MACSTEEL TRADING

CURVED CELLULAR BEAMS

MARCH 2003

Introduction

CELLULAR BEAMS

Patented Cellular beams have proved to be one of the most significant developments in steel construction since their introduction in 1987. They have been used in over 3500 projects in over twenty countries.

The structural integrity and design criteria have been verified following full scale destructive testing at Bradford University in 1988, Leeds University in 1995 and the University of Manchester Institute of Science and Technology (U.M.I.S.T) in 2000, under the supervision of the Steel Construction Institute in the UK.

MACSTEEL TRADING

Macsteel Trading, entered into an agreement with European cellular beam supplier, Westok Limited to manufacture and distribute cellular beams.

Macsteel Trading has an extensive branch network in Southern Africa. It provides economies of scale and exceptional service levels to the mild steel, special steels, pipes and fittings, fluid control, and value added markets.

Macsteel Africa supplies the full range of steel and value added steel products to Africa and the Indian Ocean islands.

Macsteel Trading is committed to the highest quality of service and workmanship.

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Contents

Why Curved Cellular Beams?

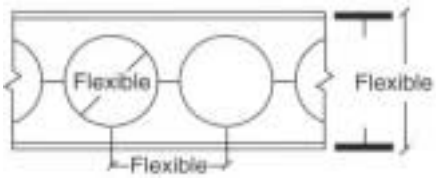
Two factors combine to make cellular beams the most economical of curved structural members:-

- STRUCTURAL EFFICIENCY
- SIMPLICITY OF CURVING

STRUCTURAL EFFICIENCY

The most important of the two contributory factors is the structural efficiency of the cellular beam.

Like its predecessor, the castellated beam a cellular beam is an expanded member, achieved by welding together the two halves of a specially profiled universal beam.



The Cellular beam is upto 1.6 times deeper than its parent universal beam, and more importantly upto 7 times stronger.

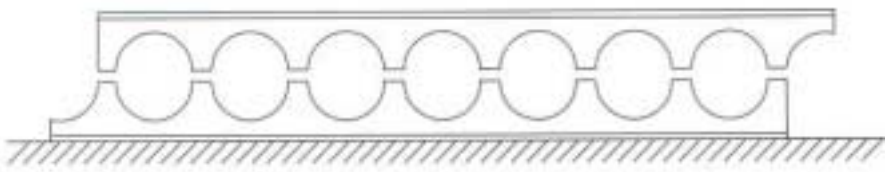
It is this enormous gain in performance without weight increase that results in cellular beams frequent use as roof members, irrespective of whether the roof is straight or curved.

Why Curved Cellular Beams?

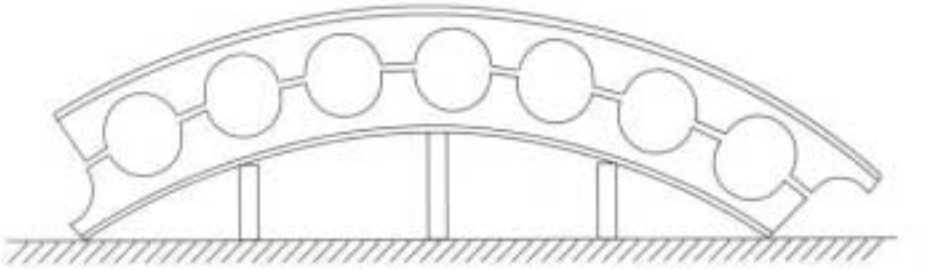
SIMPLICITY OF CURVING

In curved applications the benefits of cellular beams are multiplied by the simplicity of curving.

With only an insignificant modification to the production process, the cellular beam is quickly curved to the required radius.



Assembling straight cellular beams



Assembling curved cellular beams

Cost Considerations

PITCHED ROOF OR CURVED ROOF?

The cost difference between pitched roof construction and curved roof construction has never been as small as it is today.

The minimum cost difference is likely to be achieved at a radius of around 150m. This provides the pronounced appearance of a curved roof, whilst minimizing the number of splice connections required in the curved cellular beams, and allowing the use of standard and inexpensive roof-cladding products.

SPANS UPTO 30 METERS

For a client for whom cost is the overriding consideration, a pitched portal “shed” is the cheapest solution in this span range.

However, the cost difference to adopt a curved cellular beam roof is surprisingly modest.

SPANS > 30 METERS

Beyond the range of portal-frames a lightly curved roof costs little or no more than a pitched roof.

This is because at such spans a curved cellular beam costs no more than a parallel lattice-beam or truss, and in most cases provides cost savings.

PLAIN BEAMS OR CELLULAR BEAMS?

Once the decision has been taken to use curved beams, it is likely that cellular beams will offer economies compared to plain universal beams, due to weight savings of upto 40 % and the ease of curving.

The relative costs of plain and cellular beams depend on many factors, most critically being the span and the required radius.

The table below is an indication only of which is likely to be the most cost-effective solution:-

	Tight Radius	Medium Radius	Large Radius
Up to 16m Span	**Plain**	**Plain/Cellular**	**Cellular**
> 16m Span	**Plain/Cellular**	**Cellular**	**Cellular**

Cost Considerations

LATTICE BEAMS OR CELLULAR BEAMS?

Curved cellular beams offer distinct advantages compared to curved lattice beams and trusses:-

COST

In projects where cost has been the deciding factor, without exception cellular beams have been used in preference to trusses. A cellular beam requires much less fabrication time than a built–up lattice, more than offsetting their slightly higher weight.

The cost of painting a cellular beam is also significantly lower than that of lattice beams.

HEADROOM

Cellular beams are typically 40 – 50 % shallower than trusses. This can allow a reduced height to underside of eaves, or can increase headroom, which is particularly important for sports and leisure centers.

DETAILING FOR ECONOMY
ODD OR EVEN NUMBERS

In projects using large numbers of curved cellular beams the question of odd or even numbers of beams is irrelevant. However, in small projects it is beneficial to adopt bay centers which require an even number of beams.

NOTE: This does not refer to the number of frames, but to the number of pieces. In a building with 5 frames, spliced at the apex, there are 10 pieces, i.e. an even number.

TAPERED ENDS

Tapering the ends of curved cellular beams is often used to create an attractive feature of exposed overhanging eaves.

Where cost constraints are paramount, consideration should be given to avoiding this detail, or at least minimizing the length of the tapered portion.

AVOIDING SOLID – WEB AREAS

A cellular beam has cells along its entire length. To create solid areas within the beam requires the fitting of a circular “infill plate”. Unless absolutely essential to the required appearance, or as dictated by the structural engineer, the infilling of cells should be avoided to minimize unnecessary costs.

GRINDING FLUSH WELDS- NOT TO BE SPECIFIED

The slightly raised weld across the teeth of cellular beams is an integral part of this structural member and has never provoked a negative reaction from a client. Moreover, grinding could detract from the appearance of the beams. Manual grinding tools create uneven surfaces which become exaggerated upon the application of a high quality paint treatment.

Radii & Dimensions

Curved cellular beams fall into two categories:

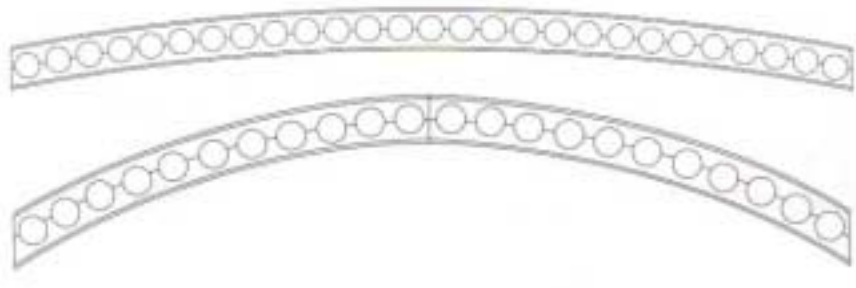
A) Curved in-house, therefore minimum cost

B) Curved in collaboration with a section–bending company

The table below indicates the approximate limits of the respective methods.

ORIGINAL SECTION SIZE	TYPICAL BEAM DEPTH	LENGTH OF BEAM	MINIMUM RADIUS A	MINIMUM RADIUS B
Up to 305X165	**450**	**10m** **12m** **14m** **16m**	**20m** **30m** **40m** **50m**	**15m**
Up to 457x191	**650**	**14m** **16m** **18m** **20m**	**50m** **60m** **80m** **95m**	**20m**

The achievable radius of a beam is not subject to overall span, but to the length of the pieces that make up that span.



A tighter radius can be achieved by introducing a splice. Splices at 1/3 points allow a further reduction in radius.

Radii & Dimensions

BEAM SIZING AND CELL DATA

Cellular beams do not have standard dimensions. The use of advanced CNC cutting equipment allows the architect and engineer considerable flexibility in their choice of beam depth, cell diameter and cell spacing.

FOR PRELIMINARY USE ONLY the table below is a guide of likely dimensions.

SPAN	CELLULAR BEAM DEPTH	CELL DIAMETER	CELL SPACING
12m	400mm	300mm	400mm
16m	550mm	350mm	425mm
20m	600mm	400mm	500mm
24m	700mm	450mm	550mm
28m	800mm	550mm	650mm
32m	900mm	600mm	750mm
36m	1000mm	700mm	1050mm

The final dimensions depend on the specific loading and layout.

ALWAYS CONSULT YOUR STRUCTURAL ENGINEER BEFORE FINALISING DIMENSIONS.

REVERSE CURVES

Double curves or reverse curves are an increasingly popular feature in modern architecture.

SYMMETRICALLY OPPOSING CURVES

This is easily achieved by inverting one of a pair of identically curved cellular beams.

ASYMMETRICALLY OPPOSING CURVES

Two curves of differing radii can also be joined. In small projects with small numbers of beams it is economical to adopt bay spacings, which produce an even number of curved frames.

Radii & Dimensions

MINOR AXIS CURVES

Cellular beams can also be curved on their minor axis, in co-operation with a specialist section bending company.

The approximate achievable radii are shown below.

Cellular Beam Depth	Approximate Minimum Radii
300mm **450mm** **600mm**	**2 meters** **3meters** **4meters**

Note the minimum radius to which any cellular beam can be curved depends on a number of factors. If your required radius is close to that shown above please contact Macsteel Trading's technical department for advice.

Technical Support

OFFICE BASED DESIGN SERVICE

Macsteel Trading have an office based design service to provide advice and full designs. To help optimize the design of a specific project and assist engineers to gain familiarity and expertise in cellular beam design, Macsteel Trading staff will attend project design meetings.

TECHNICAL SEMINARS

In house technical seminars can be arranged to promote the efficient design of cellular beams, and proficiency with the associated software, CELLBEAM.

CELLBEAM SOFTWARE

All cellular beam designs are carried out using the analysis program, CELLBEAM, written by the Steel Construction Institute UK. The results are based on full scale testing:

- Bradford University 1988
- Leeds University 1995
- U.M.I.S.T 2000

The program is available free of charge and is enhanced on a regular basis.
Technical support will be offered without charge or obligation. **Please do not hesitate to use it.**

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