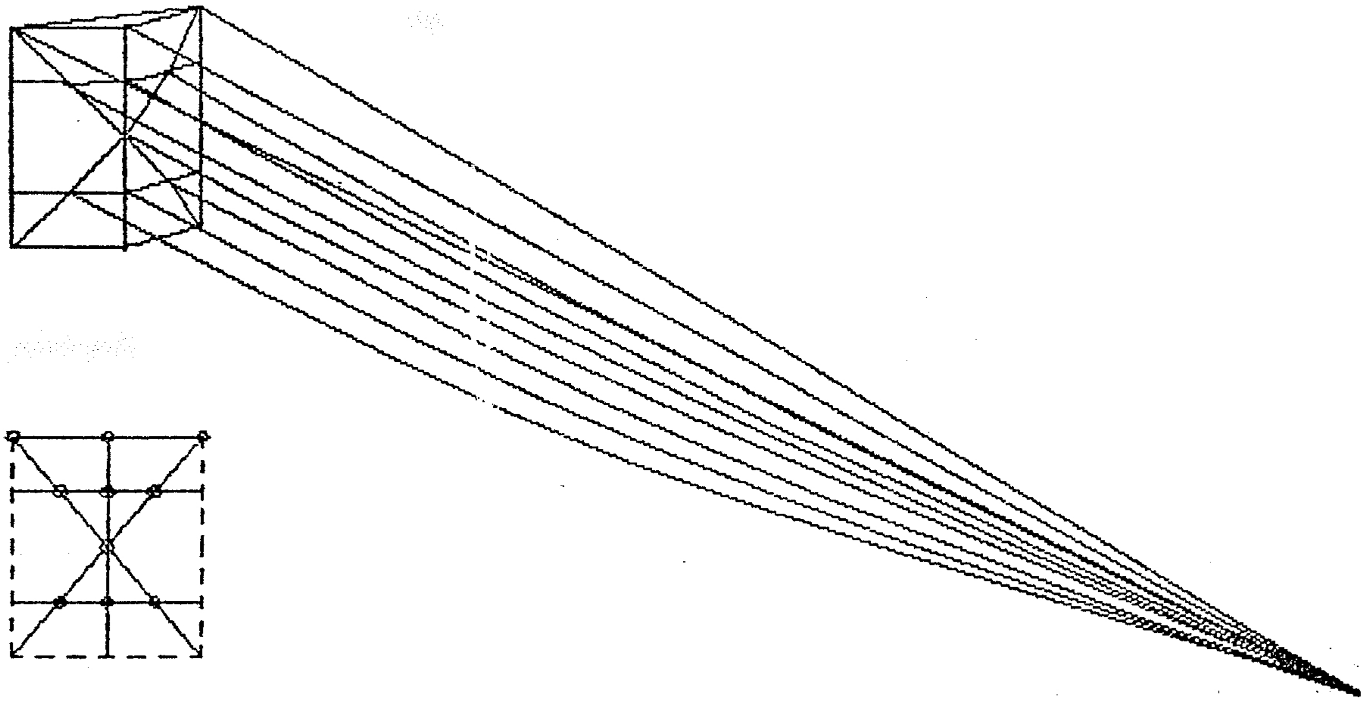
A WORKING MAN'S GUIDE TO THE EDO

This article is taken from a typescript in the possession of George Webster. The only clue to its authorship are the initials 'cw' and the date 'jan93'. There seems to be no copy on the world wide web other than this one.

Neither George nor I have any idea who 'cw' is (or was). Identification would be gratefully received and acknowledged. Thanks to him or her anyway.

I have corrected the occasional spelling mistake and lightly subedited the article for style and punctuation. I have moved one sentence from its original position to one where it seems to me better placed. I have changed the layout of the diagrams relative to the text.

Constructing on EDO 15 rather like trying to play 'Flight of the Bumble Bee' faster than Yehudi Mehnuin. Whatever you do you're faced with a long tradition of Masters nurturing unpublished 'secrets' which hold the key to success. I'm not going to deal here with the rich artistic heritage of Edo kite painting but with the Edo form: the boxed rectangle stabilised with long long bridles.



Chubari 6-rod EDO

My particular fascination is with the visual effect of the dense array of intersecting. moving curves and lines which the bridles form when suspended by the kite. The kite needs the bridles and the bridles need the kite.

Limited credentials for discussion of the subject are: 15 Edos constructed over a two year period; Frames were built in bamboo and glass fibre rods; Sails were made in Tyvec and ripstop; Bridles were made in various thicknesses of rough and smooth manmade fibre line; Proportions (length : width) ranged from 1.8 : l to 1.31 : 1 ; Sizes ranged from 0.4m^2 to 1.55m^2.

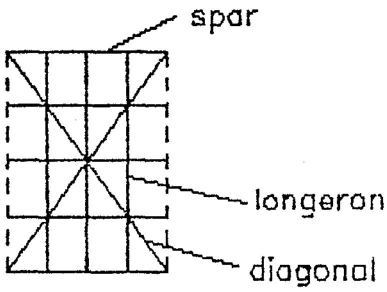
The kite plan associated with this article is a result of summarising and simplifying
what I feel I have learned about Edos into a kite which is a good 'starter' for anybody into Edos. It has enough bridles to give the effect I need but is straightforward enough to fly singlehanded and more to the point, can be built with a view to adding more spars, rods or bones (depending on your terminology) and, of course, bridles when you are ready to experiment.

When I first started on Edos the aim was to produce a kite which flew without a tail. Since almost anything seems to fly if the wind is right and the tail is long enough the real test of Edo bridles eeemed to me “can they stabilise the kite on their own”. It is a fact that for some Japanese Edo Masters the tail appears to be essential both aerodynamically and aesthetically and I admit now that since getting Edos to fly without a tail I have begun to use tails with a fresh enthusiasm. In fact they enhance the visual effect of the bridles. The Chubari kite shown is set up to fly without tails in a wind 10–15mph.

So that would-be constructors know where I’m coming from I’ve summarised my conclusions and opinions on Edos and Edo flight in the form of a simple list. I welcome comment.

1. The kite should be fairly flexible. Although the lengths of rod between bridle points should be rigid, a degree of ability to twist from corner to corner makes the kite more accommodating. Traditional kites are made with the sail applied to a lashed bamboo frame. Ripstop kites are made by stressing rods against the sail and tend to be more flexible because the rod joints can move slightly in three dimensions. Each sort has a differant ‘feel’ but the ripstop type is easier to dismantle.

2. Order of laying the rods:



a) Sail
b) Longerons
c) Spars
d) Diagonals

Rods are laid in this order for most frame types.

Sholibari (10 rod) frame

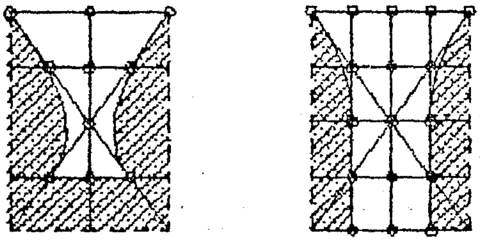
3. Generally the.kite should be set up so that the top spars are the stiffest and heaviest although using uniform spars is acceptable. Raising the centre of gravity above the sail midpoint in this manner improves stability. This effect is closely linked with the bowing.

4. The depth of bow should be in the region of 15% of the kite width up to 22% for stronger winds. Altering the bow particularly on the leading edge will change the bridle settings. More bow lightens bridles at the sides and slackens relatively the centre bridles.

5. On 10 rod kites bowing is generally the some for all spars. On 6 rod kites the lack of trailing edge and central spars allows greater flexibility at the rear and side edges of the kite making it more absorbent of turbulence and of course slightly less dependant on the stabilising effect of the bridles. I must say here that even in small sizes the 10 rod kite is a more ‘majestic’ beast!

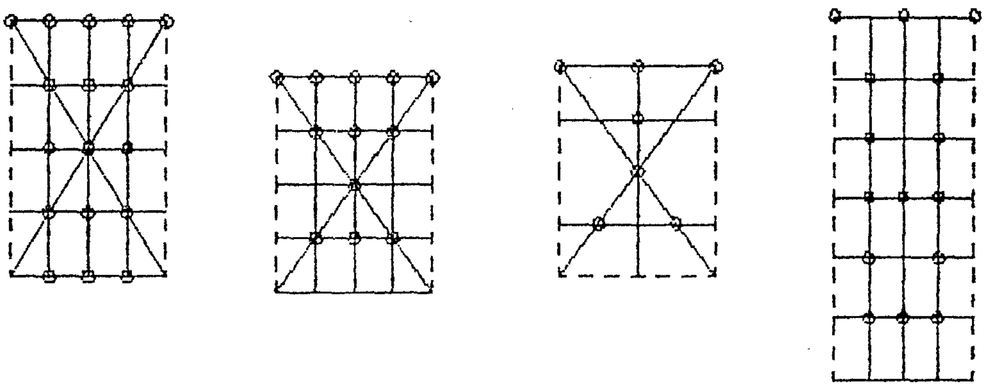
6. The bowing, locations of rods and number of supporting bridles combine to regulate how the sail structure itself can distort to either absorb or be disturbed by turbulence. This may sound obviousy glib but it is by understanding how all these elements interact that Edos can be understood Sail deformation should be considered initially assuming that the bridles fix bridle points rigidly and that any flexure that occurs will be about those points. This will give an insight into the kite’s static behaviour, Consider then the effect of altering bridle tension at any point. This will provide a visualisation of the forces available to restore a disturbed kite to stability.

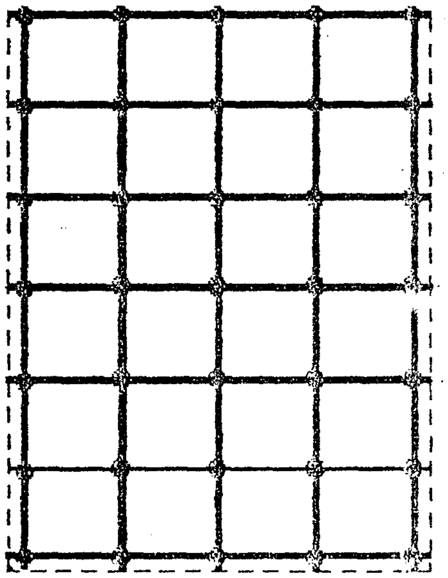
7.	Typical sail deformations can be illustrated as shown below. The shaded area shows where the kite is free to flex.



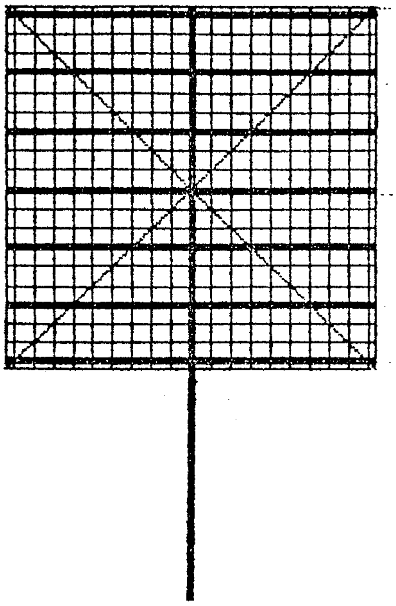
Shaded areas show flexibility assuming bridles hold bridle points fixed.

8.	Although my Edo ‘study’ is confined to a certain range of sail proportions and rod configurations there are a great number, of other classic Japanese patterns which can be seen in kite literature describing bowed rectangles with long bridles. In Western kite circles it has now become common to describe all such kites as Edos even though the name strictly refers to kites made in a specific area of Japan during a specific era.
Below I’ve illustrated some frame structures and proportions indicating the variety of the form.
Check these to find the sail flex pattern as above and you will see what a difference adding a rod or a bridle can make to the way wind ‘sees’ the kite.





The 26 feet high Shirone Odako is in fact a fighting kite controlled by altering line tension. The bottom two spars are not usually bowed allowing them to twist and flap. restrained by ....the lower bridles and rope tails. By definition this kite is not an Edo but for bridle freaks is a masterpiece, Note that the whole sail is so flexible that in flight it appears to act like a slightly stiffened sheet of cloth. Like many of the very flexible rectangles this kite seems prone to folding up completely unless carefully controlled.

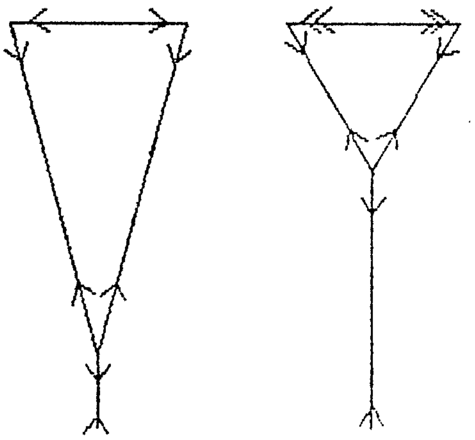


The Hamamatsu fighting kite is in fact square and has a highly 'engineered' frame with rod thicknesses for the main and subsidiary spars. The long rope tail is fixed to an extension of the central spine. The frame is made such that seven main spars are laid touching the sail, then the subsidiary spars, then longerons, then diagonals. All seven main spars are bowed. Between 20 and 40 bridles are used. I wouldn't even dare to comment on the hows and whys of this kite but have included it as an example of a higher aspect ratio rectangle.

In general the wide, short kites are more buoyant, the tall, narrow kites more stable. Low aspect ratio kites have a high 'sink rate', which basically means when the wind owing they drop like a stone!

9. Well... at last the bridles.

Broadly speaking the bridles have two jobs: to restrain the light frame members from buckling and to return kite to stability when it is disturbed in flight. Ideally the angle at which all the bridles meet should be as small as possible. This reduces to a minimum the tendency for the bridles to all pull together into a tight clump when the kite is loaded by the wind. Note that a sled needs long bridles or it won't stay open. The effect is the same, short bridles result in a larger compressive force over the front of a kite. This is simply a matter of mechanics and anybody who can remember the concept of 'components of forces' from science at school should be able to visualise the effect. From the point of view of the sail the bridles should radiate at right angles to the spars, which for a bowed kite means that they do not meet at all, So the compromise is to have the tow point as far away as possible. This reduces the compressive stress in spars. The result of course is long bridles.



The force system involved is illustrated using the sign convention of structural engineers, where < > is compression and > < is tension.

Incidentally, the effect of bowing the spars prestresses them against the force of the wind.

On a less scientific note, I find that bowing most flat kites is like breathing life into them.

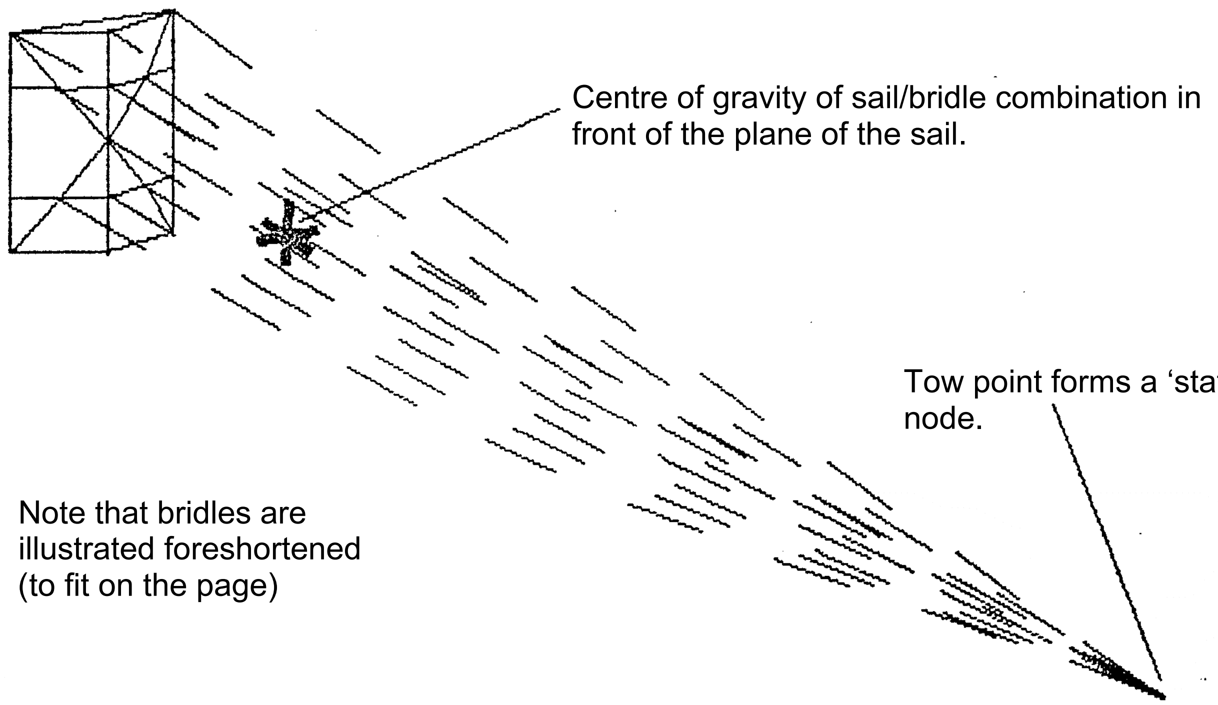
The bow brings wind and kite into harmony in a way which the word dihedral is inadequate to describe.

Some literature on Edos suggests that the bridles stabilise the kite due to drag and although this idea is attractive in some ways it does not really account for the their effectiveness.

On the Chubari design included with this article the following numbers are interesting.
Total weight of kite and bridles 550 grams
Weight of sail and frame — 350 grams
Weight of bridle system — 200 grams.

If the kite flies with all the bridles tight it can be calculated that the centre of gravity of the sail/bridle combination lies around 2.5 metres in front of the sail. Most common kites have a centre of gravity in the plane of the sail. In Edos the bridles form a 'pendulum' between the tow point and the kite face and since it is connected to the various extremes of the sail it will try to correct the kite whenever it strays off balance —maintain stability is our name for this! Of course, this makes the bridles little different to rope or string tails in that they contribute weight (more correctly mass) to the stabilising system rather than anything more aerodynamically subtle.

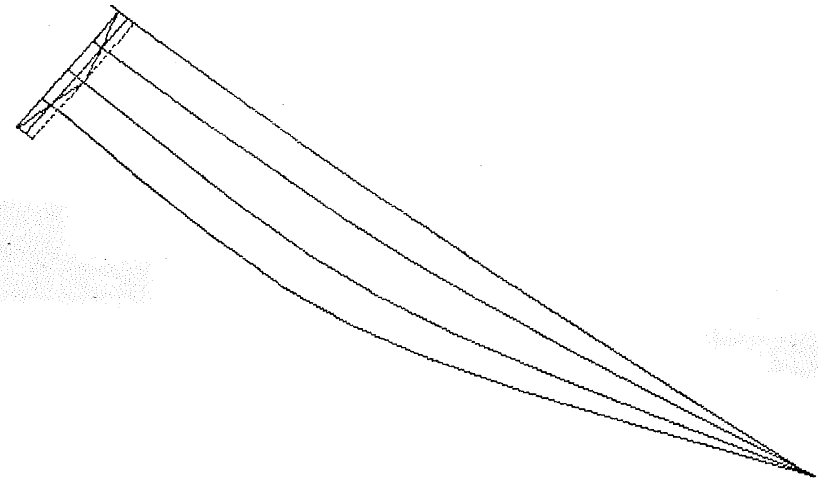
Watch an Edo fly and you will observe the effect — the tow point appears fixed in the sky whilst the bridle mass sways from side to side accommodating the sail's reaction to the wind.



The bridles are also free to move in the direction of their length, that is to say, either changes in local pressure across the kite face or changes in the angle of attack of the sail will tighten or slacken individual and groups of bridles. Strings supported at their end hang in a curve called a catenary and at the lengths of Edo bridles the sag is large being counteracted only by tensile forces. The combined force necessary to straighten all the bridles is quite large and as a result none of the bridles is actually straight when the kite is flying naturally. This makes setting bridles difficult but is a key to understanding their other effect on stability.

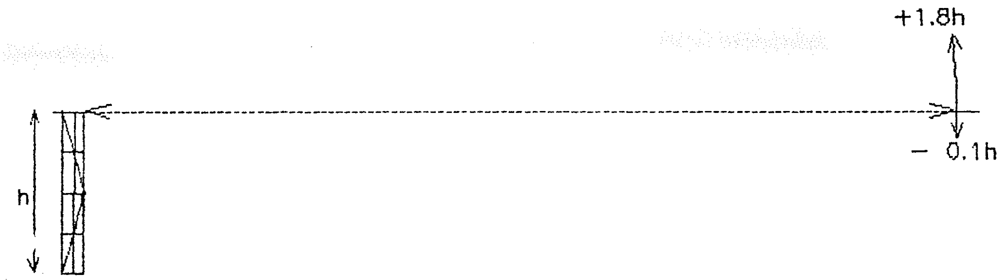
The bridle array hangs in a catenary, the 'slack' being taken up and 'given back' on individual lines as wind pressure varies across the kite face. As a group the lower bridles tighten and slacken to vary the angle of attack, the result being analogous to many individual spring bridles across the kite. Again, watch an Edo fly and the effect is clear, the catenary varies in depth as the wind rises and falls.

The bridle catenary is visually the reason for Edos as far as I am concerned but makes the whole thing very difficult to set up. Note that all the horizontal groups of bridles hang in this manner but that the top group is the nearest you get to straight. Not unexpectedly the top group are under greatest tension and are the best reference point for comparison of other groups.



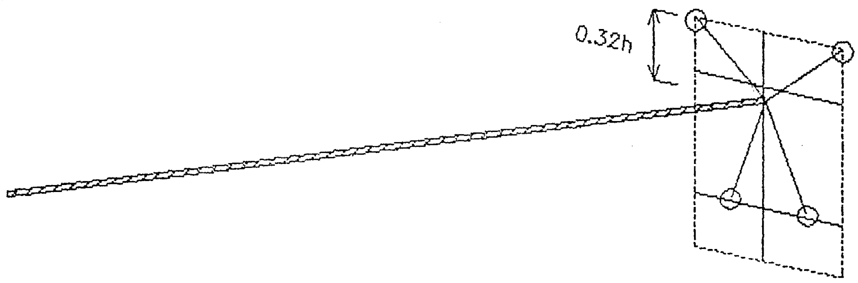
The difficulty in producing clear standard rules for location of the tow point in relation to the sail is that since each bridle set hangs in a slightly different catenary, then making any one set tight or fully tensioned will leave other sets either loose or overtightened.

Some guidelines derived from the Chubari are illustrated below, where h = length of kite. The top bridle length is approximately 9*h long. With the top row of bridles tight the tow point may vary between 1.8h above the leading edge and 0.1h below it depending on which other rows are tight.



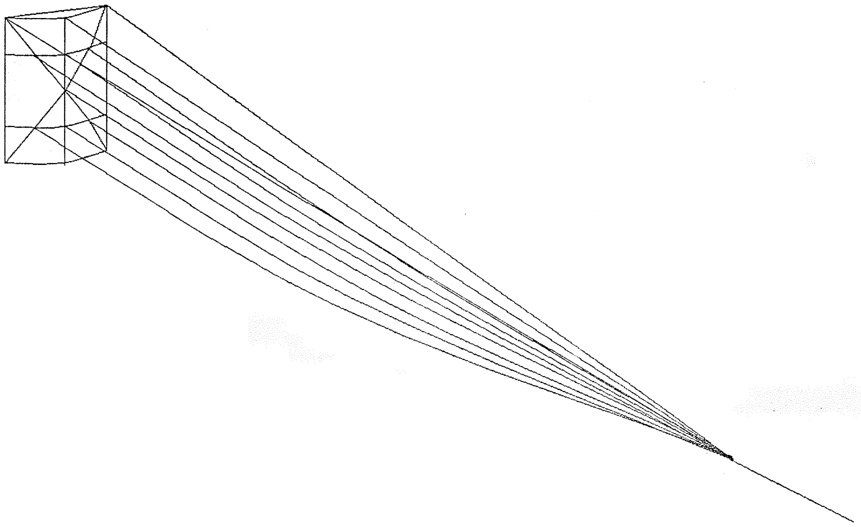
Incidentally, the addition of a hummer to the leading edge will mean that the tow point must be moved upwards.

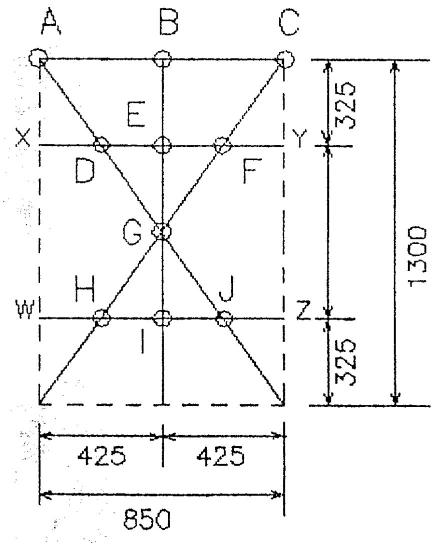
If kite is unbowed corner lines of bridle set meet at the position shown beneath the leading edge when all the bridles are drawn together in a bundle from the tow point.



Note that other bridles hang with varying degrees of slack when the corners are drawn tight like this. Keep in mind that these figures are reported only to indicate a guideline for correct bridle proportioning since the problem is really about estimating the amount of catenary 'sag' which has to be built-in.

Chubari (6 rod) Edo.





Sail dimensions in mm.

RODS. (all circular G.F.) Longeron 5mm., Diagonals 5mm. Top spar 2x3mm., Other spars 3mm.

SAIL. Ripstop nylon.
All rods run in pockets sewn to the back of the sail.

Bow depths: A—C and X—Y, 175mm.; W—Z, 150mm..
Depths assume that spars project 30mm. each side beyond sail, depth measured from tips of spars to centreline of sail.

To assist in bridle handling at the tow point end, make a 'grid' by cutting a 75x5Omm. piece of thick polythene and drilling holes which match the bridle pattern. Pass each bridle through the appropriate hole in the grid before joining at the tow point.

Bridle details:

Bridle line: 1.5mm. diameter braid.
Be sure to take all the twist out of the line before assembling the bridle set.
Approximate weight of line: 1.79 grams/metre.

For the Chubari kite plan I have indicated actual measured lengths of individual bridles for a stable well-trimmed kite.

Line lengths.

A	11.74m.
B	11.72m.
C	11.74m.
D	11.83m.
E	11.79m.
F	11.83m.
G	11.84m.
H	11.92m.
I	11.86m.
J	11.92m.