The aspect of sustainability is playing an increasingly important role in building. However, this concept is not just restricted to ecological issues but also comprises economic and socio-cultural aspects. Only structures which fulfill all these criteria are permanently successful and therefore sustainable.

In this instance, constructional steelwork certainly has an advantage over other constructive forms thanks to structural steel which spares resources when manufactured and is infinitely reusable. Moreover, the increasing usage of high strength steels enables the possibility to further optimize sustainability of the steel or composite construction.

Modern steels such as Histar 460 for example demonstrate an outstanding weldability thanks to thermomechanical rolling and subsequent QST treatment in addition to high strength owing to the low carbon equivalent.

Principally, the use of high strength steels is worthwhile if stress problems are decisive when designing structural components. This is often the case with composite girders, long-span roof girders, trusses or heavily loaded columns. The somewhat higher price per tonne is by far and away exceeded through savings on material, processing, transport and assembly.

Meanwhile one sector in which high-strength steels have been enforced is car park ceiling girders. A span of approx.16m is usually required. An example can be seen in Table 1.

With the use of Histar 460 the calculation usually results in an IPE 500 profile as opposed to an IPE 600 when using an S235JR+M.

Picture: Ceiling girders in a modern car park / ArcelorMittal

In this way, the component weight can be reduced by 24%. This leads to a cost saving of 17% for the structural component ready for assembly.

Apart from the considerable economic advantage through use of the high-strength steels, a contribution to environmental sustainability is made at the same time.

Quintessentially, this is calculated for a car park with a capacity for 1000 vehicles. 250 ceiling girders are used in such a building. If sections are used according to variant 2, a total of 127 tonnes of steel will be saved. Consequently, in addition to the lower emissions in the manufacturing process, seven journeys to the construction site by lorry can be spared for the ceiling girders alone.

Along with this, there are still savings through shorter supports, shorter lift shafts and stairwells, more favorable arrangements for ramps and a reduced façade area. Moreover, the reduced headroom leads to a lower overall height of the building – for example, a six-storey car park can be built 60 cm smaller.

Table 1: Comparison of car park ceiling girders

Car park ceiling girders	Variant 1	Variant 2
Steel grades	**S235JR+M** In accordance with EN10025-2:2004	**Histar 460** In accordance with DIBt-authorisation (German Industry Constructional Engineering) Z30.2-5
Profile	IPE 600	IPE 500
Yield strength	225 N/mm² (t_{flange} =19 mm)	460 N/mm² (t_{flange} <82 mm)
Tensile strength	360 – 510 N/mm²	540 – 720 N/mm²
Headroom	600 mm	500 mm
Component weight*	2.12 t 100%	1.61 t 76%
Costs*	**100%**	**83%**
Overall tonnage of ceiling girders**	530 t	403 t
Trusses per lorry	10	14
Lorry journeys to the construction site **	**25**	**18**

* Indication of costs and weight for a pre-finished 16m long car park ceiling girder including superelevation, toes, double head bolts, complete caps and galvanising, delivered to construction site area in North Rhein Westphalia, incl. extra fee for scrapping costs, as at August 2008
** For a car park with 1000 parking spaces and 250 ceiling girders, max. vehicle load capacity per lorry 23 t

Moreover, high strength steels also have great advantages when used in industrial construction and multi-storey buildings. Reduced dimensions of floor and roof beams, for example, lead to decreased height of buildings.

For this reason, the exterior surface area of the building can be reduced. Apart from saving on construction costs for wall and façade areas, one can also save on regular costs for heating and air-conditioning respectively.

Finally it can be determined that the use of high strength steels in construction is generally recommended for structures in which stress is relevant for the design. With the use of Histar 460 as opposed to the S235JR+M, approximately 25% of component weights and approximately 15 – 20% of component costs are saved in everyday applications.

In an extreme case – e.g. with long-span trusses – saving may even amount to 50%. Apart from economic advantages, a contribution to environmental sustainability is also made. In order to fully benefit from the advantages described, it is important that high strength steels are already included early on in the planning phases for the components in question.

By **Marc Blum** (Dipl.-Ing. Dipl.-Wirt.-Ing. SFI-IWE) and **Falk Satzger** (Dipl.-Ing)