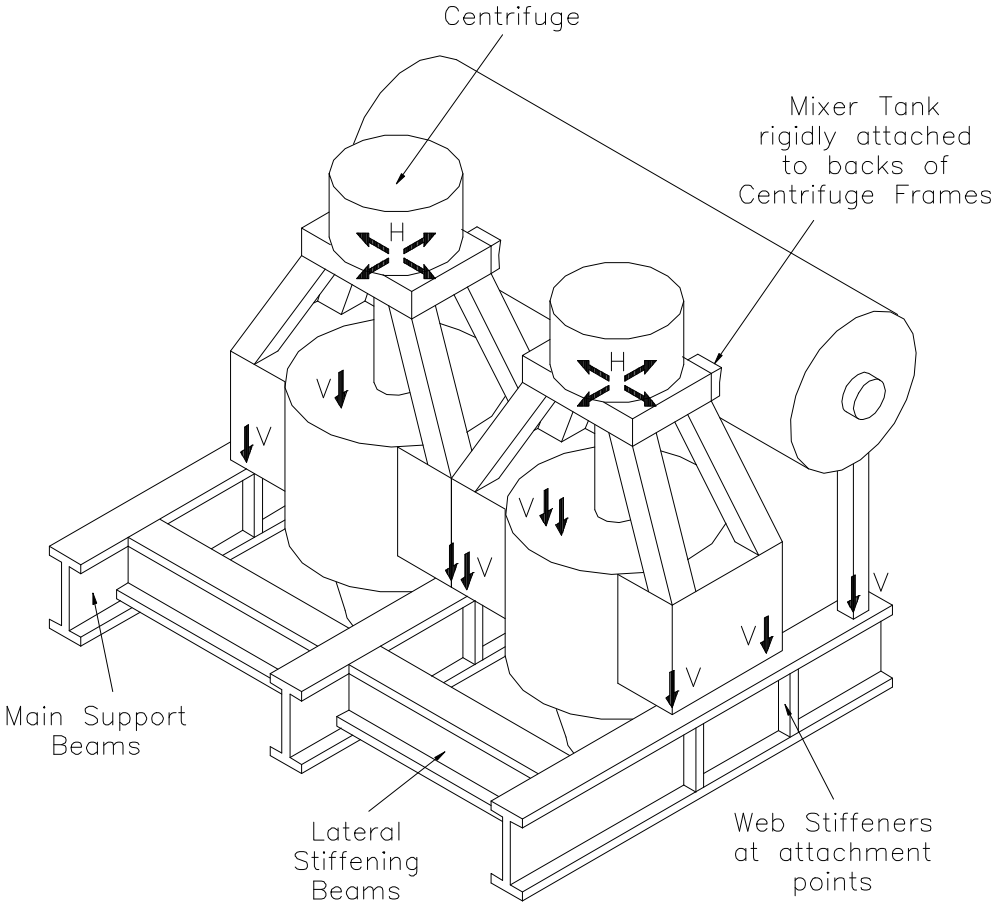
Thomas Broadbent and Sons Limited
Sugar Division

Information Sheet SI/97/1

Support Structures for Series 2000 Batch Sugar Centrifuges

This information sheet describes the general requirements for designing support substructures for Broadbent Batch Sugar Centrifuges and should be read in conjunction with the specific General Arrangement and Foundation Drawings for the equipment being supplied. It strongly recommended that the design be carried out by a competent Civil or Structural Engineer. Failure to comply with these requirements could invalidate any guarantees provided with the centrifuges.

Figure 1 Typical Battery of Batch Centrifuges



General Description

A typical battery of machines is shown in Figure 1. The centrifuges are self contained units. The rotating assembly is suspended from a 4 legged frame which rests on a monitor casing with boxed in sides. To maintain the monitor casing cover at a convenient working height, the monitor casing and sugar discharge chute extend below floor level. The battery is normally fed by a mixer tank with internal agitator which is attached to the backs of the centrifuge frames.

The centrifuge casing and the supports for the mixer tank rest on the main front to back beams of the support structure. These are normally I beams to facilitate bolting through into the bases of the centrifuges and the flanges must be narrow enough to allow the monitor casing to pass between. Depending on the civil works of the building, the ends of these main beams may be supported by reinforced concrete or steel frame structures.

Batch centrifuges are inherently a source of vibration so the complete support system must be designed to meet both the strength and the stiffness requirements given below. This will almost certainly result in a structure considerably more substantial than that required for static equipment of similar weight. Structures which are too flexible will give an uncomfortable working environment and may degrade performance by allowing vibration in one centrifuge to be transmitted to other centrifuges in the battery giving rise to nuisance trips. In extreme cases, fatigue may lead to premature failure of the centrifuges or support structure.

Strength Requirements

The Foundation Drawing for the equipment will give the locations and bolting patterns for the attachments to the main support beams. They will also give the static dead weights *W* at each point. These weights include the centrifuge plus a complete charge of massecuite in the basket. Where the mixer is of Broadbent design, the dead weights of the tank, agitator, drive and a full charge of massecuite will be included on the Foundation Drawing. Where the mixer is to another design, the dead weights must be added to those shown.

To allow for dynamic effects, the static weights must be multiplied by a vibration factor *f* of 2 to give the vertical forces $V=fW$ at each attachment point as illustrated in Figure 1. In addition, allowance must be made for a rotating out of balance force *H* at the suspension buffer of each machine as specified on the Foundation Drawing. This produces a horizontal overturning force which can be assumed to apply in any of the 4 principal directions shown in Figure 1.

An appropriate national or international standard for structural design should be used to ensure that the support structure can safely carry all the loads *V* and *H* simultaneously in the worst possible combinations.

Stiffness Requirements

The dynamic loads are all excited by out of balance forces and will therefore be alternating at the machine rotational speed. To avoid resonances, the support structure and its individual members must be sufficiently stiff to ensure that their resonant frequencies are at least 50% higher than the maximum running speed of the centrifuges as given in Figure 2. The resonant frequency of the structure is related its static deflection under self weight plus the applied weights *W*. The structure will be sufficiently rigid if the average of the static deflections at all the load points *W* is less than the value given in Figure 2.

Figure 2 Minimum Resonant Frequencies of Support Structures and Members

Maximum Rotational Speed of Centrifuges rpm	900	1,000	1,100	1,200
Minimum Permitted Resonant Frequency of Structure Hz	22.5	25	27.5	30
Maximum Permitted average static deflection mm	0.49	0.4	0.33	0.28

Recommendations

The strength and stiffness requirements for the main front to back support beams in the vertical direction can be met by using heavy section I beams and by minimising the span. If the positioning of the building's main vertical supports necessitates long main support beams, the span can be effectively reduced by adding diagonal braces to the verticals. Diagonal bracing is also recommended as a means of resisting swaying of the whole staging structure under the action of the horizontal forces *H*.

The stiffness of the main support beams in the horizontal direction can be improved by adding lateral stiffening beams as illustrated in Figure 1, particularly if short diagonal braces are added between the two.

To prevent local buckling of the main support beams, it is recommended that web stiffening plates are welded in at the equipment attachment points as shown in Figure 1.

The centrifuges can tend to sway sideways under the action of the horizontal forces *H*. It is essential that the backs of the centrifuge frames are rigidly attached to the mixer tank at the anchoring pads provided. This allows the side of the mixer tank to act as a shear panel stiffening against sideways deflection and the extra mass helps to damp the vibration forces.