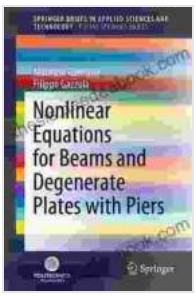
Nonlinear Equations for Beams and Degenerate Plates with Piers: SpringerBriefs in Applied Sciences and Technology

Nonlinear equations are used to describe the behavior of beams and degenerate plates with piers under various loading conditions. These equations are derived from the governing equations of elasticity and take into account the nonlinear material behavior, geometric nonlinearity, and boundary conditions. The solution of these equations is challenging due to their nonlinearity and the complex geometry of the structures.

This brief presents a comprehensive overview of the theoretical and numerical modeling of degenerate plates and beams with piers. The formulation of nonlinear equations, solution methodologies, and applications in civil and mechanical engineering are discussed. The brief is intended for researchers and engineers working in the field of structural mechanics and computational mechanics.



Nonlinear Equations for Beams and Degenerate Plates with Piers (SpringerBriefs in Applied Sciences and Technology) by Liam Quirk

4 out of 5

Language	: English
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Nonlinear Equations for Beams and Degenerate Plates

The governing equations for beams and degenerate plates are derived from the principle of virtual work. The nonlinear equations are obtained by considering the nonlinear material behavior, geometric nonlinearity, and boundary conditions. The nonlinear material behavior is modeled using a constitutive law that relates the stress and strain tensors. The geometric nonlinearity is taken into account by considering the large deformation of the structure. The boundary conditions are imposed on the displacement and rotation fields.

The nonlinear equations for beams and degenerate plates are typically solved using numerical methods. The finite element method is a widely used numerical method for solving these equations. The finite element method discretizes the structure into a finite number of elements and solves the nonlinear equations for each element.

Solution Methodologies

Various solution methodologies can be used to solve the nonlinear equations for beams and degenerate plates. These methodologies include:

* **Newton-Raphson method**: The Newton-Raphson method is an iterative method that solves the nonlinear equations by linearizing them at each iteration. * **Modified Newton-Raphson method**: The modified Newton-Raphson method is a variant of the Newton-Raphson method that uses a modified Jacobian matrix to improve the convergence rate. * **Arc-length method**: The arc-length method is a technique that follows the solution path of the nonlinear equations by controlling the arc length of the solution. * **Continuation method**: The continuation method is a technique that starts

with a simple problem and gradually increases the complexity of the problem until the desired solution is reached.

The choice of solution methodology depends on the specific problem being solved. The Newton-Raphson method is typically used for problems with a smooth solution path. The modified Newton-Raphson method is used for problems with a less smooth solution path. The arc-length method is used for problems with a highly nonlinear solution path. The continuation method is used for problems that are difficult to solve using other methods.

Applications in Civil and Mechanical Engineering

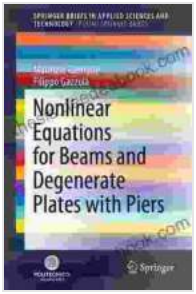
Nonlinear equations for beams and degenerate plates have a wide range of applications in civil and mechanical engineering. These applications include:

* **Analysis of bridges**: Nonlinear equations are used to analyze the behavior of bridges under various loading conditions, such as traffic loads, wind loads, and seismic loads. * **Analysis of buildings**: Nonlinear equations are used to analyze the behavior of buildings under various loading conditions, such as dead loads, live loads, and wind loads. * **Analysis of offshore structures**: Nonlinear equations are used to analyze the behavior of offshore structures under various loading conditions, such as wave loads, wind loads, and ice loads. * **Analysis of aircraft structures**: Nonlinear equations are used to analyze the behavior of aircraft structures under various loading conditions, such as aerodynamic loads, inertial loads, and thermal loads.

Nonlinear equations for beams and degenerate plates are essential for the design and analysis of structures. These equations provide a better

understanding of the structural behavior and help to ensure the safety of structures.

This brief has presented a comprehensive overview of the theoretical and numerical modeling of degenerate plates and beams with piers. The formulation of nonlinear equations, solution methodologies, and applications in civil and mechanical engineering have been discussed. The brief is intended for researchers and engineers working in the field of structural mechanics and computational mechanics.



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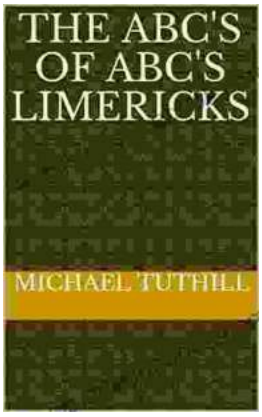

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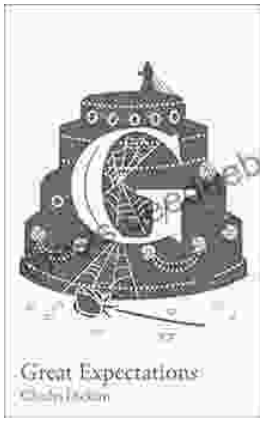

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