Technical Data Sheet

ATI K12®-MIL

Armor Plate

INTRODUCTION

For more than 35 years, ATI's Washington, PA plant has produced a roll bonded, dual hardness armor plate. The product consists of a high hardness front side and a softer back side. The purpose of the hard front side is to break up or flatten the projectile while the function of the softer back side is to capture the projectile.

The composition of both faces is a Ni-Mo-Cr alloy steel, but the front side contains a higher carbon content, which leads to a higher hardness after heat treatment. The front and back sides are roll bonded by a multi-step, proprietary process which involves heating an assembly to a specific temperature and hot rolling it until the two sides develop a strong, metallurgical bond. This bond is crucial in achieving good ballistics characteristics. The roll-bonded plates are annealed, sheared and flattened. A careful and precise heat treatment is necessary to achieve optimum ballistics performance.

DESCRIPTION OF PROPERTIES

The Ni-Mo-Cr alloy steel composition possesses an appropriate combination of hardness and toughness, which is mandatory for proper ballistics performance. ATI K12®-MIL plate is normally supplied in the annealed condition so that it may be more easily cut and formed into the desired configuration. Also, it may be supplied as heat treated parts cut to the final configuration.

TABLE 1

Physical Properties		
Density	0.284 lb/in.	7.86 g/cm^3
Specific gravity	7.86	
Specific heat	0.115 Btu/lb/°F (70-212°F)	481 J/kg·K (21-93°C)
Thermal coef. expansion	6.4 x 10^{-6} per °F (70-200°F)	11.5 x 10^{-6} /°C (21-93°C)
Electrical resistivity	10.2 microhm-in. at 32°F	26 microhm-cm at 0°C
	12.2 microhm-in. at 212°F	31 microhm-cm at 100°C

ATI K12®-MIL armor plate can be formed in the annealed condition with reasonable care, but heat treated ATI K12®-MIL plate should be bent only with special care as indicated by the results in Table 2.

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TABLE 2

Bend Recommednadtions			
ATI K12®-MIL Material	Bend Radius (X Thickness)	Maximum Load (Lbs.)	Bend Angle to Crack
Annealed	1T	2700	105°
Annealed	2T	2620	180°
Heat Treated	2T	7740 (Broke)	2°
Heat Treated	4T	5760 (Broke)	7°
Heat Treated	6T	3140 (Broke)	5°

TABLE 3

Average Tensile Properties of Annealed ATI K12®-MIL Plate			
ATI K12®-MIL Material	Ultimate Strength (ksi)	.2% Yield Strength (ksi)	Elong. %
Annealed	148	130	14.5

TABLE 4

Average Compressive Yield Strength of Hardened K12®-MIL Plate		
ATI K12®-MIL Material	Direction	Average Compressive .2% Yield Strength (ksi)
Heat Treated	Transverse	234
	Longitudinal	238

One of the primary advantages of ATI K12®-MIL plate compared with ceramic systems is its toughness; i.e., its ability to withstand multiple impacts.

TABLE 5

Impact Data – Notched		
Charpy V-Notch (.009" V-Notch in soft side then struck on hard side)		
ATI K12®-MIL Material	Temperature	Energy (ft•lbs.)
Heat Treated	Room	12, 13

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TABLE 6

Impact Data – UnNotched		
ATI K12®-MIL Material	Temperature	Energy (ft•lbs.)
Heat Treated	Room	154, 154

STRUCTURAL CHARACTERISTICS

ATI K12®-MIL plate is a refined steel that may be used not only for its intended armoring purposes, but also as integral structural components for most but not all applications. It is not brittle like ceramics; therefore, it can withstand multiple strikes within a reasonably small area without failing or disintegrating.

HARDNESS CHARACTERISTICS

The annealed hardness of the hard side is 293 Brinell maximum with the soft side 7 to 60 points less than the hard side. The heat treated hardness of the hard side generally varies between 58 and 64 Rockwell C, while the soft side varies between 48 and 54 Rockwell C. However, the most important material characteristic is its ballistics performances and not its hardness.

MICROSTRUCTURE

Proper heat treatment is crucial in developing the optimum microstructure for good ballistics properties.

FABRICATION

ATI K12®-MIL plate is difficult to machine, flatten or drill after heat treatment. As much as possible, such operations should be performed at least as a roughing operation before heat treatment. Stress risers such as cold-deformed edges, sharp corners, ragged edges, notches, etc., should be removed prior to heat treatment.

Some thicknesses of ATI K12®-MIL plate can be laser cut following heat treatment. However, the heat affected zone should be removed after laser cutting so ballistic performance is not adversely influenced. ATI K12®-MIL plates can be sheared-up to 3/8" thick and can be abrasive cut at all thicknesses. Any remaining stress risers must be removed prior to installation. Such edge conditioning is usually accomplished using abrasive grinding.

Flattening or forming should be done in the annealed condition. Only minimal flattening or forming should be attempted once ATI K12®-MIL plate is heat treated and should be done only by applying pressure on incremental areas.

ATI K12®-MIL plate can be welded, but only with special techniques. Written welding guidelines will be supplied upon request under a non-disclosure agreement.

Exposure of ATI K12®-MIL plate to heat during the fabrication process may adversely affect the ballistic characteristics of the material.

SIZES

ATI K12®-MIL plate is normally supplied in thicknesses ranging from 0.187" to 0.500" with 0.275" being the most common. Other typical thicknesses are 0.220" and 0.370". Thickness tolerance is -0.015"/+0.025". ATI K12®-MIL can be supplied in widths as wide as 60" and lengths as long as 200". Other thicknesses and sizes can be supplied for special applications.

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SPECIAL NOTES

The heat number and “Hard Side” are stenciled on each annealed plate. Hard side identification must be maintained throughout fabrication because the hard side must face the ballistics threat.

CORROSION RESISTANCE

ATI K12®-MIL plate displays slightly better corrosion resistance than plain carbon steel. Where corrosion may be a problem, ATI K12®-MIL plate should be painted or otherwise protected as plain carbon steel would be.

BALLISTIC PERFORMANCE AND APPLICATIONS

ATI K12®-MIL dual hardness armor plate has met the ballistic requirements for numerous government, military and civilian armoring applications. Ballistic tests have been performed on various armor piercing and ball type projectiles of both U.S. and foreign manufacture. ATI K12®-MIL dual hardness armor plate routinely exhibits superior ballistic performance compared with conventional homogeneous armor plate. ATI K12®-MIL armor plate is normally used in automobiles, trucks and aircraft where weight considerations are crucial.

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