材料強度・複合材料工学 Strength of Materials, Composite Materials Engineering

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1980年早稲田大学理工学部機械工学科卒業、1985年早稲田大学大学院理工学研究科機械工学専攻博士課程退学、同大助手、1988年工学博士、早稲田大学理工学部専任講師、1990年早稲田大学理工学部助教授、1992～93年米国スタンフォード大学訪問研究員、1997年早稲田大学理工学部教授、2012 年～同大材料技術研究所研究員

B.S. (1980, Waseda Univ.), M.S. (1982, Waseda Univ.), Research Associate (1985-87, Waseda Univ.), Dr.Eng. (Waseda Univ.), Assistant Professor (1988-89, Waseda Univ.), Associate Professor (1990-96, Waseda Univ.), Professor (1997-present, Waseda Univ.)

本研究室では、高分子基複合材料（PMC）の極限環境下における長期信頼性に関する実験研究を行っている。近年、PMCの大型構造物への適用が急増し、材料代替が省エネルギー対策の一つであると認知され始めている。このような中、実働荷重下における構造物に対して、複合材料の強度に及ぼす繰り返し荷重や時間依存性の影響は極めて重要であり、長期信頼性確保のために不可欠な研究課題となっている。以下にいくつかの最近の研究事例を紹介する。ガラス繊維の基礎物性とそれを強化材とするGFRPに関して、1）酸応力環境下におけるGFRPの長期耐久性評価、2）ガラス繊維強度に関する温度・速度依存性と強度発現機構の解明、3）SFCによる強化繊維 / 樹脂界面の力学的評価、4）階層型CNTハイブリッド複合材料の開発等である。CFRPに関する基礎的研究として、1）疲労負荷による内部損傷（トランスバースクラック）の発達過程の体系的な実験研究、2）宇宙用CFRP構造物の長期形状安定および寸法制御、3）層間強化CFRPの面外疲労特性、4）同時多層巻回法によって成形されたCFRPパイプの力学特性などを行っている。

複合材料の歴史は強化繊維の開発の歴史である。1961年に進藤昭男博士がPAN系炭素繊維を発明したことが、高強度繊維の幕開けとすれば、今年で丁度、半世紀が経過したことになる。複合材料の利用技術の拡大にともない、金属の代替材料のみならず産業界において不可能を可能にする新材料として、将来的に先進複合材料のさらなる進歩が期待されるであろう。

Main subject in our laboratory is an experimental study on the long- term durability of polymer matrix composites under hostile environments. Recently, applications for large structures made of composites materials have rapidly increased to realize an energy-saving measure. Effect of cyclic and time-dependent problems on strengths of the composites structures are most important issues under actual working conditions so as to ensure the reliability of those structures.

Some research topics which are studied in our laboratory are as follows;

For the fundamental mechanical properties of glass fibers and the glass-fiber reinforced plastics; 1) Evaluation of the durability in GFRP laminates under acid-stress environments and the life prediction method, 2) Temperature and strain-rate dependency of the glass fiber strength and its mechanism of the strength, 3) Mechanical evaluation of the interface between reinforcement fiber and matrix using single fiber composites, 4) Development of hierarchical CNT-hybrid composites using CVD method. For the basic studies of carbon-fiber reinforced plastics; 1) Experimental study on the internal damage evolution (transverse cracks) of CFRP laminates under fatigue loading, 2) Dimensional stability and geometrical control of the CFRP components for space structures, 3) Out-of-plane fatigue properties of interlaminar strength-improved CFRP laminates, 4) Fracture mechanism of CFRP tubes by simultaneous multi-ply winding method.

The history of composites is a development history of the reinforcement fiber. The historical event that Dr. Shindo invented the PAN based carbon fiber in 1961 was the opening of the high strength fiber production, so almost half a century would just pass in this year. With an expansion of the usage technology of the composite materials, not only as substitute materials of the metallic ones, but also as new materials for some technical breakthrough to enable impossibility in industry, those advanced composite materials would be expected to progress more in the future.

■代表論文および著書 /Representative publications

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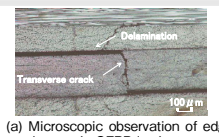
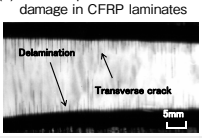


(a) Microscopic observation of edge damage in CFRP laminates



(b) Soft X-ray photography of internal damage in CFRP laminates

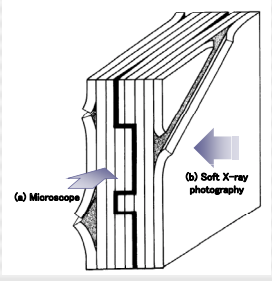


Fig. Schematic illustration of observation methods for damages in CFRP laminates subjected to fatigue loading