

# FORENSIC STRUCTURAL ENGINEERING CASE STUDIES

MARTÍN EDUARDO POLIMENI  
Structural & Forensic Engineer

Professor at the Faculty of Civil Engineering of the University of Buenos Aires

EPPP Consulting

eeppsingenieria@gmail.com

**EPPP Consulting**  
Structural & Forensic Engineering

## FORENSIC STRUCTURAL ENGINEERING – INTRODUCTION

**Forensic Engineering is the application of the art and science of Engineering in the judicial system**, which requires the professional services of legally qualified engineers. May include the investigation of physical causes of accidents and other sources of claims and litigation, preparation of engineering reports, testimony in hearings and trials in administrative or judicial proceedings, and the provision of advisory opinions to assist in the resolution of disputes that affect life or property. *Milton F. Lulich, former General Counsel to the NSPE.*

**The Forensic Engineer is a professional engineer who deals with engineering associated with legal issues.** Activities associated with forensic engineering include determining the physical or technical causes of accidents or failures, preparing reports, and presenting testimonies or advice and opinions that assist in the resolution of related disputes. The Forensic Engineer may also be asked to render an opinion on liability for the accident or failure. *Carper*

## FORENSIC STRUCTURAL ENGINEERING – CASE STUDIES

### Definition of failure:

**When an installation, structure or material does not satisfactorily fulfill the function in the way intended and for which it was created or executed.** Neither partial or total collapse, nor

# Structural Forensic Engineering Case Studies

**AW Chickering**



## **Structural Forensic Engineering Case Studies:**

**Forensic Materials Engineering** Peter Rhys Lewis, Ken Reynolds, Colin Gagg, 2003-09-29 Most books on forensic engineering focus on civil engineering failures rather than consumer or general mechanical products Unique both in scope and style this treatment is built upon case studies of real accidents broadly focused on consumer products and dedicated to problem solving through scientific principles Each well illustrated case stud

**Failure Case Studies** Navid Nastar, Rui Liu (Structural engineer), 2019 This book gives examples of failed civil engineering projects and the lessons learned from the failures The case studies were gathered by ASCE s Forensic Engineering Division Case Studies on Failure Investigations in Structural and Geotechnical Engineering Fabrizio Palmisano, Laurent Rus, 2023-09-14 Failures of structures occur in all parts of the world as the result of design errors construction defects abuse or misuse ageing and deterioration of the structure lack of maintenance as well as environmental effects such as wind flood snow earthquake and of course human errors They can result in catastrophic human costs as well as heavy financial losses to all involved including local economic growth deceleration expensive delays and repairs as well as other repercussions such as legal actions to responsible parties Welcome effects of these unfortunate events include a better understanding of the origins and causes of structural failures their corresponding lessons learnt and a more effective mitigation of their occurrence through changes in codes standards guidelines and practice In several countries the investigation process of the causes of failures responsibilities and resolution of the consequent claims have created an active demanding and specialised field of professional practice often referred to as Forensic Structural Engineering with well defined technical and legal procedures This bulletin is the result of the work lead by the Task Group 5 1 Forensic Structural Engineering It provides understanding of the origins causes and consequences of failures their forensic investigations and the lessons learnt from them The aim of the bulletin is not only to describe different examples but mainly to use emblematic case studies to show procedures that can be used when dealing with structural failures In addition to obtaining a deeper insight into the technical causes for structural failure the reader would be duly informed about the different countries legal issues related to the investigation process The bulletin is aimed at young mid career and experienced structural engineers who want to acquire a better understanding of failure mechanisms towards improving their design inspection construction administrative and other project related practices to avoid pitfalls that may lead to failures It also aims at those wanting to acquire a working knowledge of the challenging professional practice of forensic structural engineering

**Failure Case Studies** AMER. SOC. OF CIVIL ENGINEERS., 2019 This book gives examples of failed civil engineering projects and the lessons learned from the failures The case studies were gathered by ASCE s Forensic Engineering Division Case Studies on Forensic Structural Engineering Chin Seng Nguee, 2006 Forensic Engineering Colin R. Gagg, 2020-02-21 Forensic Engineering The Art and Craft of a Failure Detective synthesizes the current academic knowledge with advances in process and techniques developed in the last several years to

bring forensic materials and engineering analysis into the 21st century The techniques covered in the book are applied to the myriad types of cases the forensic engineer and investigator may face serving as a working manual for practitioners Analytical techniques and practical applied engineering principles are illustrated in such cases as patent and intellectual property disputes building and product failures faulty design air and rail disasters automobile recalls and civil and criminal cases Both private and criminal cases are covered as well as the legal obligation requirements and responsibilities under the law particularly in cases of serious injury or even death Forensic Engineering will appeal to professionals working in failure analysis loss adjustment occupational health and safety as well as professionals working in a legal capacity in cases of produce failure and liability including criminal cases fraud investigation and private consultants in engineering and forensic engineering

**Perspectives in Civil Engineering** Jeffrey S. Russell, 2003-01-01 This report contains 27 papers that serve as a testament to the state of the art of civil engineering at the outset of the 21st century as well as to commemorate the ASCE s Sesquicentennial Written by the leading practitioners educators and researchers of civil engineering each of these peer reviewed papers explores a particular aspect of civil engineering knowledge and practice Each paper explores the development of a particular civil engineering specialty including milestones and future barriers constraints and opportunities The papers celebrate the history heritage and accomplishments of the profession in all facets of practice including construction facilities special structures engineering mechanics surveying and mapping irrigation and water quality forensics computing materials geotechnical engineering hydraulic engineering and transportation engineering While each paper is unique collectively they provide a snapshot of the profession while offering thoughtful predictions of likely developments in the years to come Together the papers illuminate the mounting complexity facing civil engineering stemming from rapid growth in scientific knowledge technological development and human populations especially in the last 50 years An overarching theme is the need for systems level approaches and consideration from undergraduate education through advanced engineering materials processes technologies and design methods and tools These papers speak to the need for civil engineers of all specialties to recognize and embrace the growing interconnectedness of the global infrastructure economy society and the need to work for more sustainable life cycle oriented solutions While embracing the past and the present the papers collected here clearly have an eye on the future needs of ASCE and the civil engineering profession

*Construction Failure* Jacob Feld, Kenneth L. Carper, 1996-12-26 First published in 1968 Jacob Feld s *Construction Failure* has long been considered the classic text on the subject Retaining all of the key components of Feld s comprehensive exploration of the root causes of failure this Second Edition addresses a multitude of important industry developments to bring this landmark work up to date for a new generation of engineers architects and students In addition to detailed coverage of current design tools techniques materials and construction methods *Construction Failure* Second Edition features an entire chapter on the burgeoning area of construction litigation including a thorough examination of alternative dispute resolution

techniques Like the original this edition discusses technical and procedural failures of many different types of structures but is now supplemented with new case studies to illustrate the dynamics of failure in action today Jacob Feld knew thirty years ago that in order to learn from our mistakes we must first acknowledge and understand them With this revised volume Kenneth Carper has ensured that Feld's posthumous message will continue to be heard for years to come Jacob Feld's comprehensive work on failure analysis has now been skillfully amended to address current design and construction tools materials and practices Building on the first edition's peerless examination of the causes and lessons of failure Construction Failure Second Edition provides you with expanded coverage of Technical procedural structural and nonstructural failures Natural hazards earthworks soil and foundation problems and more Reinforced precast and prestressed concrete steel timber masonry and other materials Responsibility and litigation concerns dispute avoidance and alternative dispute resolution techniques Construction safety issues Many different types of structures including dams and bridges Construction Failure has as much to teach us today as it did thirty years ago This revised volume is an essential resource for design engineers architects construction managers lawyers and students in all of these fields *Forensic Engineering* Kenneth L. Carper, 2000-09-28 This edition of *Forensic Engineering* updates the original work with new case studies and investigative techniques Contributors to the book are the foremost authorities in each area of specialization These specialty areas include fire investigation industrial accidents product liability traffic accidents civil engineering and transportation disasters and environmental systems failures Each chapter includes discussions of guidelines techniques methods and tools employed in accident investigation and analysis In addition the book contains vital information on forensic photogrammetry the planning and writing of reports and the presentation of evidence as an expert witness in traditional litigation The book also analyzes the role of the forensic engineer in the evolving methods of alternate dispute resolution Overall *Forensic Engineering* is a tremendously valuable reference for forensic experts practicing in all engineering fields as well as design and construction professionals attorneys product manufacturers and insurance professionals It is also an excellent supplemental text for engineering and law students [Forensic Structural Engineering Handbook](#) Robert Ratay, 2009-11-05 The Most Complete and Up to Date Resource on Forensic Structural Engineering Thoroughly revised and featuring contributions from leading experts this definitive handbook offers comprehensive treatment of forensic structural engineering and expert witness delivery From exploring the possible origins of errors through investigating and analyzing failures to working with the legal profession for assigning responsibilities *Forensic Structural Engineering Handbook* Second Edition covers every important topic in the field The design and construction process Design and construction safety codes standards and regulations Standard of care and duty to perform First steps and legal concerns after a failure Engineering investigation of failures Origins and causes of failures Loads and hazards Design errors construction defects and project miscommunication Defects deterioration and durability Mechanisms and analyses of failures in steel concrete masonry timber and temporary structures

building envelope and structural foundations Litigation and dispute resolution The expert consultant and witness **Case Studies on Failure Investigations in Structural and Geotechnical Engineering** Fabrizio Palmisano, Laurent Rus, 2023-09-20 Failures of structures occur in all parts of the world as the result of design errors construction defects abuse or misuse ageing and deterioration of the structure lack of maintenance as well as environmental effects such as wind flood snow earthquake and of course human errors They can result in catastrophic human costs as well as heavy financial losses to all involved including local economic growth deceleration expensive delays and repairs as well as other repercussions such as legal actions to responsible parties Welcome effects of these unfortunate events include a better understanding of the origins and causes of structural failures their corresponding lessons learnt and a more effective mitigation of their occurrence through changes in codes standards guidelines and practice In several countries the investigation process of the causes of failures responsibilities and resolution of the consequent claims have created an active demanding and specialised field of professional practice often referred to as Forensic Structural Engineering with well defined technical and legal procedures This bulletin is the result of the work lead by the Task Group 5 1 Forensic Structural Engineering It provides understanding of the origins causes and consequences of failures their forensic investigations and the lessons learnt from them The aim of the bulletin is not only to describe different examples but mainly to use emblematic case studies to show procedures that can be used when dealing with structural failures In addition to obtaining a deeper insight into the technical causes for structural failure the reader would be duly informed about the different countries legal issues related to the investigation process The bulletin is aimed at young mid career and experienced structural engineers who want to acquire a better understanding of failure mechanisms towards improving their design inspection construction administrative and other project related practices to avoid pitfalls that may lead to failures It also aims at those wanting to acquire a working knowledge of the challenging professional practice of forensic structural engineering Point of Impact Roger M. Sherman, 2001

**Forensic Engineering** Kevin L. Rens, 1997 This collection contains 44 papers presented at the first Forensic Engineering Congress held in Minneapolis Minnesota October 5 8 1997 *Forensic Engineering*, 2006 *Civil Engineering Practice*, 1997 **Proceedings of the Institution of Civil Engineers**, 2009 **Forensic Engineering** Technical Council on Forensic Engineering (American Society of Civil Engineers), 2000 This collection contains papers presented at the second Forensic Congress held in San Juan Puerto Rico May 21 23 2000 Materials and Product Technologies Zhi Yun Shen, M.N. James, W.D. Li, Y.X. Zhao, 2008-06-12 Selected peer reviewed papers from 2008 International Conference on Advances in Product Development and Reliability August 4 6 2008 Chengdu China PDR 2008 **Forensic Engineering** Paul A. Bosela, Norbert J. Delatte, Kevin L. Rens, 2003 This collection contains 55 papers presented at the third Forensic Congress held in San Diego California October 19 21 2003 **Forensic Geotechnical and Foundation Engineering** Robert W. Day, 1999 Learn how to conduct a professional forensic geotechnical and foundation investigation Clearly written and easy to

use this authoritative book shows you step by step how to INVESTIGATE damage deterioration or collapse in a structure EVALUATE problems caused by settlement expansive soil slope movement moisture intrusion and more INVESTIGATE damage from earthquakes and other natural causes DETERMINE what caused the damage DEVELOP repair recommendations PREPARE files and reports AVOID civil liability No matter what caused the structural damage this book will help you pinpoint it and if necessary suggest a remedy With advice on all aspects of the process from accepting the assignment to testifying compellingly this book is your all in one guide to geotechnical and foundation investigations in forensic engineering

Yeah, reviewing a ebook **Structural Forensic Engineering Case Studies** could add your near friends listings. This is just one of the solutions for you to be successful. As understood, talent does not recommend that you have astonishing points.

Comprehending as without difficulty as pact even more than additional will provide each success. next-door to, the proclamation as capably as insight of this Structural Forensic Engineering Case Studies can be taken as skillfully as picked to act.

[https://matrix.jamesarcher.co/results/browse/index.jsp/Psychological\\_Suspense\\_Practice\\_Workbook.pdf](https://matrix.jamesarcher.co/results/browse/index.jsp/Psychological_Suspense_Practice_Workbook.pdf)

## **Table of Contents Structural Forensic Engineering Case Studies**

1. Understanding the eBook Structural Forensic Engineering Case Studies
  - The Rise of Digital Reading Structural Forensic Engineering Case Studies
  - Advantages of eBooks Over Traditional Books
2. Identifying Structural Forensic Engineering Case Studies
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Structural Forensic Engineering Case Studies
  - User-Friendly Interface
4. Exploring eBook Recommendations from Structural Forensic Engineering Case Studies
  - Personalized Recommendations
  - Structural Forensic Engineering Case Studies User Reviews and Ratings
  - Structural Forensic Engineering Case Studies and Bestseller Lists
5. Accessing Structural Forensic Engineering Case Studies Free and Paid eBooks
  - Structural Forensic Engineering Case Studies Public Domain eBooks

- Structural Forensic Engineering Case Studies eBook Subscription Services
- Structural Forensic Engineering Case Studies Budget-Friendly Options
- 6. Navigating Structural Forensic Engineering Case Studies eBook Formats
  - ePub, PDF, MOBI, and More
  - Structural Forensic Engineering Case Studies Compatibility with Devices
  - Structural Forensic Engineering Case Studies Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Structural Forensic Engineering Case Studies
  - Highlighting and Note-Taking Structural Forensic Engineering Case Studies
  - Interactive Elements Structural Forensic Engineering Case Studies
- 8. Staying Engaged with Structural Forensic Engineering Case Studies
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Structural Forensic Engineering Case Studies
- 9. Balancing eBooks and Physical Books Structural Forensic Engineering Case Studies
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Structural Forensic Engineering Case Studies
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Structural Forensic Engineering Case Studies
  - Setting Reading Goals Structural Forensic Engineering Case Studies
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Structural Forensic Engineering Case Studies
  - Fact-Checking eBook Content of Structural Forensic Engineering Case Studies
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks

### 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

### **Structural Forensic Engineering Case Studies Introduction**

In the digital age, access to information has become easier than ever before. The ability to download Structural Forensic Engineering Case Studies has revolutionized the way we consume written content. Whether you are a student looking for course material, an avid reader searching for your next favorite book, or a professional seeking research papers, the option to download Structural Forensic Engineering Case Studies has opened up a world of possibilities. Downloading Structural Forensic Engineering Case Studies provides numerous advantages over physical copies of books and documents. Firstly, it is incredibly convenient. Gone are the days of carrying around heavy textbooks or bulky folders filled with papers. With the click of a button, you can gain immediate access to valuable resources on any device. This convenience allows for efficient studying, researching, and reading on the go. Moreover, the cost-effective nature of downloading Structural Forensic Engineering Case Studies has democratized knowledge. Traditional books and academic journals can be expensive, making it difficult for individuals with limited financial resources to access information. By offering free PDF downloads, publishers and authors are enabling a wider audience to benefit from their work. This inclusivity promotes equal opportunities for learning and personal growth. There are numerous websites and platforms where individuals can download Structural Forensic Engineering Case Studies. These websites range from academic databases offering research papers and journals to online libraries with an expansive collection of books from various genres. Many authors and publishers also upload their work to specific websites, granting readers access to their content without any charge. These platforms not only provide access to existing literature but also serve as an excellent platform for undiscovered authors to share their work with the world. However, it is essential to be cautious while downloading Structural Forensic Engineering Case Studies. Some websites may offer pirated or illegally obtained copies of copyrighted material. Engaging in such activities not only violates copyright laws but also undermines the efforts of authors, publishers, and researchers. To ensure ethical downloading, it is advisable to utilize reputable websites that prioritize the legal distribution of content. When downloading Structural Forensic Engineering Case Studies, users should also consider the potential security risks associated with online platforms. Malicious actors may exploit vulnerabilities in unprotected websites to distribute malware or steal personal information. To protect themselves, individuals should ensure their devices have reliable antivirus software installed and validate the legitimacy of the websites they are downloading from. In conclusion, the ability to download Structural Forensic Engineering Case Studies has transformed the way we access information. With the convenience, cost-effectiveness, and accessibility it offers, free PDF

downloads have become a popular choice for students, researchers, and book lovers worldwide. However, it is crucial to engage in ethical downloading practices and prioritize personal security when utilizing online platforms. By doing so, individuals can make the most of the vast array of free PDF resources available and embark on a journey of continuous learning and intellectual growth.

### **FAQs About Structural Forensic Engineering Case Studies Books**

How do I know which eBook platform is the best for me? Finding the best eBook platform depends on your reading preferences and device compatibility. Research different platforms, read user reviews, and explore their features before making a choice. Are free eBooks of good quality? Yes, many reputable platforms offer high-quality free eBooks, including classics and public domain works. However, make sure to verify the source to ensure the eBook credibility. Can I read eBooks without an eReader? Absolutely! Most eBook platforms offer web-based readers or mobile apps that allow you to read eBooks on your computer, tablet, or smartphone. How do I avoid digital eye strain while reading eBooks? To prevent digital eye strain, take regular breaks, adjust the font size and background color, and ensure proper lighting while reading eBooks. What the advantage of interactive eBooks? Interactive eBooks incorporate multimedia elements, quizzes, and activities, enhancing the reader engagement and providing a more immersive learning experience. Structural Forensic Engineering Case Studies is one of the best book in our library for free trial. We provide copy of Structural Forensic Engineering Case Studies in digital format, so the resources that you find are reliable. There are also many Ebooks of related with Structural Forensic Engineering Case Studies. Where to download Structural Forensic Engineering Case Studies online for free? Are you looking for Structural Forensic Engineering Case Studies PDF? This is definitely going to save you time and cash in something you should think about.

### **Find Structural Forensic Engineering Case Studies :**

**psychological suspense practice workbook**

gothic fantasy quick start

**self help mindset complete workbook**

**phonics practice guide award winning**

**collection AI in everyday life**

**friendship stories kids hardcover**

**international bestseller trauma healing workbook**

paperback martial arts manual

bullying awareness book reference

**AI usage manual practice workbook**

ultimate guide career planning for teens

investing simplified paperback

gothic fantasy hardcover

electronics repair guide reference

global trend children bedtime story

### **Structural Forensic Engineering Case Studies :**

The Norton Sampler: Short Essays for Composition (Eighth ... A trusted collection of short essays arranged by rhetorical mode—with charming, practical writing instruction. With 71 readings (half new to this edition), ... The Norton Sampler | Thomas Cooley Short, diverse essays that spark students' interest—now with more reading support., The Norton Sampler, Thomas Cooley, 9780393537123. The Norton Sampler: Short Essays for Composition ... A trusted collection of short essays arranged by rhetorical mode—with charming, practical writing instruction. The Norton Sampler: Short Essays for Composition (Eighth ... This new edition shows students thatdescription, narration, and the other patterns of exposition are notjust abstract concepts used in composition classrooms ... The Norton Sampler: Short Essays for Composition (Eighth ... The Norton Sampler: Short Essays for Composition (Eighth Edition) ; ISBN: 0393919463 ; Authors: Cooley, Thomas ; Edition: Eighth ; Publisher: W. W. Norton & Company ... The Norton Sampler: Short Essays for Composition (Eighth ... The Norton Sampler: Short Essays for Composition (Eighth Edition) - satisfaction guaranteed. Give this Used Book by Cooley, Thomas a good home. 8th edition. The Norton Sampler: Short Essays for Composition (Eighth ... The Norton Sampler: Short Essays for Composition (Eighth Edition) - VERY GOOD ; Item Number. 274336187371 ; Brand. Unbranded ; MPN. Does not apply ; Accurate ... The Norton Sampler: Short Essays for Composition A trusted collection of short essays arranged by rhetorical mode—with charming, practical writing instruction. With 71 readings (half new to this edition), ... The Norton Sampler: Short Essays for Composition Eighth ... The Norton Sampler: Short Essays for Composition Eighth Edition , Pre-Owned Paperback 0393919463 9780393919462 Thomas Cooley · How you'll get this item: · About ... The Norton Sampler Short Essays for Composition | Buy Edition: 8th edition ; ISBN-13: 978-0393919462 ; Format: Paperback/softback ; Publisher: WW Norton - College (2/1/2013) ; Dimensions: 5.9 x 7.9 x 1 inches. Building Design | OpenBuildings Designer | BIM Software OpenBuildings Designer, Bentley's all-in-one BIM modeling software, streamlines the work among architects and electrical,

mechanical, and structural engineers. AECOsim Building Designer - Bentley Communities Jul 16, 2013 — AECOsim Building Designer is Bentley's combined BIM Product that includes tools for Architecture, Structural, Mechanical and Electrical ... AECOsim Design, analyze document, and visualize buildings of any size, form, and complexity with AECOsim from Bentley Systems. OpenBuildings Designer is the best BIM Software for ... Jul 16, 2021 — OpenBuildings Designer — formerly AECOsim Buildings Designer — is an interdisciplinary BIM software that includes tools for architectural, ... AECOsim Building Designer Quick Start Guide Choose the Mechanical Building Designer icon from the desktop or the Start menu [Start > All Programs > Bentley > AECOsim Building Designer V8i. (SELECTseries 3)] ... Bentley AECOsim Building Designer ABD/COBie. Schema? Create. BIM. Design. Structural. Interiors. Mechanical. Electrical. Plumbing. Bentley AECOsim Building Designer - TAdviser AECOsim Building Designer is a software package for creation of an information model of buildings and release of a complete packet of the project documentation. International business : environments and operations May 29, 2020 — International business : environments and operations. by: Daniels, John ... DOWNLOAD OPTIONS. No suitable files to display here. IN COLLECTIONS. Does anyone have a PDF or free download for Does anyone have a PDF or free download for International Business: Environments and Operations? Does anyone have a PDF or free download for. International business : environments and operations Dec 11, 2019 — International business : environments and operations. by: Daniels, John D ... Better World Books. DOWNLOAD OPTIONS. No suitable files to display ... International Business Environments and Operations ... by F Edition — Modes of Operations in International Business. 60. Merchandise Exports and ... • PART FOUR: THE GLOBAL MONETARY ENVIRONMENT. 339. 8 Markets for Foreign Exchange. Environments & Operations, Global Edition - Business eBooks are downloaded to your computer and accessible either offline through the Bookshelf (available as a free download), available online and also via the ... International Business Environments & Operations - ppt ... The International Environment. Download ppt "International Business Environments & Operations". Similar presentations ... International Business: Environments and Operations Abstract The article tackles the political and legal environment within the borders of the European Union (EU) member states. Determinants of the political ... International Business: Environments and Operations (11th ... International Business: Environments and Operations (11th Edition) [Daniels, John D., Radebaugh, Lee H., Sullivan, Daniel P.] on Amazon.com. International Business Environments & Operations International business consists of all commercial transactions—including sales, investments, and transportation—that take place between two or more countries ... International Business Environment by PS RAO · Cited by 11 — The concept of global village resulted in exchange of cultures across the globe, location of manufacturing centres in various countries by ...