Study of superconducting strands damage and mechanical characteristics by different shape of CICC conductors

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Introduction

The China Fusion Engineering Test Reactor is a new tokamak reactor under preliminary design, where the toroid field coil was designed to create over 14.3T magnetic field, and the TF conductors need to operate at 14.3T with 87.6kA and 5.7K with stable performance. For these requirements, the top priority is to limit the conductor performance degradation as much as possible. The maximum Lorentz force will reach to about 1200kN/m, which is much higher than that of ITER conductors. In the previous research, the conductor's performance degradation was found during electromagnetic cycles and WUCD cycles, and a relationship was also found between the conductor's performance degradation and mechanical properties. In this study, the different shape of CICC conductors were test to compare the damage of strands, and establish the relationship between strand indentations and cable shapes.

Cabling

SC strand type	ITER CS	Squared CS	Rectangle CS	ITER TF	Squared TF	Rectangle TF
Strand(Cu)	0.820mm			0.820mm		
Core1	N/A			3x4Cu		
Thick x Width	0.1x15mm			0.1x(12-15)mm		
Coverage	70%			50%		
Thick x Width	0.1x40mm			0.1x40mm		
Overlap	40%			40%		
Central Spiral	10X1			10X1		
Petal Layout	(2SC+1Cu)x3x4x4			(2SC+1Cu)x3x5x5+1Core		
Final cable layout	6 petals around spiral					
1st Stage	25			80		
2nd Stage	45			140		
3rd Stage	80			190		
4th Stage	150			300		
Final Stage	450			420		
CICC outside diameter	32.6mm	33.2X33.2mm	45.2X20.6mm	39.7mm	39.4X39.4mm	53.8X28.9mm
Void Fraction	32.6%	32.9%	32.5%	29%	29.4%	29.4%

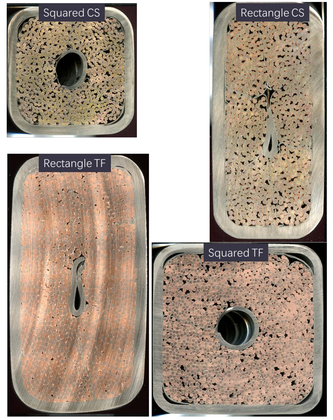
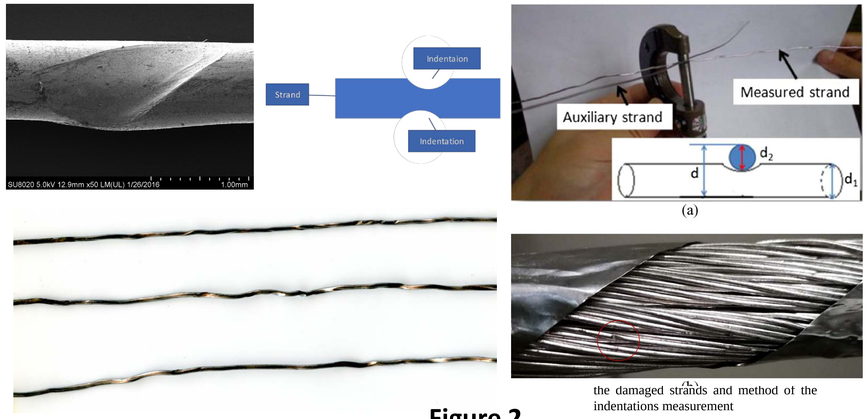


Figure 1

Autopsy of Cable



the damaged strands and method of the indentations measurement

Figure 2

As showed in Figure 3, During the indentations statistic, the squared and rectangle cable were spotted higher indentation than the round cable , but limited the strands movement in the cable. The performance degradation caused by indentations are shown in figure 4 .

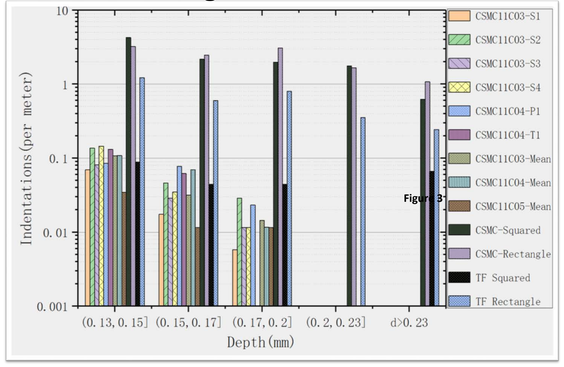
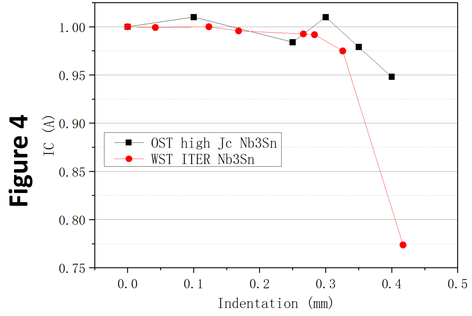


Figure 3



Conclusions

The twist pitch of cable is an important factors to affect the damage of strands

The indentations have a certain allowable margin to absorb the compact between strands with limited performance degradation