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Integrity Methods for Airframe Durability and Damage Tolerance Progress in Advanced Materials and Processes Durability of Composites for Civil Structural Applications Analysis of Durability of Advanced Cementitious Materials for Rigid Pavement Construction in California Advanced Face Gear Surface Durability Evaluations Durability of Concrete Structures Incorporating Conventional and Advanced Materials Advanced Durability and Camage Tolerance Design and Analysis Methods for Composite Structures Progress in Advanced Materials and Processes Durability of Composite Systems Fatigue and Durability of Structural Materials Regeneration and Durability of Advanced Zinc Ferrite Sorbent for Hot Coal Gas Desulfurization Advanced fibre-reinforced polymer (FRP) composites for structural applications NSF Advanced Workshop on Model-based Simulation of Durability of Materials and Structures Durability Performance of Advanced Construction Materials Computational Methods in Advanced Stress and Durability Analysis Advanced Durability Analysis. Volume 1. Analytical Methods Durability of Concrete and Cement Composites Advanced Civil Infrastructure Materials

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Fatigue and Durability of Structural Materials explains how mechanical material behavior relates to the design of structural machine components. The major emphasis is on fatigue and failure behavior using engineering models that have been developed to predict, in advance

of service, acceptable fatigue and other durability-related lifetimes. The book covers broad classes of materials used for high-performance structural applications such as aerospace components, automobiles, and power generation systems. Coverage focuses on metallic materials but also addresses unique capabilities of important nonmetals. The concepts are applied to behavior at room or ambient temperatures; a planned second volume will address behavior at higher-temperatures. The volume is a repository of the most significant contributions by the authors to the art and science of material and structural durability over the past half century. During their careers, including 40 years of direct collaboration, they have developed a host of durability models that are based on sound physical and engineering principles. Yet, the models and interpretation of behavior have a unique simplicity that is appreciated by the practicing engineer as well as the beginning student. In addition to their own pioneering work, the authors also present the work of numerous others who have provided useful results that have moved progress in these fields. This book will be of immense value to practicing mechanical and materials engineers

and designers charged with producing structural components with adequate durability. The coverage is appropriate for a range of technical levels from undergraduate engineering students through material behavior researchers and model developers. It will be of interest to personnel in the automotive and off-highway vehicle manufacturing industry, the aeronautical industry, space propulsion and the power generation/conversion industry, the electric power industry, the machine tool industry, and any industry associated with the design and manufacturing of mechanical equipment subject to cyclic loads. This report provides general information concerning the deleterious reactions that may damage concrete pavements in California. The reactions addressed in this report are sulfate attack, aggregate reactions, corrosion of reinforcing steel, and freeze-thaw action. Specifically, the expected performance of Portland cements and blends, calcium aluminate cements and blends, calcium sulfoaluminate cements, and fly ash-based cements are examined with regard to each of the deleterious reactions listed. Additional consideration is given to any deterioration mechanism that is particular to any of these cement types. Finally, the

recommended test program for assessing potential long-term durability with respect to sulfate attack is described. This report is volume IV of a 5-volume final report on the work conducted under AF contract F33615-84-C-3208. The objectives of this program were to:(1) recommend improvements to the current Air Force durability design requirements(i.e., MIL-A-8866B and MIL-A-87221), (2) develop a probabilistic durability analysis method capable of predicting the durability of advanced metallic aircraft structure for functional impairment such as excessive cracking, fuel leakage and ligament breakage, and (3) update the current Air Force Durability Design Handbook(AFWAL-TR-83-3027). fatigue cracking is the form of degradation considered. This three-phase program consisted of eight tasks. Advanced durability analysis methods were developed and refined under Phase 1. Fatigue test results and fractographic data were acquired and evaluated under Phase 2. Durability, fatigue, equivalent initial flaw size (EIFS), initial fatigue quality (IFQ), time-to-crack initiation (TICI), deterministic and stochastic crack growth. Durability of Composite Systems meets the challenge of defining these precepts and

requirements, from first principles, to applications in a diverse selection of technical fields selected to form a corpus of concepts and methodologies that define the field of durability in composite material systems as a modern discipline. That discipline includes not only the classical rigor of mechanics, physics and chemistry, but also the critical elements of thermodynamics, data analytics, and statistical uncertainty quantification as well as other requirements of the modern subject. This book provides a comprehensive summary of the field, suited to both reference and instructional use. It will be essential reading for academic and industrial researchers, materials scientists and engineers and all those working in the design, analysis and manufacture of composite material systems. Makes essential direct and detailed connections to modern concepts and methodologies, such as machine learning, systems controls, sustainable and resilient systems, and additive manufacturing Provides a careful balance between theory and practice so that presentations of details of methodology and philosophy are always driven by a context of applications and examples Condenses selected information regarding the durability of

composite materials in a wide spectrum of applications in the automotive, wind energy, civil engineering, medical devices, electrical systems, aerospace and nuclear fields In this chapter, we report the findings of experimental investigations conducted on durability of glass fiber-reinforced polymer (GFRP) composites with and without the addition of montmorillonite nanoclay. First, neat and nanoclay-added epoxy systems were characterized to evaluate the extent of clay platelet exfoliation and dispersion of nanoclay. GFRP composite panels were then fabricated with neat/modified epoxy resin and exposed to six different conditions, i.e. hot-dry/wet, cold-dry/wet, ultraviolet radiation and alternate ultraviolet radiation–condensation. Room temperature condition samples were also used for baseline consideration. An improved dispersion of nanoclay and exfoliation of clay platelets were observed in 2wt% of epoxy samples. Weight change, discoloration and significant reduction in properties were observed in all conditioned GFRP samples. However, addition of nanoclay considerably improved the durability of GFRP samples as evident from the mechanical and micrographical results in comparison to neat samples subjected to similar

conditions. Aerospace vehicles are designed to be durable and damage tolerant. Durability is largely an economic life-cycle design consideration whereas damage tolerance directly addresses the structural airworthiness (safety) of the vehicle. However, both durability and damage tolerance design methodologies must address the deleterious effects of changes in material properties and the initiation and growth of microstructural damage that may occur during the service lifetime of the vehicle. Durability and damage tolerance design and certification requirements are addressed for commercial transport aircraft and NASA manned spacecraft systems. The state-of-the-art in advanced design and analysis methods is illustrated by discussing the results of several recently completed NASA technology development programs. These programs include the NASA Advanced Subsonic Technology Program demonstrating technologies for large transport aircraft and the X-33 hypersonic test vehicle demonstrating technologies for a single-stage-to-orbit space launch vehicle.Harris, Charles E. and Starnes, James H., Jr. and Shuart, Mark J.Langley Research CenterAIRCRAFT RELIABILITY; DAMAGE; DESIGN ANALYSIS;

MICROSTRUCTURE; LIFE (DURABILITY); AEROSPACE VEHICLES; CERTIFICATION; COMMERCIAL AIRCRAFT; ECONOMICS; HYPERSONIC VEHICLES; X-33 REUSABLE LAUNCH VEHICLE "A proper optimization of local materials to produce high-performance and high-strength concrete improves the long-term durability. CFRP strengthening and crack injection using epoxy based materials are excellent sources of rehabilitation techniques; however, harsh environmental conditions may cause stiffness loss. New advances in Microwave Technology and Acousto-Ultrasonic Technique were proven to be an effective means for the investigation of detection of surface defects between CFRP and concrete substrate"--Abstract, leaf iv. The effect of temperature on the tension-tension fatigue life of the T300/5208 graphite/epoxy angle-ply laminate system was investigated in an effort to develop an acceptable and reliable method of accelerated loading. Typical S log sub 10 N curves were determined experimentally at 25 C, 75 C, and 115 C. The time-temperature superposition principle was employed to find the shift factors of uniaxial fatigue strength, and a general linear equation of S log sub 10 N for shifting purpose was

established. The combined techniques of cyclic creep measurements and optical microscopy upon fatigue failure allow some assessment of the possible physical basis of S log 10 N curve shifting. Before fatigue, the laminates at all test temperatures and stress levels undergo a unique damage mechanism during fatigue loading. It is concluded that an accelerated loading method is feasible. Shih, H. M. Unspecified Center NASA-CR-166405, NAS 1.26:166405 NAS2-10061...
Fibre-reinforced polymer (FRP) composites are increasingly being used in the field of civil engineering, either for the rehabilitation/retrofitting of existing infrastructures or for the construction of new structural elements. However, such applications are still recent and there are still unresolved questions regarding the long-term durability of FRP reinforcements or structural elements under service conditions, and their behaviour under accidental fire events as well. In this chapter, it is proposed to highlight the basic mechanisms involved in the environmental degradation of FRP composites, with a large emphasis on ageing mechanisms of the polymer matrix and their consequences on the mechanical properties. The last section is specifically devoted to the fire

behaviour of polymer composites and also recalls existing fire-proofing solutions. Most structures are comprised of a number of individual parts or components which have to be connected to form a system with integral load transmission path. The structural adhesive bonding represents one of the most enabling technologies to fabricate most complex structural configurations involving advanced materials (e.g. composites) for load-bearing applications. Quite recently there has been a lot of activity in harnessing nanotechnology (use of nanomaterials) in ameliorating the existing or devising better performing structural adhesives. The 10 chapters by subject matter experts look at the following issues: Surface preparation for structural adhesive joints (SAJ) Use of nanoparticles in enhancing performance of SAJ Optimization of SAJ Durability aspects of SAJ Debonding of SAJ Fracture mechanics of SAJ Failure analysis of SAJ Damage behavior in functionally graded SAJ Impact, shock and vibration characteristics of composites for SAJ Delamination arrest methods in SAJ Structural Integrity and Durability of Advanced Composites: Innovative Modelling Methods and Intelligent Design presents scientific and technological research from

leading composite materials scientists and engineers that showcase the fundamental issues and practical problems that affect the development and exploitation of large composite structures. As predicting precisely where cracks may develop in materials under stress is an age old mystery in the design and building of large-scale engineering structures, the burden of testing to provide "fracture safe design" is imperative. Readers will learn to transfer key ideas from research and development to both the design engineer and end-user of composite materials. This comprehensive text provides the information users need to understand deformation and fracture phenomena resulting from impact, fatigue, creep, and stress corrosion cracking and how these phenomena can affect reliability, life expectancy, and the durability of structures. Presents scientific and technological research from leading composite materials scientists and engineers that showcase fundamental issues and practical problems Provides the information users need to understand deformation and fracture phenomena resulting from impact, fatigue, creep, and stress corrosion cracking Enables readers to transfer key ideas from research and development to both

the design engineer and end-user of composite materials Given the increasing use of fibre-reinforced polymer (FRP) composites in structural civil engineering, there is a vital need for critical information related to the overall durability and performance of these new materials under harsh and changing conditions. Durability of composites for civil and structural applications provides a thorough overview of key aspects of the durability of FRP composites for designers and practising engineers. Part one discusses general aspects of composite durability. Chapters examine mechanisms of degradation such as moisture, aqueous solutions, UV radiation, temperature, fatigue and wear. Part two then discusses ways of using FRP composites, including strengthening and rehabilitating existing structures with FRP composites, and monitoring techniques such as structural health monitoring. Durability of composites for civil and structural applications provides practising engineers, decision makers and students with a useful and fundamental guide to the use of FRP composites within civil and structural engineering. Provides a thorough overview of key aspects of the durability of composites Examines mechanisms of degradation

such as aqueous solutions, moisture, fatigue and wear Discusses ways of using FRP composites, including strengthening and rehabilitating existing structures In this study, we investigate the regeneration characteristics, desulfurization performance after regeneration and the durability of zinc ferrite sorbent in the desulfurization/regeneration cycles. In recent decades, material development in response to a call for more durable infrastructures has led to many exciting advancements. Fiber reinforced composite designs, with very unique properties, are now being explored in many infrastructural applications. Even concrete and steel are being steadily improved to have better properties and durability. Advanced civil infrastructure materials provides an up-to-date review of several emerging construction materials that may have a significant impact on repairs of existing infrastructures and/or new constructions. Each chapter explores the 'materials design concept' which leads to the creation of advanced composites by synergistically combining two or more constituents. Such design methodology is made possible by several key advancements in materials science and mechanics. Each chapter is concluded with selective examples of real world

applications using these advanced materials. This includes relevant structural design guidelines and mechanics to assist readers in comprehending the uses of these advanced materials. The contributors are made up of renowned authors who are recognized for their expertise in their chosen field. Advanced civil infrastructure materials is of value to both graduate and undergraduate students of civil engineering, and will serve as a useful reference guide for researchers and practitioners in the construction industry. A valuable reference for researchers and practitioners in the construction industry Essential reading for graduate and undergraduate students of civil engineering Written by an expert pannel Whilst most structures made using concrete and cement-based composites have not shown signs of premature degradation, there have been notable exceptions. In addition, there is increasing pressure for new structures to remain in serviceable condition for long periods with only minimal maintenance before being recycled. All these factors have highlighted the issues of what affects the durability of these materials in different circumstances and how material properties can be measured and improved.

Durability of concrete and cement composites summarises key research on these important topics. After an introductory chapter, the book reviews the pore structure and chemistry of cement-based materials, providing the foundation for understanding the particular aspects of degradation which are discussed in the following chapters. These include dimensional stability and cracking processes, chemical and microbiological degradation of concrete, corrosion of reinforcing and prestressing steels, deterioration associated with certain aggregates, effects of frost and problems involving fibre-reinforced and polymer-cement composites. With its distinguished international team of contributors, Durability of concrete and cement composites is a standard reference for all those concerned with improving the service life of structures using these materials. Analyses a range of materials such as reinforced steel in concrete, pre-stressed concrete and cement composites Discusses key degradation phenomena such as cracking processes and the impact of cold weather conditions A standard reference for those concerned with improving the service life of structures using concrete and cement based composites Advanced durability

analysis 'design tools' have been developed for metallic aircraft structures. These tools can be used to evaluate durability design requirements for functional impairments due to excessive cracking and fuel leakage/ligament breakage. The methodology accounts for the initial fatigue quality variation of structural details, the crack growth accumulation for a population of structural details under specified design conditions and structural properties. Step-by-step procedures are provided. This volume is limited to the analytical methods, technical aspects, concepts and philosophy for the durability analysis of metallic aircraft structures. The methodology reflects a probabilistic approach, a fracture mechanics philosophy and both deterministic and stochastic crack growth methods. It can be used to predict the probability of crack exceedance at any service time and/or the cumulative distribution of the time-to-crack initiation at any crack size. The methodology applies to the small crack size range associated with excessive cracking (e.g.,

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