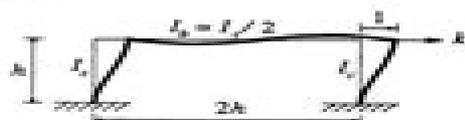


**Problem 1.15**



Define degrees of freedom (DOF):



Form structural stiffness matrix:

$$u_1 = 1, \quad u_2 = u_3 = 0$$



$$k_{11} = 2 \frac{12 EI_c}{h^3} = \frac{24 EI_c}{h^3}$$

$$k_{21} = k_{31} = \frac{6 EI_c}{h^2}$$

$$u_2 = 1, \quad u_1 = u_3 = 0$$



$$k_{22} = \frac{4 EI_c}{h} + \frac{4 EI_b}{(2h)} = \frac{4 EI_c}{h} + \frac{EI_c}{h} = \frac{5 EI_c}{h}$$

$$k_{32} = \frac{2 EI_b}{(2h)} = \frac{EI_c}{2h}$$

$$k_{12} = \frac{6 EI_c}{h^2}$$

$$u_3 = 1, \quad u_1 = u_2 = 0$$



$$k_{33} = \frac{4 EI_c}{h} + \frac{4 EI_b}{(2h)} = \frac{4 EI_c}{h} + \frac{EI_c}{h} = \frac{5 EI_c}{h}$$

$$k_{23} = \frac{2 EI_b}{(2h)} = \frac{EI_c}{2h}$$

$$k_{13} = \frac{6 EI_c}{h^2}$$

Hence

$$k = \frac{EI_c}{h^3} \begin{bmatrix} 24 & 6h & 6h \\ 6h & 5h^2 & \frac{1}{2}h^2 \\ 6h & \frac{1}{2}h^2 & 5h^2 \end{bmatrix}$$

The lateral stiffness  $k$  of the frame can be obtained by static condensation since there is no force acting on DOF 2 and 3:

$$\frac{EI_c}{h^3} \begin{bmatrix} 24 & 6h & 6h \\ 6h & 5h^2 & \frac{1}{2}h^2 \\ 6h & \frac{1}{2}h^2 & 5h^2 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \end{Bmatrix} = \begin{Bmatrix} F_1 \\ 0 \\ 0 \end{Bmatrix}$$

First partition  $k$  as

$$k = \frac{EI_c}{h^3} \begin{bmatrix} 24 & 6h & 6h \\ 6h & 5h^2 & \frac{1}{2}h^2 \\ 6h & \frac{1}{2}h^2 & 5h^2 \end{bmatrix} = \begin{bmatrix} k_{11} & k_{12} \\ k_{12}^T & k_{00} \end{bmatrix}$$

where

$$k_{11} = \frac{EI_c}{h^3} [24]$$

$$k_{12} = \frac{EI_c}{h^3} [6h \quad 6h]$$

$$k_{00} = \frac{EI_c}{h^3} \begin{bmatrix} 5h^2 & \frac{1}{2}h^2 \\ \frac{1}{2}h^2 & 5h^2 \end{bmatrix}$$

Then compute the lateral stiffness  $k$  from

$$k = k_{11} - k_{12} k_{00}^{-1} k_{12}^T$$

Since

$$k_{00}^{-1} = \frac{4h}{99 EI_c} \begin{bmatrix} 5 & -\frac{1}{2} \\ -\frac{1}{2} & 5 \end{bmatrix}$$

we get

# Dynamics Of Structures Chopra Solutions

**J Elliott**



## **Dynamics Of Structures Chopra Solutions :**

**Dynamics of Structures** Anil K. Chopra,2012-02-28 This is the eBook of the printed book and may not include any media website access codes or print supplements that may come packaged with the bound book Designed for senior level and graduate courses in Dynamics of Structures and Earthquake Engineering Dynamics of Structures includes many topics encompassing the theory of structural dynamics and the application of this theory regarding earthquake analysis response and design of structures No prior knowledge of structural dynamics is assumed and the manner of presentation is sufficiently detailed and integrated to make the book suitable for self study by students and professional engineers *Introduction to Dynamics of Structures and Earthquake Engineering* Gian Paolo Cimellaro,Sebastiano Marasco,2018-03-26 This work is an elementary but comprehensive textbook which provides the latest updates in the fields of Earthquake Engineering Dynamics of Structures Seismology and Seismic Design introducing relevant new topics to the fields such as the Neodeterministic method Its main purpose is to illustrate the application of energy methods and the analysis in the frequency domain with the corresponding visualization in the Gauss Argand plan However emphasis is also given to the applications of numerical methods for the solution of the equation of motion and to the ground motion selection to be used in time history analysis of structures As supplementary materials this book provides OPENSIGNAL a rare and unique software for ground motion selection and processing that can be used by professionals to select the correct earthquake records that would run in the nonlinear analysis The book contains clear illustrations and figures to describe the subject in an intuitive way It uses simple language and terminology and the math is limited only to cases where it is essential to understand the physical meaning of the system Therefore it is suitable also for those readers who approach these subjects for the first time and who only have a basic understanding of mathematics linear algebra and static analysis of structures *Advanced Structural Mechanics* David Johnson,2000 This text is addressed to professional engineers offering a broad introduction to the principal themes of continuum mechanics and structural dynamics This edition includes a greater focus on worked examples problems and solutions to engage the reader **Safety, Reliability, Risk and Life-Cycle Performance of Structures and Infrastructures** George Deodatis,Bruce R. Ellingwood,Dan M. Frangopol,2014-02-10 Safety Reliability Risk and Life Cycle Performance of Structures and Infrastructures contains the plenary lectures and papers presented at the 11th International Conference on STRUCTURAL SAFETY AND RELIABILITY ICOSAR2013 New York NY USA 16 20 June 2013 This set of a book of abstracts and searchable full paper USBdevice is must have literature for researchers and practitioners involved with safety reliability risk and life cycle performance of structures and infrastructures *Modern Protective Structures* Theodor Krauthammer,2008-02-01 In today s world reasonably predictable military operations have been replaced by low intensity conflicts less predictable terrorist activities carried out by determined individuals or small groups that possess a wide range of backgrounds and capabilities Because of the threats posed by this evolving type of warfare civil engineers and emergency

personnel face new challenges in designing facilities to protect lives and property and in conducting effective rescue operations and forensic investigations Addressing these needs Modern Protective Structures develops realistic guidelines for the analysis design assessment retrofit and research of protected facilities After introducing a comprehensive risk management approach the author provides a general background on explosive devices and their capabilities as well as explosive effects and the processes that generate them He then discusses the effects of conventional and nuclear explosions The book subsequently considers the significant design differences between conventional and nuclear loads and between existing design procedures and state of the art information from recent research It also summarizes existing blast resistant design approaches and describes the dynamic responses of structural systems to blasts shocks and impacts Additional coverage includes the behavior of specific structural connections the traditional concept of P I diagrams and progressive collapse The book concludes with a systematic and balanced protective design approach Tackling the analytical design assessment and hazard mitigation issues associated with short duration dynamic loads this book examines how impulsive loads affect various types of buildings and facilities It provides the necessary material to help ensure the safety of persons assets and projects

*Extreme Loading of Structures* Tim Huff, 2025-04-24 Extreme Loading of Structures serves as a valuable resource for graduate studies or as a reference for practicing engineers and covers various topics including tornado and tornado generated missiles vehicular collision vessel collision blast ice load earthquake ground motion and more While focusing mainly on extreme loadings analytical procedures through which the effects of extreme loads on structures can be assessed are included as well National design standards and other design specifications are referenced and used throughout the text Features Offers comprehensive coverage on extreme loading scenarios such as tornadoes vehicular and vessel collisions blasts ice loads and earthquake ground motions Provides analytical methods for assessing various load impacts on structures referencing national design standards and specifications throughout Systematically organizes specific types of extreme load into separate chapters with detailed explanations of related design criteria and computational procedures for each

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*Catalogs of Courses* University of California, Berkeley, 1995 Includes general and summer catalogs issued between 1878 1879 and 1995 1997      **Report**, 1985      **Thirty-sixth AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and AIAA/ASME Adaptive Structures Forum**, 1995      *Advances in Analytical, Experimental, and Computational Technologies in Fluids, Structures, Transients, and Natural Hazards* K. Karim-Panahi, 1997 Forty two papers presented at the July 1997 conference discuss recent research in the development and application of advanced

models and computational techniques to aid in the understanding of complex fluids and structures systems and natural hazards Topics include advances in FSI computational te     Ductile Design of Steel Structures, 2nd Edition Michel Bruneau, Chia-Ming Uang, S.E. Rafael Sabelli, 2011-07-14 Comprehensive coverage of the background and design requirements for plastic and seismic design of steel structures Thoroughly revised throughout Ductile Design of Steel Structures Second Edition reflects the latest plastic and seismic design provisions and standards from the American Institute of Steel Construction AISC and the Canadian Standard Association CSA The book covers steel material cross section component and system response for applications in plastic and seismic design and provides practical guidance on how to incorporate these principles into structural design Three new chapters address buckling restrained braced frame design steel plate shear wall design and hysteretic energy dissipating systems and design strategies Eight other chapters have been extensively revised and expanded including a chapter presenting the basic seismic design philosophy to determine seismic loads Self study problems at the end of each chapter help reinforce the concepts presented Written by experts in earthquake resistant design who are active in the development of seismic guidelines this is an invaluable resource for students and professionals involved in earthquake engineering or other areas related to the analysis and design of steel structures

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