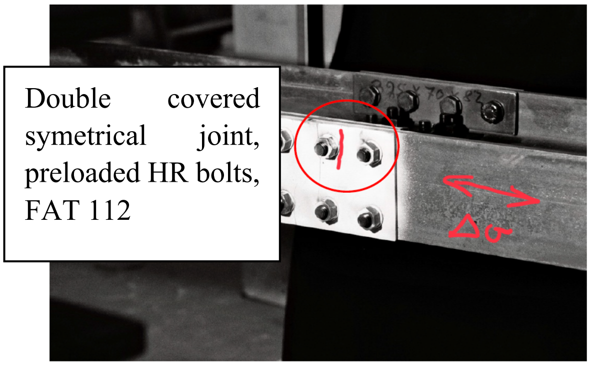
FAT2 EXERCISE: DETAIL CLASSIFICATION – CORRECTION

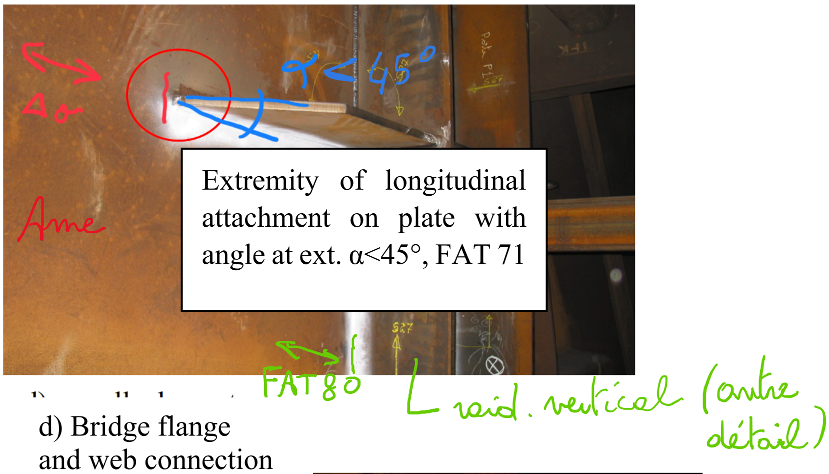
PROBLEM 1: Detail photos, detail categories

a) Cover joint with preloaded high strength bolts



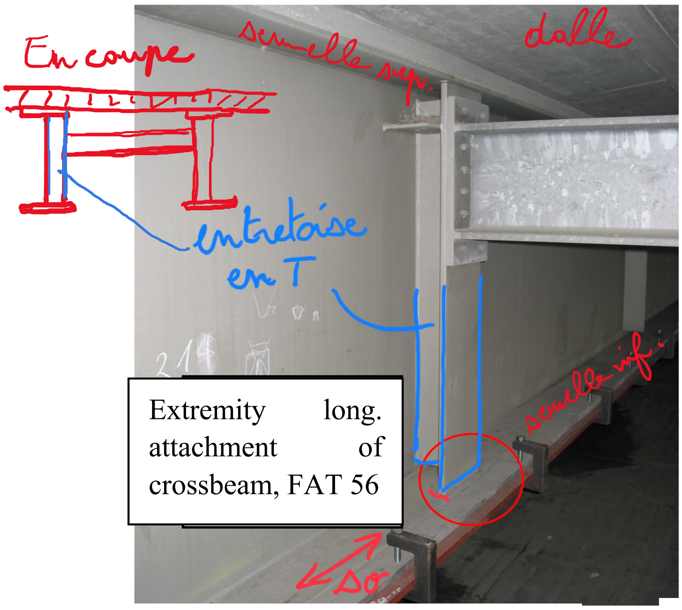
Double covered symetrical joint, preloaded HR bolts, FAT 112

(b) Web of a bridge box girder with longitudinal and transverse attachments/stiffeners



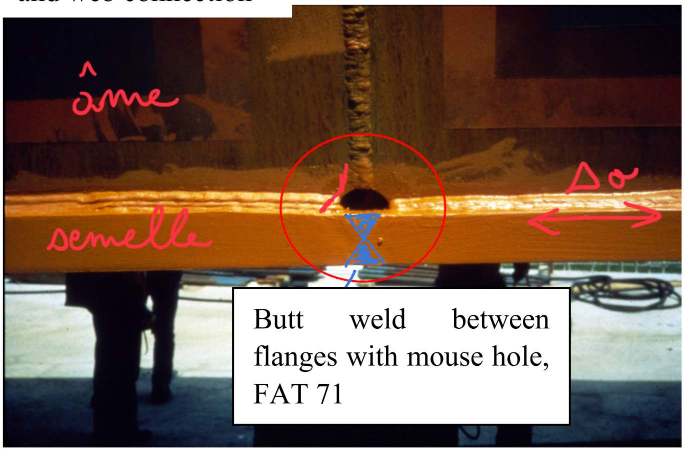
Extremity of longitudinal attachment on plate with angle at ext. α<45°, FAT 71

c) Bridge main girder – crossbeam connect.



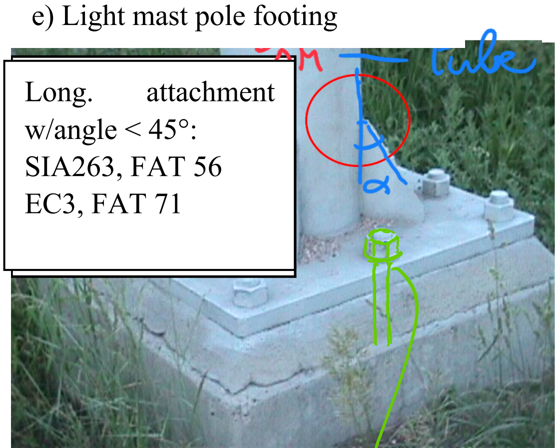
Extremity long. attachment of crossbeam, FAT 56

d) Bridge flange and web connection



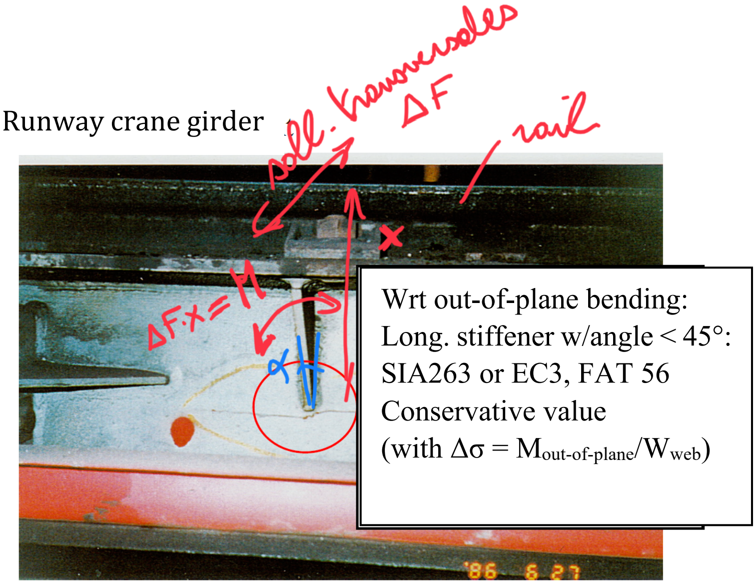
Butt weld between flanges with mouse hole, FAT 71

e) Light mast pole footing



Long. attachment w/angle < 45°: SIA263, FAT 56 EC3, FAT 71

f) Runway crane girder



Wrt out-of-plane bending: Long. stiffener w/angle < 45°: SIA263 or EC3, FAT 56 Conservative value (with $\Delta\sigma = M_{out\text{-}of\text{-}plane}/W_{web}$)

Figure 1: Photos of details on steel and composite structures, with comments

PROBLEM 2

Questions 1. and 2. Crack locations and detail categories

Figures 2 and 3 below show the potential cracking locations and the detail categories according to Eurocode 3, EN 1993-1-9.

Note: SIA 263, Appendix E, contains simplified tables of the Eurocode 3 prestandard, ENV 1993-1-9, which explains why some differences in the detail categories may exist.

Note: Cracks in preloaded bolted joints should be in front of the bolts and not starting from the bolt holes.

The justification for each of the cracking locations in Figure 2 is:

a) This detail should, in general, be avoided because it has poor fatigue resistance. It is preferable to continue the longitudinal stiffener (with a mouse hole) through the transversal one. The detail presented corresponds to a cruciform assembly, Table 8.5, details 1 and 3, which we will admit was welded with partial penetration (more economical). In this case, it is necessary to check both the cracking from the root (in the weld: $\Delta\sigma$ FAT 36 and $\Delta\tau$ FAT 80, $m = 5$) and from the weld toe (Table 8.4, detail 6, FAT 80 or 71 depending on the width of the joint).

b) The FAT 112 category is given because it is the most commonly encountered case (Table 8.2, detail 3). The fillet welds are made automatically, but there are inevitably welds stop/start. In areas where there are stiffeners, it is also possible that these fillets need to be made partly manually, so we have at the best a FAT 100 (detail 5).

c) In bridges, bolted connections should always be preloaded. This the case in this example and they are simple covered joints (loaded in shear). The stress is therefore calculated in relation to the gross cross-section of the element and a FAT 90 (table 8.1, detail 10).

d) The detail of the end of a longitudinal stiffener is treated as a long longitudinal attachment ($L >$ 100 mm). Using Table 8.4, Detail 1, we find a FAT 56.

e) The gusset welded onto the angle, as shown in the figure, can be considered for <u>the forces in the angle</u> as a reinforcement plate wider than a flange, table 8.5, detail 6. On the one hand, it is a detail FAT 50 (because most likely we have t and $t_c < 20$ mm). On the other hand, we also have a transfer of force in shear, thus a FAT 80, $m = 5$ (table 8.5, detail 8).

   However, the detail can also be considered from the point of view of the transfer of <u>forces in the plate</u> to the angle (forces coming from the diagonals). In doing so, we are rather dealing with a coverplate detail, table 8.5, detail 5, and therefore a FAT 45* under normal stress and with respect to shear stresses we have a FAT 80, $m = 5$ (table 8.5, detail 9).

   Conclusion: the two ways of dealing with this detail lead to practically the same categories.

f) The stud connectors are embedded in concrete. They can cause two types of fatigue cracks: they are small fasteners on a plate, so a crack in the plate can start there (Table 8.4, detail 9), FAT 80; they transmit the shearing force between the slab and the beam, thus the connectors can crack at their base in shear (Table 8.5, detail 10), $\Delta\tau$ FAT 90, $m = 8$.

Additional detail as indicated in the solution (not in the exercise) :

g) <u>Use of a coverplate (mediocre detail for the coverplate ends, thus no longer done today, replaced by tapered plates ; b</u>ut present in many existing bridges). Along the coverplate, each fillet weld between the coverplate and the base plate is carried out on one side, partly using automatic or fully mechanized welding, and manual welding for the ends. There are also stop/start positions (including near the ends of the coverplates), thus the detail of the longitudinal fillet weld corresponds to a FAT 100 (Table 8.2, detail 5 or 6).

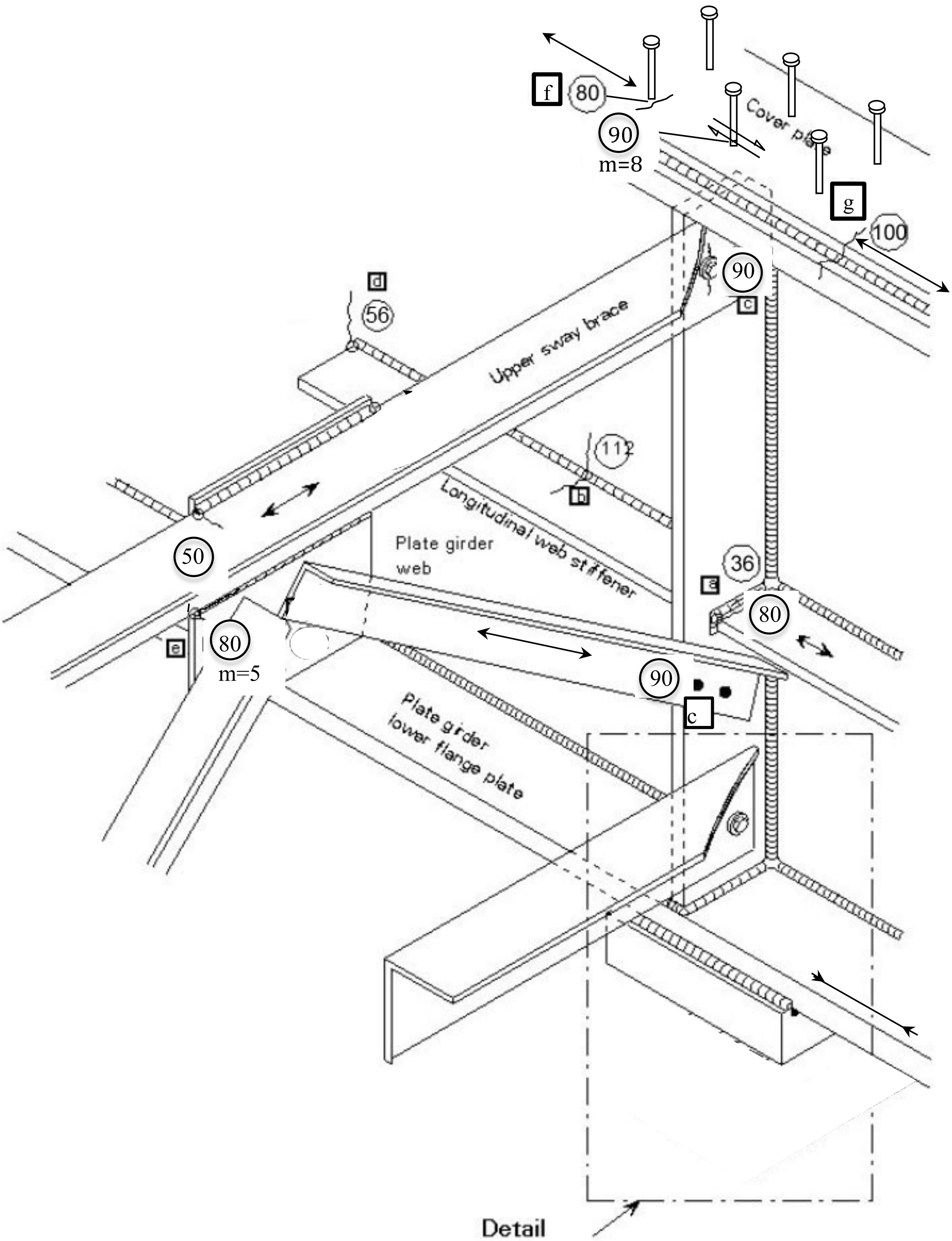


Figure 2: Potential crack locations and detail categories (FAT)

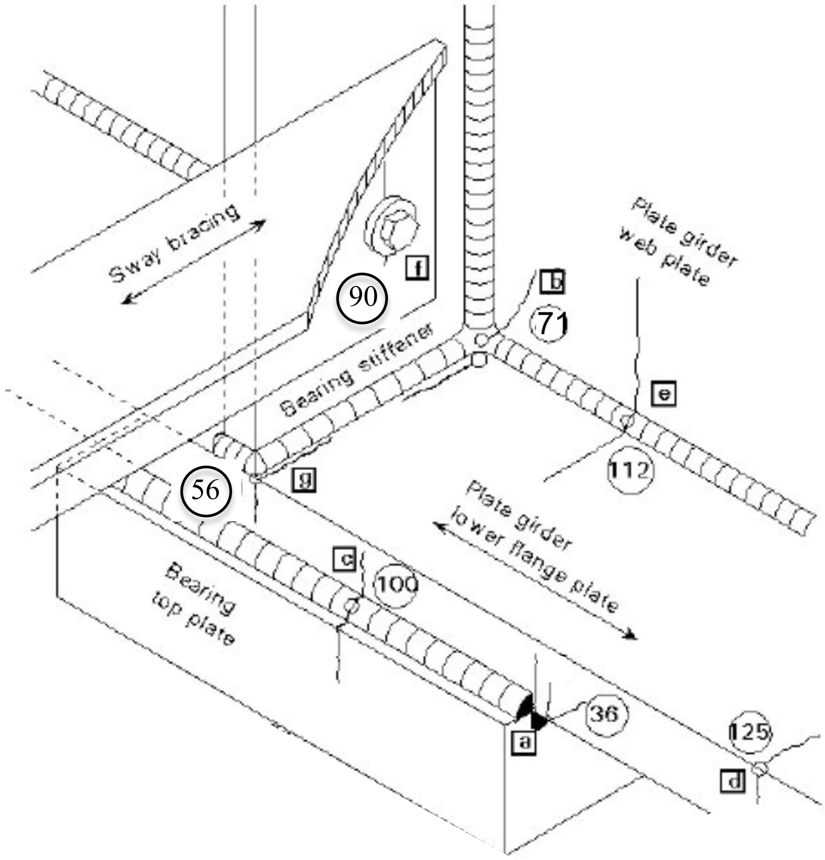


Figure 3: Detailed view of the support itself with potential cracking locations and detail categories

The justification for each of the cracking location in Figure 4 is:

a) It is equivalent to a coverplate wider than a flange, table 8.5, detail 6. Detail FAT 36 because the thicknesses are important (t > 50 or t_c > 30 mm).

b) This is a transverse stiffener, Table 8.4, detail 7. It must be checked using a FAT 80, or a FAT 71 (which is the case here, a stiffener at a support being thicker than those in span region).

c) Weld between flange and coverplate, as in Figure 2, note g. Detail FAT 100.

d) Edge of a thermally cut plate, detail function of production process. In general, this detail will not be decisive in relation to the welded details since we have at least FAT 125 (Table 8.1, detail 4 or 5).

e) As in Figure 2, note b. Continuous longitudinal weld, FAT 112.

f) As in Figure 2, note c. Bolted assembly, FAT 90.

g) Detail not explicitly given in the standard. In general, the welder avoids making a weld that touches a plate edge, it is a difficult weld and easily creates an undercut. Indeed, the edge "melts" and creates a spot for a crack. The closest case is a coverplate wider than the plate, where the weld must go around (Table 8.5, detail 6). It is a FAT 56* because the perturbation is short (it is not a coverplate but remains a transverse attachment). Keeping FAT 71, typical of a transverse attachment, could also be justified but only if the weld is carefully ground to eliminate the undercuts !