STRUCTURAL STEEL

MANUFACTURE AND PROPERTIES

ADVANTAGES

- STRONG
- STIFF
- DUCTILE
- EASY TO FABRICATE
- EASY / SPEEDY TO ERRECT
- EASY TO MODIFY
- RELATIVELY CHEAP

COMPOSITION

STRUCTURAL STEEL IS PRINCIPALLY AN ALLOY OF IRON, CARBON AND MANGANESE

OTHER ELEMENTS INCLUDE

- CHROMIUM
- MOLYBDENUM
- VANADIUM
- NICKLE
- COPPER

INFLUENCE OF CARBON CONTENT ON PROPERTIES

AS THE CARBON CONTENT INCREASES SO THE STEEL STRENGTH INCREASES BUT THE IMPACT ENERGY REQUIRED TO INDUCE BRITTLE FRACTURE (KNOWN AS TOUGHNESS) AND DUCTILITY DECREASES.

BY CONTROLLING THE GRAIN SIZE IT IS POSSIBLE TO PRODUCE STEEL THAT IS BOTH STRONG AND DUCTILE.

CONTROL OF GRAIN SIZE

FINER GRAIN SIZE CAN BE ACHIEVED BY

- REMOVAL OF STEEL FROM THE FURNACE AND AIR COOLING
- COOLING OF SMALLER SECTIONS
- HEAVY DEFORMATION OF STEEL AT TEMPERATURES > 723°C

STEEL MAKING

THE PROCESS OF STEEL MAKING CONSISTS OF THREE STAGES

- SMELTING IRON ORE TO PRODUCE PIG OR CAST IRON
- REDUCTION OF PIG IRON INTO STEEL
- ROLLING

STEEL MAKING: STAGE 1

STAGE 1 CONSISTS OF HEATING IRON ORE, COKE AND LIMESTONE IN A BLASTFURNACE TO RELEASE THE IRON

$$FeO + C \longrightarrow Fe + CO$$

THE CAST IRON THUS PRODUCED CONTAINS A LARGE AMOUNT OF IMPURITIES WHICH RENDERS IT WEAK IN TENSION AND BRITTLE

STEEL MAKING: STAGE 2

STAGE 2 CONSISTS OF REMELTING PIG IRON WITH SCRAP STEEL IN A VESSEL TERMED A CONVERTER WHICH IS BLOWN WITH OXYGEN TO OXIDISE THE IMPURITIES.

VARIOUS TYPES OF CONVERTERS ARE USED, THE TWO MOST COMMON BEING

- BASIC OXYGEN FURNACE
- ELECTRIC ARC FURNACE

THE STEEL IS USED TO PRODUCE EITHER INGOTS OR TO FORM CONTINUOUS SOLID STRANDS.

STEEL MAKING: STAGE 3

STAGE 3 INVOLVES USUALLY HOT ROLLING (> 1000°C) THE INGOTS INTO PLATES, STRUCTURAL STEEL SECTIONS, BARS, ETC

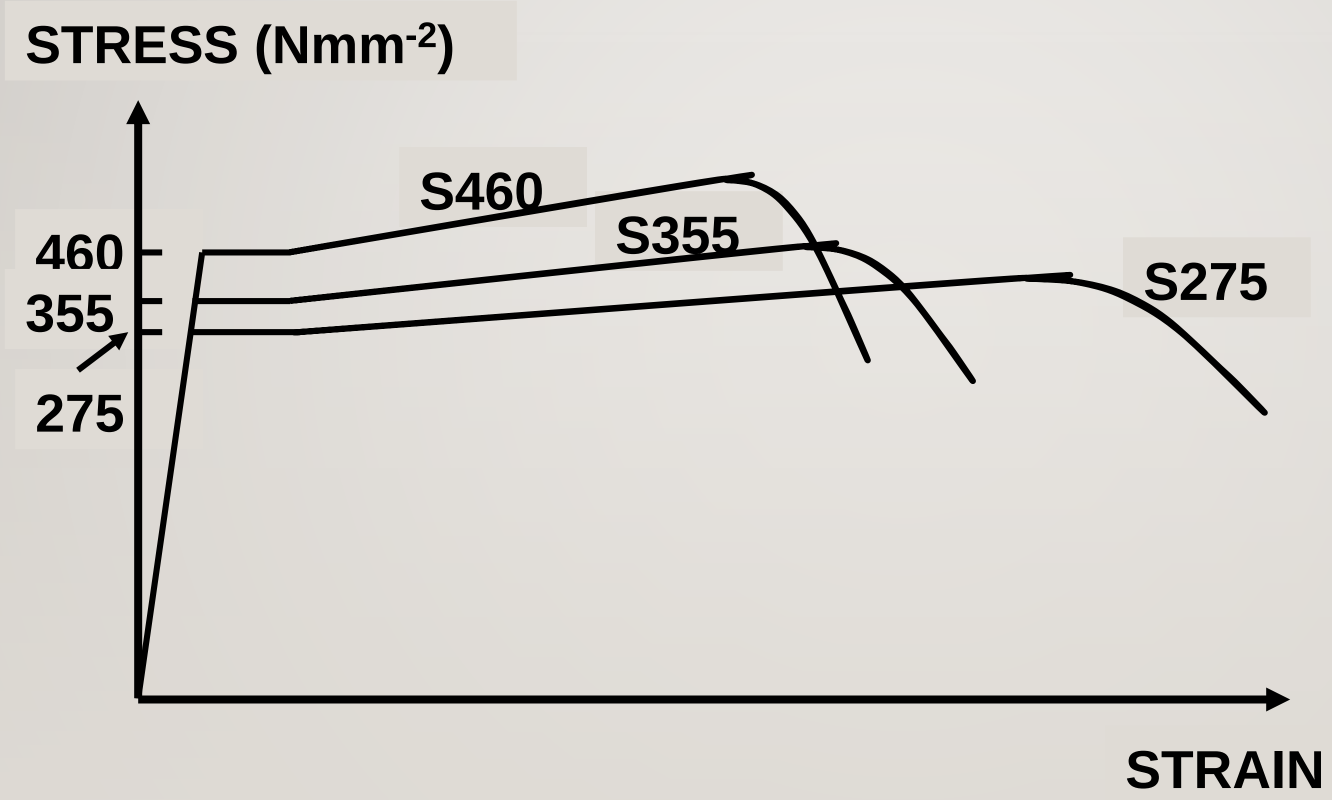
IF HEAVY DEFORMATIONS ARE APPLIED LOW IN THE TEMPERATURE RANGE THE NET RESULT IS VERY HIGH STRENGTH BUT LACK OF DUCTILITY (COLD FORMING)

ENGINEERING PROPERTIES OF STEEL

WHEN SELECTING STEEL FOR A PARTICULAR PURPOSE IT IS NORMAL TO CONSIDER THE FOLLOWING

- STRENGTH
- DEFORMATION
- TOUGHNESS
- FATIGUE
- WELDABILITY
- FIRE
- CORROSION

AVAILABLE STRENGTH GRADES



DEFORMATION

THE DEFORMATION (e.g. DEFLECTION) OF A STEEL MEMBER IS GOVERNED BY YOUNG'S MODULUS

THE VALUE OF YOUNG'S MODULUS (E) IS ABOUT 210 kN/mm^2 IRRESPECTIVE OF STEEL GRADE

CONTROL OF DEFORMATION IS ACHIEVED THROUGH SELECTION OF SECTION GEOMETRY AND DETAILING CONNECTIONS.

TOUGHNESS

STEEL MAY FAIL BY BRITTLE FRACTURE. THIS CAN ARISE DUE TO:

- LOW TEMPERATURES
- HIGH STRAIN RATE (IMPACT)
- GEOMETRICAL DISCONTINUITIES

BRITTLE FRACTURE CAN BE AVOIDED BY SELECTING STEEL WITH HIGH TOUGHNESS. TOUGHNESS IS A FUCTION OF CARBON CONTENT.

THE CHARPY TEST IS USED TO DETERMINE THE RESISTANCE OF STEEL TO BRITTLE FRACTURE.

FATIGUE

WITH REPEATED LOADING AT A MEAN STRESS WELL BELOW THE STRENGTH OF THE MATERIAL, STEEL MAY FAIL BECAUSE OF INITIATION AND PROPAGATION OF CRACKS,

FACTORS INFLUENCING FATIGUE STRENGTH ARE:

- NUMBER OF LOADING CYCLES
- MEAN LOADING STRESS
- MICROSTRUCTURE
- GEOMETRY AND SURFACE
- WELDING
- CORROSION

WELDABILITY

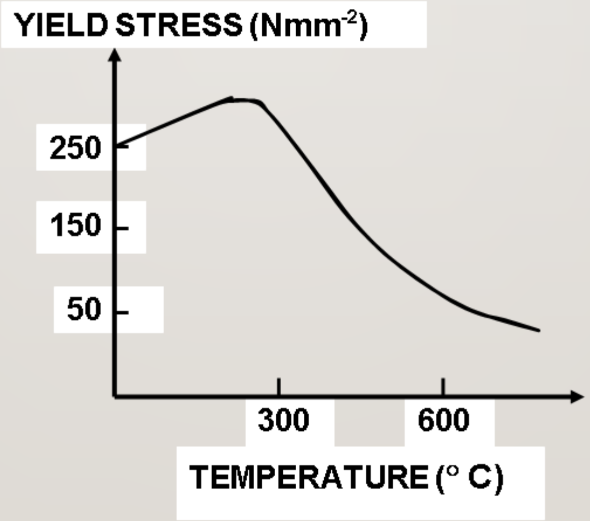
THE HIGH TEMPERATURES AND SUBSEQUENT HIGH COOLING RATES INVOLVED ALTER THE BEHAVIOUR OF STEEL WHEN WELDED.

WELDING CAN GIVE RISE TO VARIOUS TYPES OF CRACKING INCLUDING:

- SOLIDIFICATION (OR HOT) CRACKING
- HYDROGEN INDUCED (OR COLD) CRACKING

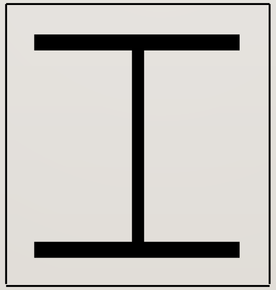
FIRE RESISTANCE

- ALTHOUGH INCOMBUSTIBLE THE STRENGTH OF STEEL RAPIDLY DECREASES WITH INCREASING TEMPERATURE
- AT A TEMPERATURE OF ABOUT 550°C STEEL LOSES APPROXIMATELY 40% OF ITS ROOM TEMPERATURE STRENGTH



METHODS OF FIRE PROTECTION

- SPRAY APPLIED PROTECTION
- BOARD PROTECTION
- INTUMESCENT COATING
- CONCRETE CASING



CORROSION

- EXPOSED STEELWORK CAN BE SEVERELY AFFECTED BY CORROSION DUE TO ATMOSPHERIC POLLUTANTS
- THE FORMATION OF FERROUS OXIDES (RUST)

➢ REDUCES STRUCTURAL STRENGTH

➢ REDUCES TOUGHNESS AND FATIGUE LIFE

➢ LEAVES THE STEEL SURFACE PITTED

➢ INCREASES SUSCEPTIBILITY TO WELDING DEFECTS