VEREIN HANSEATISCHER TRANSPORTVERSICHERER e.V.
HAMBURG - BREMEN

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Damage to Rudderblades

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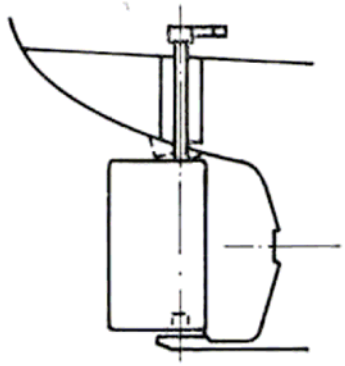
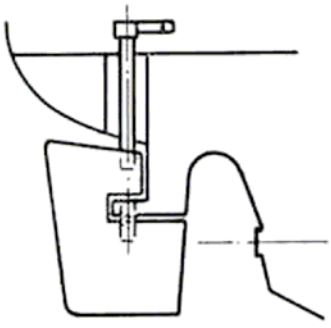
Steerage and manoeuvrability of a moving vessel is created by the rudder (Producer of Transverse Force). The Transverse Force occurs during the act of steering as a resultant force to the sum of all Partial Forces occurring on the underwater section of a vessel. Partial Forces are occurring due to the flow of water, whereas it is of no concern whether the vessel is kept in motion by its own propulsion of by the use a tug. The "Passive Transverse Force" reaches its theoretical maximum at a rudder angle of 45°. In praxis however the maximum rudder angle will be between 35° and 40°. Subject to the speed of the vessel smaller or bigger Transverse Forces will occur.

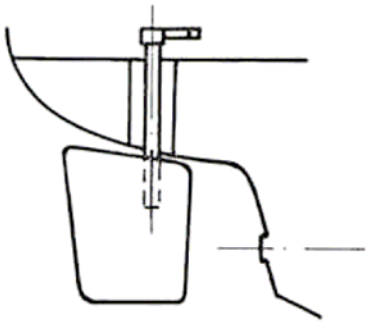
Semi balanced Rudders and Spade Rudders are state-of-the-art today (e.G. Becker Rudder, Hinze Rudder, etc.). the traditional rudder, constructed with a heel, will be seen rarely only today (predominantly on fishing vessels if at all).



Rudder with a heel



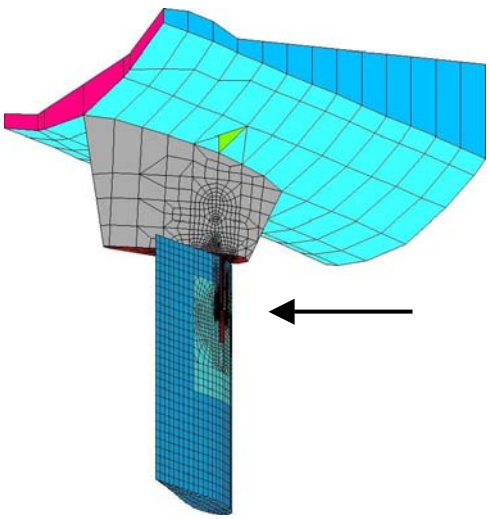
Semi balanced Rudder



Spade Rudder

Forces occurring on the construction of a rudder can be shown by applying the method of "Finite-Elements"

A demanding „Finite Elements" model was developed for the construction of a Spade Rudder. By using the model, reliable strength-calculations are possible.



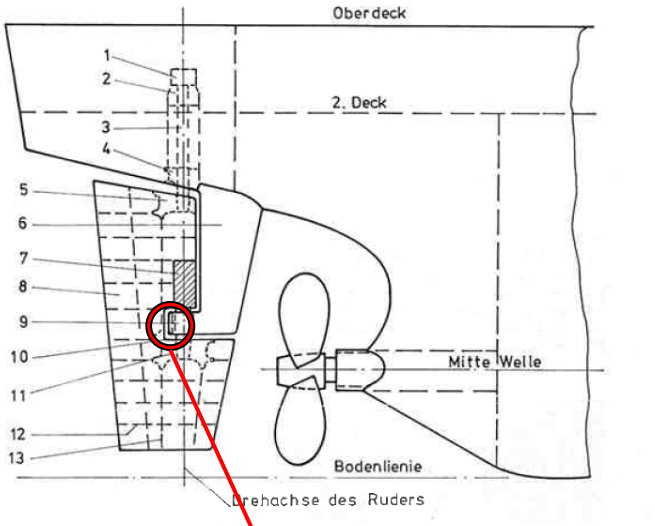
Clearly it can be seen where the biggest forces do occur.

Cracks, which eventually led to the loss of parts of a rudder, did occur on many vessels fitted with a Semi balanced or Spade Rudder. Cracks do occur in ship constructions which are underlying cyclical loads (e.g. rudders) and more or less exclusively at locations of load concentration.

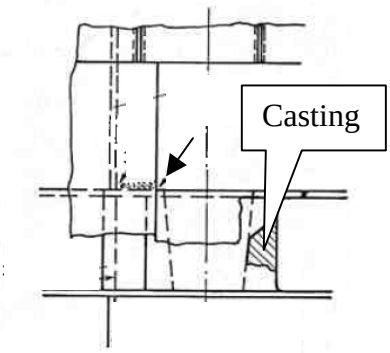
Semi balanced Rudder

A rudder horn (or heel) is required to support the lower rudder bearing.

1 – rudder engine
2 – upper journal bearing
3 – rudder shaft
4 – neck bearing
5 – rudder shaft conical coupling made of cast steel
6 – rudder horn
7 – access opening
8 – rudder blade
9 – pintle
10 – geometrical notch
11 – conical coupling for the pintle made of cast steel
12 – horizontal frame
13 – vertical frame



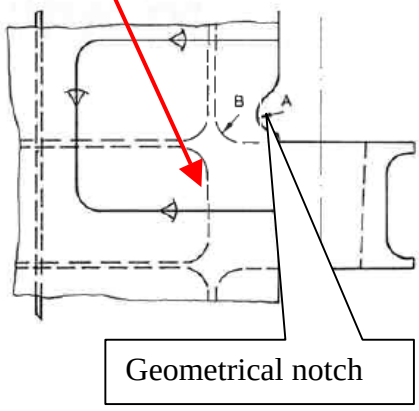
The picture shows that the construction of a rudder horn for a semi balanced rudder requires a distinctive geometrical notch (10).



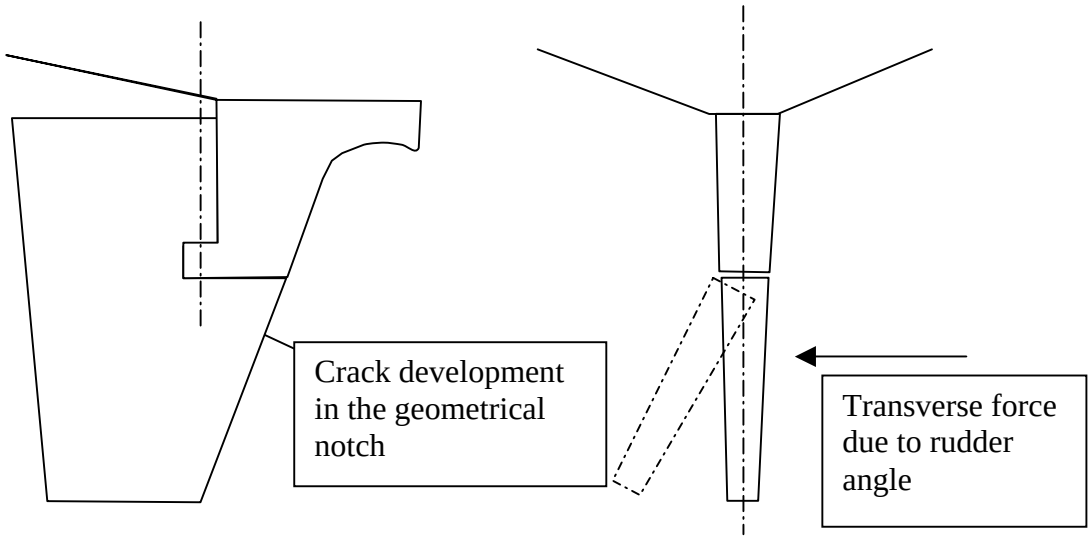
The geometrical notch (change in rigidity) is located at the intersection of the horizontal and vertical contour line at the upper end of the conical coupling (casting) for the pintle.
The highest dynamical bending loads will occur at this intersection. To avoid any notch effect at this location it is necessary to construct a “soft” transition for occurring stresses.

In the area of this notch, respectively in the immediate vicinity of it, on many vessels damage due to cracks did occur. The starting point of these cracks is characterised by the geometrical notch in connection with cyclical strong dynamical loads in this section of the rudder blade.

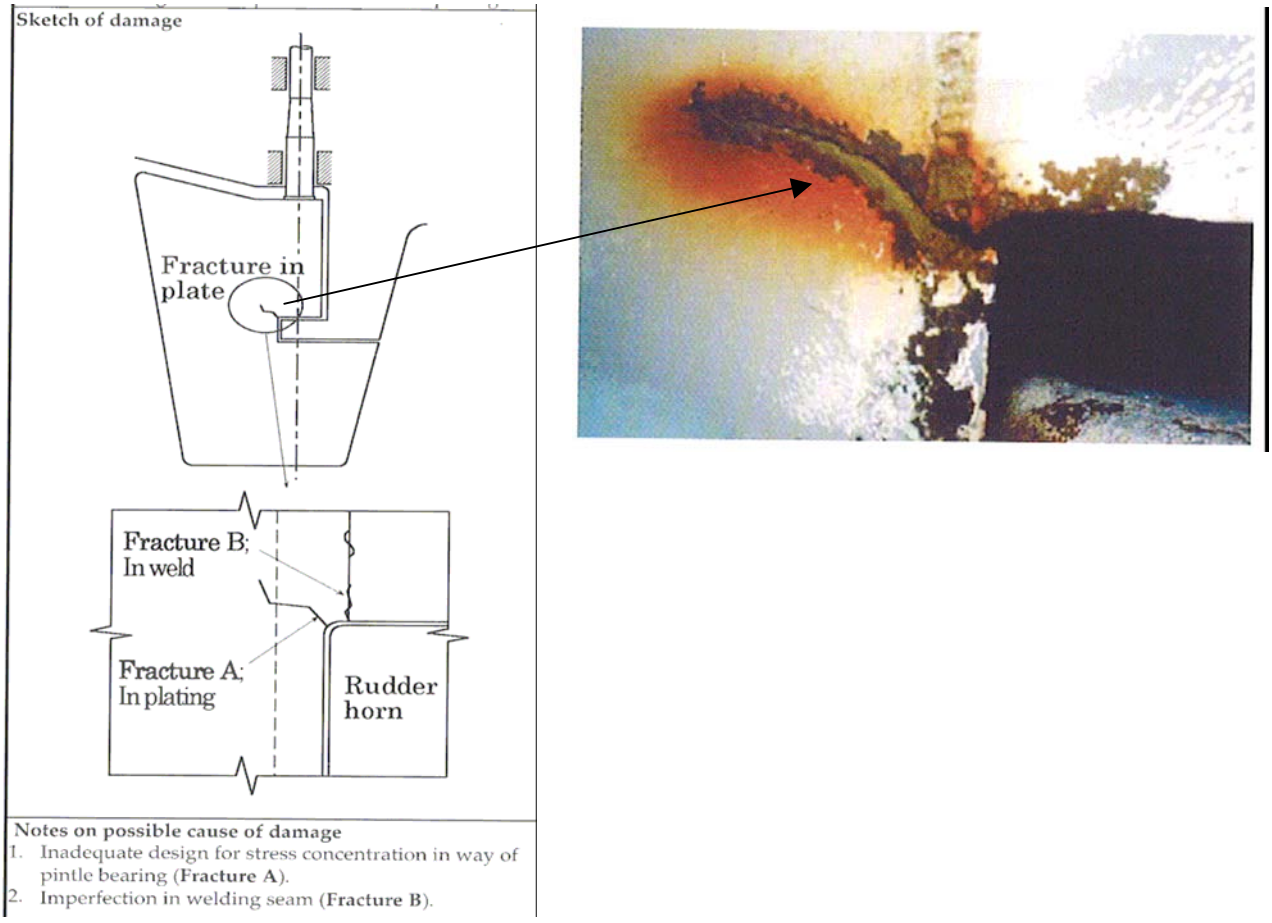
Another starting point for cracks may be found above the pintle bearing in the area of the access opening.

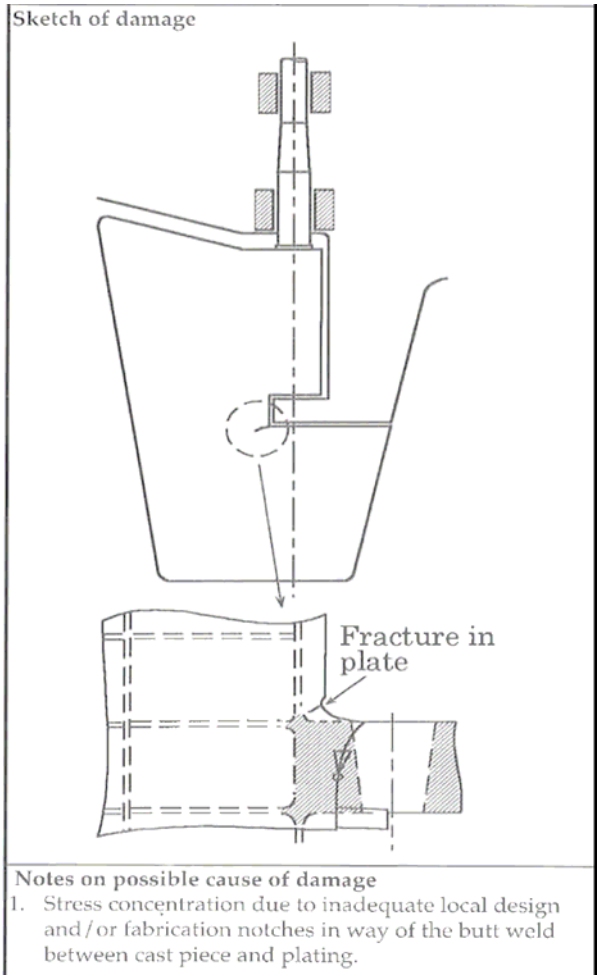


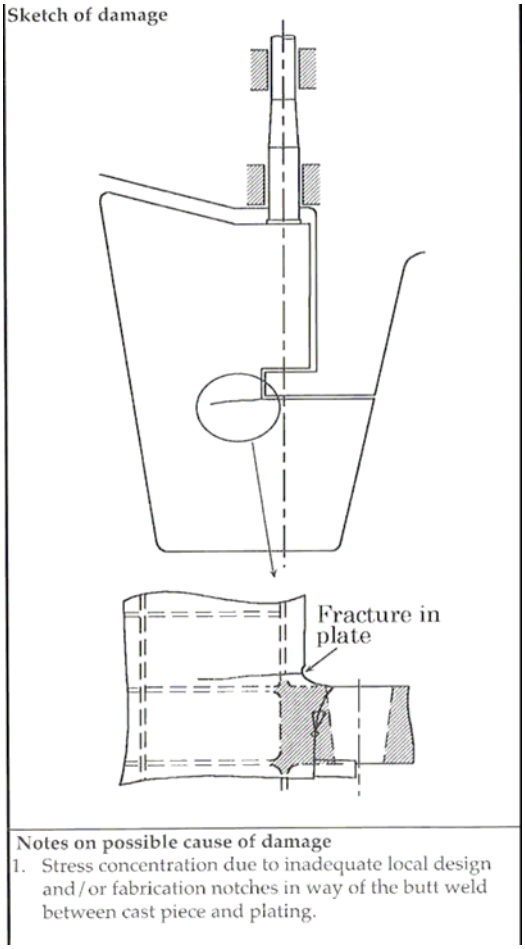
As a consequence of such cracks rudder blades broke below the rudder horn or were even lost totally.



Examples for cracks in the vicinity of the geometrical notch and its causes:







Caused by a crack in the geometrical notch the lower section of a rudder has been lost at sea.

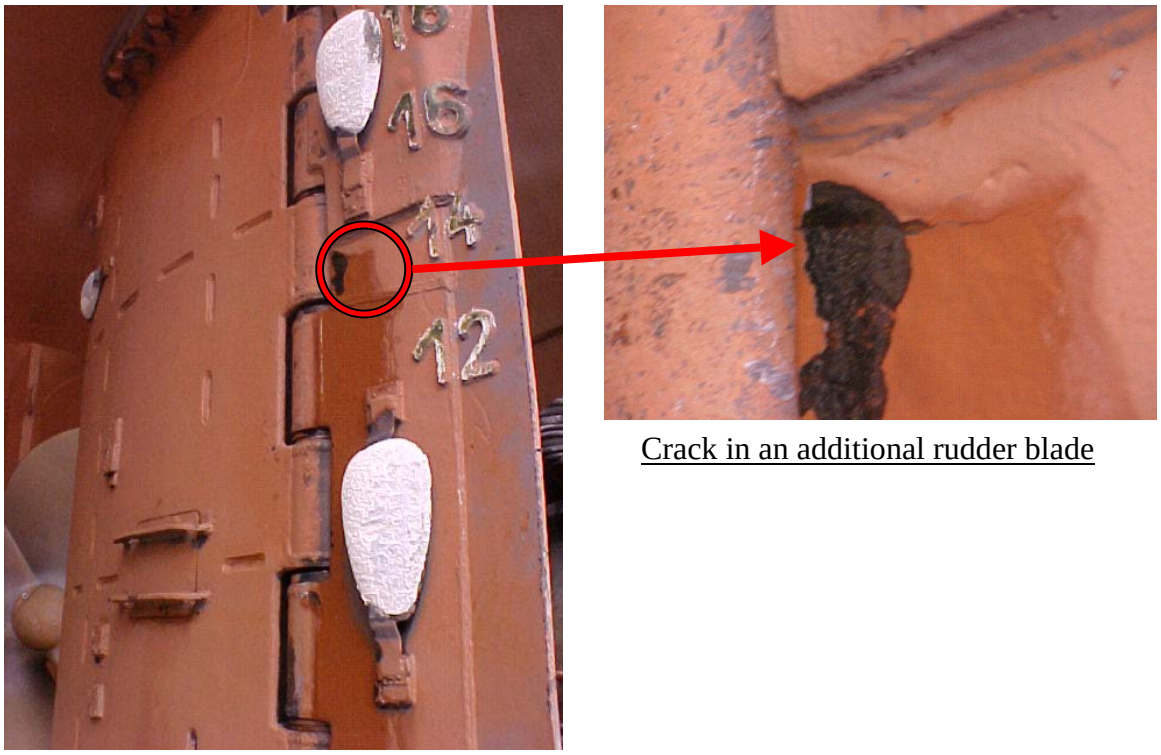
Spade Rudder

Cracks will occur on Spade Rudders (e.g. Becker Rudder, Hinze Ruder or Barkemeyer Rudder) just below the conical coupling. The highest bending loads will occur in this area. These cracks may as well lead to the loss a the rudder.

Typical cracks below the conical coupling

Loss of a Becker Rudder

Cracks will not occur in the rudder blades only but as well in the additional blades of special rudders.



Crack in an additional rudder blade

Preventive measure to avoid damage to rudders and loss of rudders. Vorbeugende

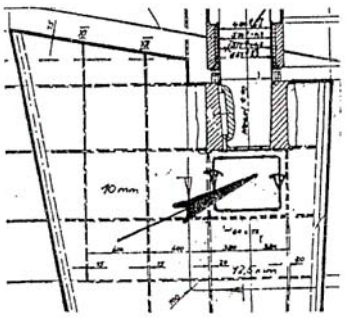
During docking attention has to be paid to rudder blades as follows:

1. The sensitive sections of a rudder blade have to be inspected carefully for cracks (visual, ultrasonic test or alternatively by dye check or magnetic powder inspection),
2. Cracks in or around access openings,
3. Deformation of the rudder blade,
4. Wet spots,
5. Corrosion, Erosion.

If in any doubt, a pressure test at the rudder blade should be performed.

Because of given reason the butt welds of the access opening on port and starboard side have to be tested by ultrasonic for freedom from error

- at each dry-docking
- at each refitting of the assembly plate of the access opening



The cause fort this type of damage often is superficial and negligent fitting work. The owners representative should carefully check any and all works carried out to the rudder at all times.

All IACS Classification Societies, in addition to their Class Rules have developed survey and repair guidelines for rudder systems which can obtained from them upon request.

If a rudder blade or a part of it has been lost in most of the cases it will be extremely difficult to manufacture a new casting piece for the rudder- pintle because:

1. in most of the cases the manufacturing drawings will not be readily available and if at all, can only be made available at high costs.
2. even if the manufacturing drawings are available extended manufacturing and delivery time has to be expected.

If alternatively and for time saving reason a welded construction will be chosen, this has to be done in close communication and approval of the respective classification society.